

NIATT

ANNUAL REPORT



PREPARED FOR UNIVERSITY TRANSPORTATION CENTERS PROGRAM

RESEARCH AND INNOVATIVE TECHNOLOGY ADMINISTRATION

U.S. DEPARTMENT OF TRANSPORTATION

FUNDING PERIOD JULY 1, 2007 THROUGH JUNE 30, 2008 - FY08

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.

Cover: IDEAWorks Laboratory; at computer, Jessica Rodriguez, undergraduate, mechanical engineering; at printer in rear: Brandon Folk, undergraduate, mechanical engineering, and Dr. Steven Beyerlein, professor, mechanical engineering. (Also see page 25).

An undergraduate mechanical engineering student working in the Small Engine Bay on one of the many hands-on projects students undertake during the academic year. The Small Engine Bay has been developed using University Transportation Centers funding.

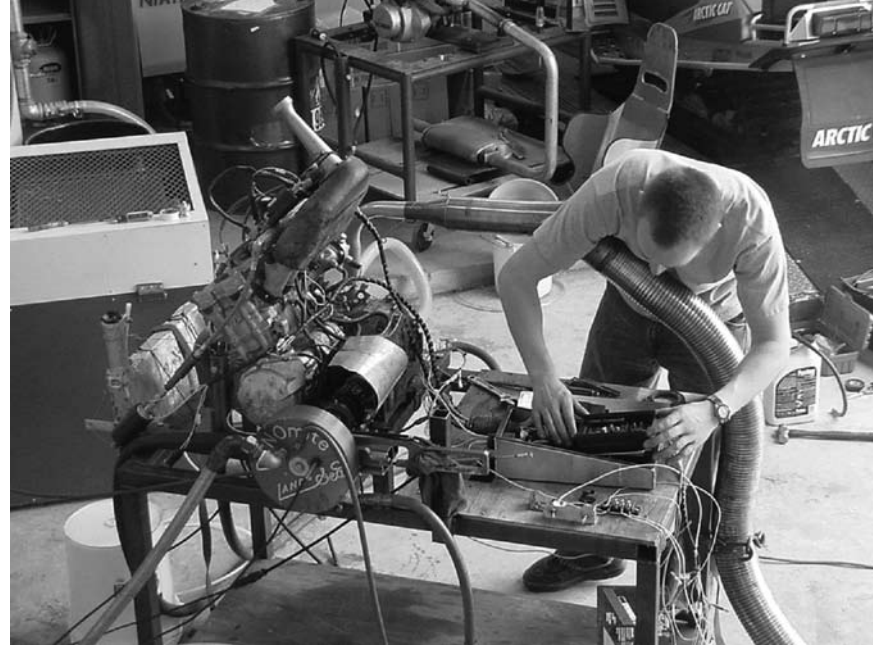


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To access an electronic copy of this report and to read more about the research, education and outreach activities in which our students and faculty are involved, we invite you to visit <http://NIATT.org>

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Michael Kyte, NIATT Director

DIRECTOR'S LETTER

Our *Strategic Plan* was developed over a two-year period and approved by the U.S. Department of Transportation in 2007. While it was a Department of Transportation requirement, our strategic plan means something important to us. It guides how we invest our UTC program funds. It guides how we spend our time and the ideas that we develop and pursue.

In this year's Annual Report, we'll introduce you to some of our faculty and students, and relate the ways in which their accomplishments help us to meet the four objectives of NIATT's *Strategic Plan*.

As I close this letter, I also want to reflect briefly on my tenure as NIATT director. I accepted this position in May 1994, and in May 2009, after 15 years of service, I will be returning full time to my position as Professor of Civil Engineering. I am sincerely grateful for the challenges that I have had to grow both personally and professionally and for the opportunities to work with each of you.

I have heard many wonderful things from you about NIATT over the years. Your stories show that we have had an impact on your lives and the work that you do to improve the nation's transportation system. Joe Marek was my first graduate student at the University of Idaho, completing his master's degree in Civil Engineering in 1988. Today, Joe works as the Traffic Engineer and Development Review Manager for Clackamas County, Oregon. Here's what Joe had to say about NIATT:

"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."

Two things strike me about what Joe says. First, our technical work is important and relevant. Second, the atmosphere that we create is critical for the development of each of us, as people and as engineers. These thoughts capture our primary values. Thank you for being a part of this effort.

Michael Kyte

Michael Kyte, Director

SPECIAL MESSAGES

"I can't thank you enough for the time you and your staff spent last week explaining the UI's clean vehicle research program. Absolutely fascinating! Your work is extremely important and I look forward to supporting it in the future."

Walt Minnick, U.S. Congress, 1st District, Idaho.



During his visit to UI, Walt Minnick learns about some machined parts made for the clean snowmobile from undergraduate snowmobile team member, Alex Fuhrman.

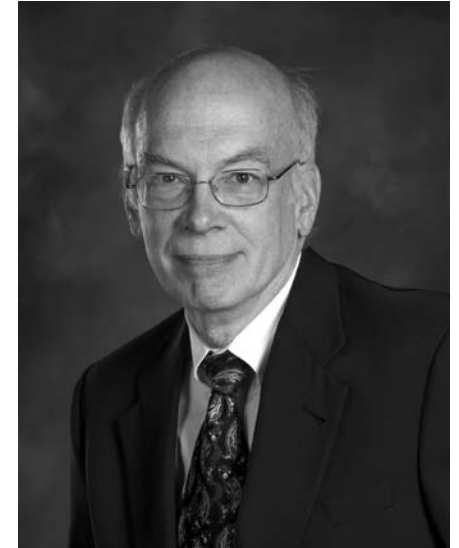


The University of Idaho has focused the past several years in developing and implementing a strategic plan that will ensure a sustainable and productive future for our university. Indeed, we are moving closer to our vision for a vital, vibrant and sustainable University of Idaho, one that can lead effectively in the 21st century. What does success look like? How will we know we're achieving our aspirations through our visioning, consultation and strategic decision making? One of the ways that we measure success is by looking at the students that we graduate and the way in which our programs are viewed nationally by our peers. I congratulate the faculty and students of the University of Idaho's National Institute for Advanced Transportation Technology for focusing on their own strategic plan for the University Transportation Centers program, a plan that supports and enhances the University's plan. We remain proud of NIATT's wonderful and important accomplishments and its contributions to the difficult and vexing problems that we face as a state and a nation.

Steven Daly-Laursen, *President, University of Idaho*

Since I arrived at the University of Idaho in spring 2008, I have been impressed with the vibrancy of interdisciplinary research and programs at the University of Idaho. The university's program of scholarship exists as an integral part of a greater community that holds many opportunities for fruitful collaborations and partnerships. NIATT's success in its approach to interdisciplinary research supports my vision of bringing together the best researchers and students on our campus to work on the critical problems of energy and the environment that are so important to our state and our nation.

Jack McIver, *Vice President, Research, University of Idaho*



In the College of Engineering, we remain busy with the implementation of our Engineering Strategic and Advancement Plans, the graduate and undergraduate recruitment initiatives, and the development of signature areas of research. We are embarking on strategies to consider how best to adapt to the changing world around us. NIATT is a significant part of this effort, in its interdisciplinary approach to critical transportation problems, in how it involves both undergraduate and graduate engineering students in its program, and how its strategic plan supports that of the College of Engineering. I have worked closely with NIATT over the past ten years, as a faculty member, and director of NIATT's Center for Clean Vehicle Technology, as an interim director of NIATT, and now as Dean of Engineering. I know that we will continue to see the quality and excellence in research, education, and technology transfer in transportation for which NIATT is well known.

Don Blacketter, *Dean, College of Engineering, University of Idaho*

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).



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

Michael Kyte
Director, NIATT
Professor, Civil Engineering

Karen Den Braven
Director, Center for Clean Vehicle Technology
Professor, Mechanical Engineering

Judy B. LaLonde
Assistant to the Director, NIATT

Deborah Foster
Financial Technician, NIATT

Victor House
ITS Integration Analyst, NIATT



Advisory Board members Zong Tian (back to camera), Peter Koonce, Bruce Christensen and George List discuss projects proposed by researchers from the Center for Traffic Operations and Control.

NIATT ADVISORY BOARD

NIATT held its annual Advisory Board meeting in April 2008. Members of the Advisory Board heard presentations from NIATT researchers, bringing them up to date on the status of their current research, and explaining their proposals for new funding for the upcoming year. Board members reviewed each research proposal and made recommendations concerning funding for 2008-2009.

Board members also heard from Guillermo Madrigal, NIATT's 2008 Student-of-the-Year, including his experiences as an undergraduate and graduate researcher. Nick Harker, leader of the student Clean Snowmobile Team, talked about the team's experience at the 2008 Clean Snowmobile Challenge and told how the experience has broadened and enhanced his education.

At the close of the Advisory Board meeting, Drs. Edwin Odom and Steven Beyerlein and their graduate students gave the board members a tour of the IDEAWorks lab, a new lab funded in part with UTC program funds (as pictured on the cover) as well as the College of Engineering and engineering alumni.

The University of Idaho's annual Engineering Expo was held on campus the day following the advisory board meeting. A number of board members took part in Expo as judges or took the opportunity to talk with the students about their exhibits and posters.

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

James Colyar
*Highway Research Engineer
Federal Highway Administration*

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 Manager
Yellowstone National Park*

Gerry D. Galinato
*Principal Energy Specialist, Energy Division
Idaho Department of Water Resources*

Peter Koonce
*Associate Engineer
Kittelson & Associates*

Tom LaPointe
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*

Ernie Oakes
*Project Manager, Clean Cities/
National Parks
U.S. Department of Energy: Energy
Efficiency and Renewable Energy*

Paul Olson
*ITS Technology Engineer
Federal Highway Administration*

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*

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

Anthony Davis
Assistant Professor, Range Resources

Karen DenBraven
Professor, Mechanical Engineering

Michael Dixon
Associate Professor, Civil Engineering

Jim Frenzel
Associate Professor, Electrical Engineering

Brian He
*Associate Professor, Biological and
Agricultural Engineering*

Brian Johnson
*Professor, Electrical and Computer
Engineering*

James Kingery
Associate Professor, Range Resources

Axel Krings
Professor, Computer Science

Stanley M. Miller
Professor, Geological Engineering

Richard J. Nielsen
Associate Professor, Civil Engineering

Edwin Odom
Professor, Mechanical Engineering

Paul Oman
Professor, Computer Science

Karl Rink
*Associate Professor, Mechanical
Engineering*

Edwin R. Schmeckpeper
Associate Professor, Civil Engineering

Judi Steciak
*Associate Professor, Mechanical
Engineering*

Jon Van Gerpen
*Chair, Biological and Agricultural
Engineering*

Richard Wall
*Professor, Electrical and Computer
Engineering*

Students have an opportunity to explain their research projects to Advisory Board members and guests at the annual Advisory Board banquet.



STRATEGIC PLAN, STRATEGIC DECISIONS



Dr. Richard Wall (kneeling) with Electrical and Computer Engineering graduate students (left to right) Gabriel DeRuwe, Sanjeev Giri and Dustin Devoe, as they check the Smart Signals connections in a traffic controller in the NIATT lab. (Also see page 12.)

Our strategic plan does not just sit on a shelf; it regularly guides decisions that we make on how to invest our University Transportation Center program funds. It is a touchstone for our staff and faculty as we decide what new projects to pursue, what strategic alliances to form, and what ideas to develop.

We completed our first UTC strategic plan in 1999. That plan successfully guided our work for six years. We revisited that plan as part of a two-year planning process beginning in 2005. This process was informed by more than 30 individual interviews with research faculty and stakeholders and a two-day planning meeting that year that brought together 40 faculty, stakeholders, and external reviewers including the research directors from two state DOTs, two UTC directors, and the UTC program manager from RITA.

In anticipation of the UTC Tier-I competition in 2006, we began developing a new strategic plan. This plan, approved by RITA in 2007, identifies a new focus for our work and our new theme: “Advanced Technology for Sustainable Transportation.” The choice of this theme is based on our past successes as well as our recognition of federal research priorities. This plan also addresses how we will meet the six goals of the UTC program--research selection, research performance, education, human resources, diversity, and technology transfer.

The foundation of our strategic plan is the four objectives listed below.

- **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 3.** Increase the number of faculty and students in our research and education programs to enhance the transportation workforce.
- **Objective 4.** Transfer the results of our research program to practicing professionals in forms that are usable to them to improve the quality and performance of the workforce.

In the following sections of this report, you will read about how the projects that we are funding and the work that we are doing help us to meet each of these objectives.

OBJECTIVE 1:

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

- **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 1.2:** 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
- **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 FHWA's Vehicle Infrastructure Integration initiative

Three research projects now underway in NIATT's Center for Traffic Operations and Control support this objective. The title, investigators, duration, funding, and objectives are listed below for these three projects.

PROJECT	PAGE
KLK711: Traffic and Controller Data Collection System Enhancement, Deployment and Testing	9
Investigators: Dr. Michael Dixon, Dr. Ahmed-Abdel-Rahim and Dr. Richard Wall University Transportation Centers Funding: \$116,530 Duration: August 2007 to January 2009	
Objectives:	
<ul style="list-style-type: none">• Deploy and test new portable 12-camera video collection system• Conduct pilot data collection studies of arterial traffic flow characteristics and publish results and data sets online• Establish on-line access to laboratory for professionals across the U.S.	
KLK712: Improved Simulation of Stop Bar Driver Behavior at Signalized Intersections	10
Investigators: Dr. Ahmed Abdel-Rahim, Dr. Michael Kyte, Dr. Jan-Mou Li and Dr. Michael Dixon University Transportation Centers Funding: \$90,000 Duration: August 2007 to August 2008	
Objectives:	
<ul style="list-style-type: none">• Develop characteristics for stop-line behavior at both the beginning and end of green• Develop algorithms for driver behavior during queue discharge and phase termination periods at the approach to a signalized intersection using field data collected by FHWA's NGSIM project.	
KLK710: Street Deployment of Pedestrian Control Smart Traffic Signals	12
Investigators: Dr. Richard Wall, Dr. James Frenzel, and Dr. Brian Johnson University Transportation Center Funding: \$85,100 Duration: August 2007 to January 2009	
Objectives:	
<ul style="list-style-type: none">• Develop new pedestrian control system using distributed network• Develop technology for low-vision pedestrians	

KLK711: TRAFFIC AND CONTROLLER DATA COLLECTION SYSTEM ENHANCEMENT, DEPLOYMENT AND TESTING

This project is developing and testing performance measurement methodologies that can be used with standard detector configurations and/or detection technologies at isolated actuated signalized intersections. Data extraction and processing techniques being developed by the research team will support the calculation of performance measures, traffic operations diagnostics, and controller parameter adjustments. These performance measurement methodologies will facilitate evaluating, diagnosing, and improving various aspects of intersection operations to improve traffic flow, a vital component of reducing fuel consumption and vehicle emissions.

Simulation software and field video data are being used to test and refine the performance measurement methodologies. Data are being generated using the VISSIM microsimulation model. Field data from FHWA's NGSIM project is also being used. Detector status data are used to generate occupancy percentages and flow rates. Both data sets showed that detector occupancy has its peak for the first portion of green indication and then lowers to minimum values once the standing queue of vehicles has cleared. The research team concludes that it is feasible to use microsimulation to produce realistic detector occupancy data.

Information is the key to monitoring traffic signal operations and intersection performance. The typical data source for this information is vehicle detectors, which usually are limited to occupancy data alone. As a result, the two hypotheses tested in this project were directly related to detector occupancy data:

1. Detector data can be used to reliably predict traffic states.
2. The status of stop bar detector provides sufficient information to build a traffic flow status model.

This project will benefit the public by improving traffic simulation models, resulting in better signal timing and intersection designs and improved operation of the transportation system. In addition, this project will benefit the public and the engineering profession by improving the capacity to extract meaningful signalized intersection performance measures. Such measures will be a valuable input to traveler information services and to traffic operations improvement projects.

A secondary goal of this project is to increase opportunities to engage graduate and undergraduate students in transportation problems by creating on-line access to high quality, easily understood traffic data, which will significantly reduce data collection efforts needed to support thesis and dissertation research.

KLK712: IMPROVED SIMULATION OF STOP BAR DRIVER BEHAVIOR AT SIGNALIZED INTERSECTIONS

The Federal Highway Administration has made a major shift in its role in microscopic simulation modeling of traffic flow, focusing its resources on the development of core driver behavior algorithms and the supporting data sets representing driver behavior in a range of traffic environments.

This program, known as the NGSIM or Next Generation Simulation program, has produced new high-resolution data sets for both freeway and arterial operations. The program has identified a set of priority algorithms for arterial operations that are yet to be developed. These algorithms include starting/stopping behavior and permitted left turns at signalized intersections.

Four UTCs joined together to form a new organization, known as the Region X Transportation Consortium, to meet national transportation research needs. Three University Transportation Centers in the Pacific Northwest (including four universities, Portland State University, Oregon State University, University of Washington, and University of Idaho) have formed a regional simulation collaboration to specifically address the simulation modeling needs of FHWA as well as the individual states in the region.

The first such collaborative project is the University of Idaho's NGSIM project titled "Improved Simulation of Stop Bar Driver Behavior at Signalized Intersections." The project aims to develop new insights on the operation of traffic along arterials, particularly driver behavior at the beginning and end of green. The project uses the NGSIM high-resolution data sets from California and Georgia to develop improved algorithms for the starting and stopping behavior of vehicles at signalized intersections.

Three objectives were established for the project:

1. Develop characteristics for stop line behavior at both the beginning and end of green
2. Develop algorithm(s) for driver behavior during queue discharge and phase termination periods at the approach to a signalized intersection
3. Determine the level of precision that can be accomplished for calibration of simulation models using data bases of various levels of detail

“As an example, the Region X UTC Consortium will be partnering with the NGSIM program this summer to develop driver behavior algorithms for starting and stopping behavior at signalized intersections. The University of Idaho will lead this development project for the Region X UTC Consortium. The UTCs will provide funding for their research, while the NGSIM program will assist in data collection activities, provide a framework and forum for peer review of the research, and assist in outreach and communications with commercial developers and the overall traffic simulation community. The final driver behavior algorithms will be joint UTC-NGSIM products that will be openly available to commercial developers and the overall traffic simulation community with the end goal of improving the quality, trust, and use of traffic simulation models to enable better transportation decision-making.”

-Toni Wilbur, late director of FHWA's Office of Operations R&D on NIATT's work on the NGSIM Program

A white paper is being developed that documents the characteristics of driver behavior models as they relate to stop bar behavior at signalized intersection approaches. It also documents the characteristics of the NGSIM data sets. The paper identifies parameters used in various simulation models and examines how these parameters can be obtained from the NGSIM data set.

The project team will be reviewing its work with its technical oversight committee to seek input in three areas:

1. Are the parameters identified in the white paper thorough and appropriate and are there other parameters that should be included?
2. Are the proposed research questions enough to address the needs of modelers and researchers or should other research questions be included?
3. Is the data smoothing/filtering approach suggested appropriate?

The project directly supports FHWA's objective of developing new algorithms for microscopic simulation in key areas, including the simulation of arterial traffic flow. Results from this research project will be available to commercial developers, researchers, and the overall traffic simulation community, with the end goal of improving the quality, trust, and use of traffic simulation models to enable better transportation decision-making.

PROJECT TEAM

Ahmed Abdel-Rahim (University of Idaho)

Michael Kyte (University of Idaho)

Michael Dixon (University of Idaho)

Jan-Mou Li (University of Idaho)

TECHNICAL OVERSIGHT COMMITTEE

Vassili Alexiadis (Cambridge Systems)

Jaume Barcelo (TSS-Transport Simulation Systems)

James Colyer (FHWA)

John Halkias (FHWA)

Nagui Roupail (North Carolina State University)

Meenakshy Vasudevan (Noblis)

Peter Vortisch (PTV)

Li Zang (Cambridge Systems)

Karl Wunderlich (Noblis)

KLK710: STREET DEPLOYMENT OF PEDESTRIAN CONTROL SMART TRAFFIC SIGNALS

Dr. Richard Wall began his innovative work on “Smart Signals” in the fall of 2005. He 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 [9], far less than is often needed to effectively display signal status to drivers and pedestrians. Smart traffic signal devices can be used to display a wider 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. With Smart Signals, dynamic signaling can communicate information such as system failure modes or symbols for redirecting traffic during special events or emergencies.

Wall’s research focused first on issues of safety for pedestrians. When asked why a transportation project should address pedestrians, besides affirming that pedestrians are legitimate intersection users and that walking is a viable alternative mode of transportation, he cites three statistics:

1. The average cost of a vehicle pedestrian accident is \$312K
2. The fatality rate of pedestrians is 15 times higher per mile than for motor vehicle operators
3. The fatality rate for pedestrians is 150 percent higher per hour than motor vehicle operators

His research then turned to an underserved population of intersection users, safer access for blind or mobility impaired pedestrians. At present, the traffic signal controller cannot detect pedestrian with special needs. With the installation of sensors and network capable microprocessors within the pedestrian signal display equipment or in the vicinity of this equipment, it is possible to communicate useful information such as pedestrian volume, pedestrian types, and vehicle types to the traffic controller. The traffic controller, in turn, could use this information to modify the pedestrian walk phases, and the duration of the traffic signal green phases.

By May of 2006, Wall and his team of graduate and undergraduate students from the University of Idaho’s Electrical and Computer Engineering Department had developed a prototype system to improve existing traffic signal technology in a way that would benefit both pedestrians and traffic engineers. This system allowed for two-way communication between the traffic controller and the components of the control system, simplifying the wiring to each of the system devices, and allowing for confirmation when a pedestrian presses the pedestrian button. A wireless pedestrian button was also developed for use by disabled pedestrians who might have trouble physically accessing the regular button.

INNOVATIONS FROM SMART SIGNALS

- **New network based controls integration with existing NEMA TS2 and 2070 controllers**
- **Uses NTCIP software standard objects, the industry’s standard**
- **Allows finer control and identification of classes of users**
- **Uses safety critical methodologies**
- **Provides a scalable and adaptive approach for traffic controls**

Dr. Richard Wall established a peer review panel whose members work with him specifically on his Smart Signals work. This panel consists of a variety of representatives and stakeholders. The group met in Boise, Idaho, in February 2008 where graduate students Dustin DeVoe and Gabriel DeRuwe gave the peer review team a status report on their research. The members broke into working groups to discuss three challenges: pedestrian users, service providers, and alternative users. The panel encouraged the research team to develop a remote pedestrian button that could give pedestrians with special needs access to the call system without looking for the regular pedestrian button. This will be part of the research in 2008-2009.

Carol Baron, Idaho School for the Deaf and Blind

Gary Duncan, Econolite Traffic Controls

Craig Gardner, Intelight Incorporated

Michael Graham, Idaho Division of Vocational Rehabilitation

Jacque Truax, Idaho Division of Vocational Rehabilitation

Brent Jennings, Idaho Transportation Department

Lance Johnson, Federal Highway Administration

Phil Tate, Campbell Company

Joseph Marek, Clackamas County (Oregon)

Dana Ard, Idaho Commission for the Blind and Visually Impaired
(local chapter of the National Federation of the Blind)

Brian Jain, Idaho Commission for the Blind and Visually Impaired

Bob Koeberlein, Idaho Transportation Department

Terry McAdams, Idaho Transportation Department

The system also includes a countdown timer to aid pedestrians crossing the intersection, a two-way communication bridge between the traffic controller and the signals, and a system monitor to record changes to human observable events generated by the system, i.e., the traffic lights changing. This distributed plug-and-play system demonstrated the advantages of a distributed approach to road traffic signal system such as dynamic signaling and improved operations of pedestrian countdown signals.

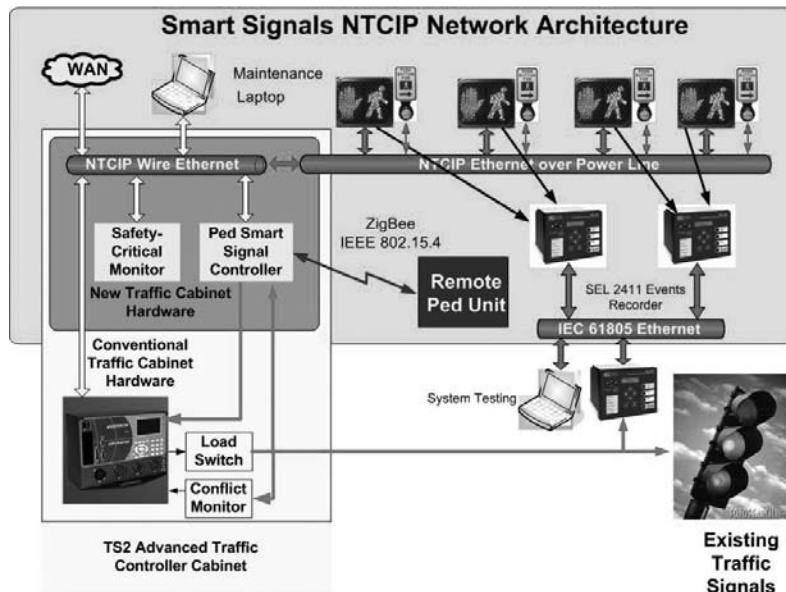
During the 2007-2008 academic year, the project team redesigned several of the original devices to make up for deficiencies identified during the research and to extend the Smart Signals technology. One particular issue that the earlier research did not address was the traffic controller's inability to detect conflicts in vehicle and pedestrian signal states. The design team modified the Smart Signals hardware and software to address this issue. A new network scheduling scheme, utilizing a Malfunction Management Unit Interface Device (MMUID), ensures that all devices now perform in a correct and timely manner.

Current traffic controllers work in a manner similar to very old computers in which users can't connect through a network, but had to physically take punch cards to the computer. In the current controller set-up, when its Malfunction Management Unit (MMU) senses conflicting signals (e.g., green lights for vehicles and pedestrians coming in opposite directions), all lights turn to flashing red. When the controller uses a distributed network like Smart Signals, signals come in from more than one device/user. An interface between those devices (such as a camera or a remote pedestrian button) is needed to identify conflicts and communicate with the MMU. The research team's MMUID, actually a computer chip in the network, either validates the safe (or identifies unsafe) operation and interfaces with the MMU, which in turn, can react to a conflict by identifying a problem with the flashing red light.

The results from this research project address the one issue that is necessary for industry and public acceptance of the Smart Signals concept: a safety critical control environment. The students made a presentation of their work at the annual University of Idaho Engineering Expo in May 2008, displaying their safety critical network capable of detecting conflicts within 450 milliseconds.

In addition to his work on the Smart Signals program, Richard Wall has teamed with his colleague, Electrical and Computer Engineering Professor Jim Frenzel, on several other traffic signal system related projects:

1. Development of an automated controller tester for the Idaho Transportation Department, in collaboration with Dr. Ahmed Abdel-Rahim.
2. Development of a bus locator that shows the real-time positions of Moscow Valley Transit buses so that users are better able to schedule their trips each day.



The Smart Signals system consists of five types of network nodes: the traffic controller, the Smart Signals pedestrian signal, the Smart Signals pedestrian button, the Malfunction Management Unit Interface Device and the traffic controller interface device. In the Smart Signals architecture, a local pedestrian button interfaces a Smart Pedestrian Node using a wire or wireless type communications. A remote pedestrian button currently interfaces with the pedestrian node using a wireless IEEE compliant communications modem. A remotely operated pedestrian button has access and safety benefits for vision and mobility impaired pedestrians.

HIGHER EDUCATION RESEARCH COUNCIL GRANT APPROVED

The Smart Signals research being conducted by Richard Wall, James Frenzel and their students aligns with the goals of the State of Idaho's Towards Zero Death safety initiative, which includes "Protection of Vulnerable Users" as an area of emphasis. It also dovetails with Federal Highway Administration programs such as the Vehicle Infrastructure (VII) initiative, the Cooperative Intersection Collision Avoidance System (CICAS), as well as the Intelligent Transportation Systems Program. The significance of their work was recognized by the Idaho Board of Education, which made a grant of \$75,000 to the researchers to continue their work.

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

- **Strategy 2.1:** Advance state-of-the-art in transit, recreational, and hybrid vehicle design
- **Strategy 2.2:** Significantly expand vehicle research infrastructure and capabilities
- **Strategy 2.3:** Develop new biofuels production methods and techniques for reducing biofuels emissions
- **Strategy 2.4:** Develop new automotive and energy storage sub-systems and components for cleaner, safer, and lighter vehicles

Four research projects now underway in NIATT's Center for Clean Vehicle Technology support this objective. The title, investigators, duration, funding, and objectives are listed below for these four projects.

PROJECT	PAGE
KLK751: Development of an Ethanol Fueled, Two-Stroke, Direct-Injection Snowmobile for Use in the Clean Snowmobile Challenge and National Parks.....	16
Investigator: Dr. Karen Den Braven University Transportation Centers funding: \$64,061 Objectives: <ul style="list-style-type: none"> • Developing an advanced ethanol-powered recreational vehicle, the UI Clean Snowmobile • Fostering the development of student teamwork skills 	
KLK752: Compression Ratio and Catalyst Aging Effects on Aqueous Ethanol Ignition.....	18
Investigators: Dr. Judith Steciak and Dr. Steven Beyerlein University Transportation Centers Funding: \$108,358 Objectives: <ul style="list-style-type: none"> • Maintaining and expanding laboratories dedicated to combustion studies and small engine testing developed over the past ten years through NIATT UTC projects 	
KLK750: Thermal Processing of Low-Grade Glycerol to Alcohols for Biodiesel Production	20
Investigator: Dr. Brian He University Transportation Centers Funding: \$78,092 Objectives: <ul style="list-style-type: none"> • Conduct experimental research on converting the low-grade glycerol derived from biodiesel production to short-chain primary alcohols of methanol, ethanol, and/or propanols, or their mix, and applying back to the biodiesel production process. 	
KLK421: Biodiesel Demonstration Plant, Phases I and II	22
Investigators: Dr. Jon Van Gerpen University Transportation Centers Funding: \$68,818 Objectives: <ul style="list-style-type: none"> • Develop a biodiesel demonstration plan to duplicate commercial practices and to assist with process development and research on new feedstocks • Develop techniques for biodiesel production using ethanol to produce biodiesel that is totally bio-based rather than the normal fossil-based methanol method.. 	

KLK751

DEVELOPMENT OF AN ETHANOL FUELED, TWO-STROKE, DIRECT-INJECTION SNOWMOBILE FOR USE IN THE CLEAN SNOWMOBILE CHALLENGE AND NATIONAL PARKS

The University of Idaho Clean Snowmobile team has made significant technological advances in the last eight years in engine technology, fuel economy and noise emissions of engines used in snowmobiles. The goal of teams competing in the Society of Automotive Engineers Clean Snowmobile Challenge (CSC) is to re-engineer existing snowmobiles to reduce pollution and noise emissions while maintaining the performance characteristics that the market demands. Most recently, the UI Clean Snowmobile Team has designed and fabricated direct-injected two-stroke engine technology that now is reaching the marketplace. Its two-stroke engine technology doubles snowmobile fuel economy and reduces pollution produced by 80-85 percent.

This break-through technology won the CSC in 2007, and achieved overall second place in 2008. The snowmobile team has been successful in other earlier efforts. In addition to its win last year, the team won the competition in 2002 and 2003 with a four-stroke powered snowmobile.

This year, the University of Idaho team concentrated on utilizing an ethanol blend fuel E85 and improving the combustion chamber to reduce exhaust emissions and improve fuel efficiency. The team used vibration absorbing materials on the chassis and the hood to reduce mechanical noise emission, while exhaust noise was diminished with use of a non-standard exhaust silencer. Their efforts earned the Best Acceleration, Quietest Snowmobile, and Cold Start awards. In addition to second place in the internal combustion engine class and awards recognizing its engineering accomplishments, the University of Idaho's CSC team also won the award for the Best Oral Presentation and received the Kreider Award for best internal combustion written paper at this year's competition.



The Clean Snowmobile Team receives the National Park Award for Second Place in the 2008 CS Competition, held here by team captain Nick Harker. To the left of the team is Jay Meldrum, Director of Michigan Tech's Keweenaw Research Center and lead organizer of the Clean Snowmobile Competition. On the right side of the team is Yellowstone National Park's Environmental Manager and NIATT Advisory Board member, Jim Evanoff.

Gene Merrell, associate vice-president for technology transfer, sent us the following comment after a presentation by the Clean Snowmobile Team to UI President Tim White and his Cabinet.

“The two presenters were very energetic, and enthusiastic about the project and how it contributes to the students learning experience. They spoke to the mentoring of the younger students by the more advanced students, the continuous learning from year-to-year, the benefits to recruiting students to the UI and providing employment opportunities for our graduates. Credit was given to team members, the team’s sponsors and companies that provided proprietary information regarding how they approach some of the team’s challenges. The President’s Cabinet was fully engaged by the presenters.”

After the same presentation, UI Provost Doug Baker noted:

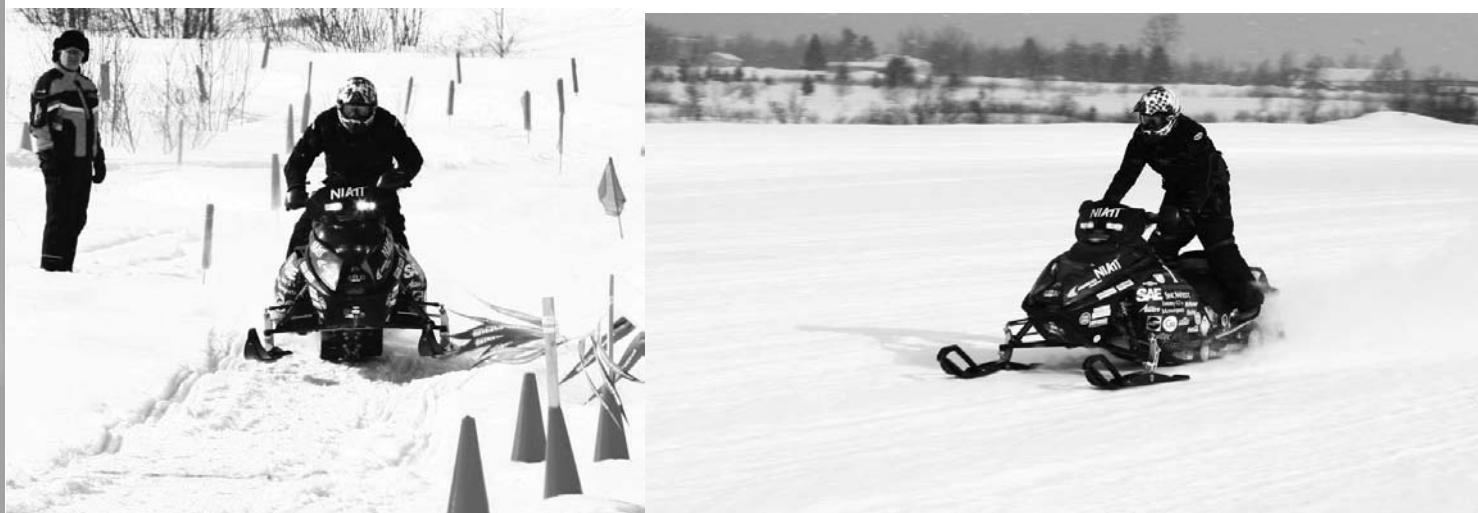
“They did a great job as always. They presented the process, engineering, and collaborations as they went through. It was clear they had learned a lot and that there was a strong tie among students, faculty, and industry. I think President White would like to use some of their material at the State Board of Education tomorrow and show them off.”

With the Winter Use regulations in place for snowmobile use at Yellowstone and other national parks, the federal government is very interested in the CSC. They want to know how clean and quiet it is possible to make a snowmobile, how well snowmobiles can perform and what these improvements would cost. The Clean Snowmobile Challenge is a major force for generating interest in technical solutions to an important environmental problem.

As team advisor Karen Den Braven explains, “Our snowmobile meets Yellowstone Best Available Technology (BAT) noise emissions standards and is very close to meeting their pollution emissions standards with a two-stroke engine. This is quite a feat, as all of the current BAT snowmobiles use four-stroke engines.”

The Society of Automotive Engineers and member industries are particularly interested in growing student interest in the automotive and small-engine field. At the competition, engine and vehicle manufacturers get the opportunity to talk to and evaluate soon-to-be engineers who are looking for employment. A high number of the Clean Snowmobile Team members have received summer internships and then permanent jobs after graduation with the industries with whom they made contact during the competition.

Even for those without an interest in snowmobiles, the engineering advancements of the University of Idaho team may soon be seen in other products such as chainsaws, lawn mowers and outboard motors, all of which currently use four-stroke or dirty two-stroke engines. If a two-stroke engine is as clean and efficient as a four-stroke, the two-stroke has an advantage because of its lighter weight.



NIATT’s clean snowmobile in the handling (left) and acceleration (right) portions of the 2008 competition.

KLK752: COMPRESSION RATIO AND CATALYST AGING EFFECTS ON AQUEOUS ETHANOL IGNITION

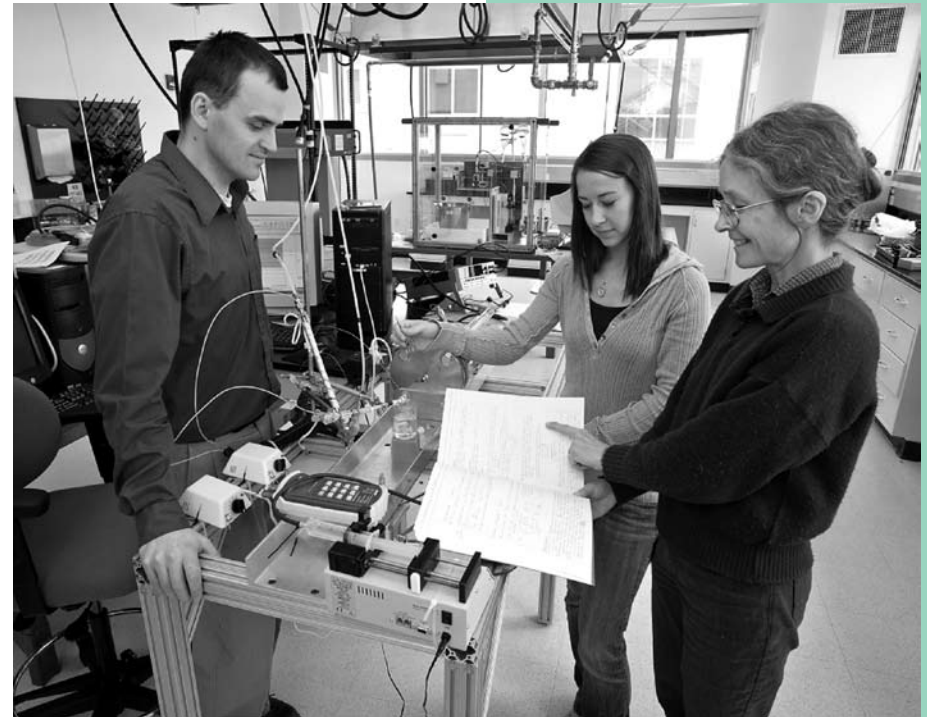
This project seeks to advance catalytic plasma torch (CPT) technology through coordinated reactor studies, engine design, modeling and engine testing activities. CPT technology permits the combustion of very fuel lean mixtures in internal combustion engines used for transportation. With our industry partner ARI, we have fueled engines with blends of 65 percent ethanol/35 percent water. In high compression engines, cooling due to the excess water inhibits the formation of thermal NO_x, while steam reforming and expansion boost power to levels expected with conventional fuel.

An evaporator for low-density liquids including ethanol and water was developed, tested, and installed in the new combustion laboratory located in the UI's Boise Water Center. Experiments are underway to measure the temperature of a heated platinum wire exposed to propane, oxygen, and water vapor for comparison with our prior research and one-step global model of catalytic ignition of propane and oxygen on platinum. We will include ethanol-water blends in upcoming experiments.

In the future, project team members intend to enclose the reactor to measure the conversion efficiency of fuel to combustion products. These experiments require a water cooled nitrogen quenching probe, which was designed and built as part of the project.

The student team, under the direction of Dr. Judi Steciak, used a coiled catalytic wire to ignite very lean homogeneous air-fuel mixtures in a plug-flow reactor, specifically studying the detailed behavior of catalysts exposed to ordinarily non-flammable mixtures.

Progress in modeling was significant: The research team used a finite element modeling program to determine the average temperature of a coiled platinum wire catalyst with internal energy generation subjected to a cross-flow. The results were compared to experimental data found by heating the platinum wire catalyst with a constant electric current. The calculated average wire temperature was in good agreement with experimentally obtained values with deviations close to experimental uncertainty bounds at temperatures between 530K and 815K.



Graduate students Josh Gibson and Katie Leichter confer with Dr. Steciak in the combustion lab.

Model results were consistently about 26K higher than the experimental data across the entire temperature range and did not show an increased deviation at low temperatures. This suggests that including the temperature variation of properties improved the model's agreement with physical phenomena but that a consistent temperature offset remains. However, both the preliminary and detailed model results remain within the experimental uncertainty, which justifies a more accurate and precise power supply and volt meter rather than additional focus on modeling. These instruments have been purchased and are now in use.

The model predicted a temperature variation along each coil, with the lowest temperatures along the leading edges of the coil and the higher temperatures at the trailing edges. The variation is important to understand because of the sensitivity of surface reaction kinetics to temperature.

The rate of heat generated at the wire surface from catalytic reactions was found for the ignition of lean propane/oxygen/nitrogen mixtures. The heat generation rate and ignition temperature are important data for the development of practical igniters that achieve near-HCCI conditions in internal combustion engines.

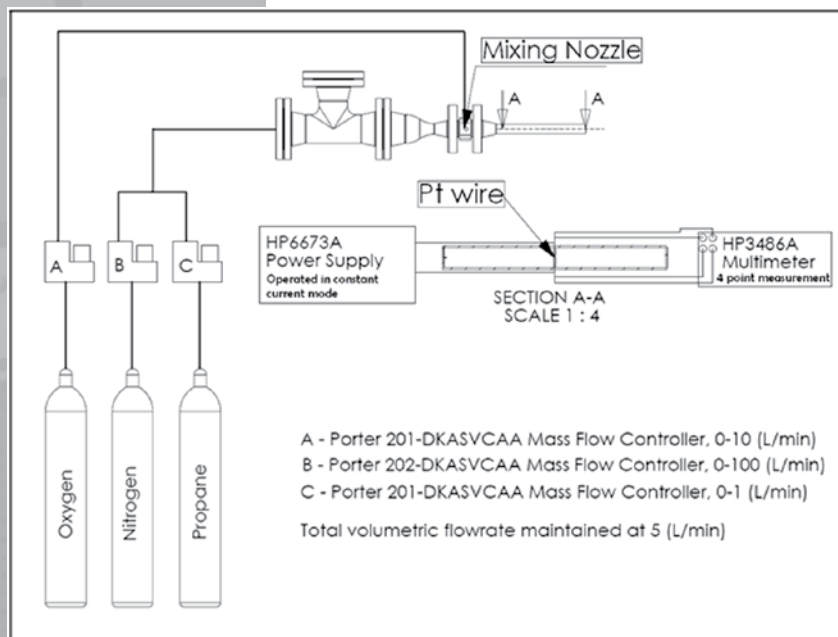


Illustration of the experimental setup of the plug-flow reactor used to determine ignition temperatures of non-flammable propane/oxygen/nitrogen mixtures over a coiled platinum wire catalyst.

KLK750: THERMAL PROCESSING OF LOW-GRADE GLYCEROL TO ALCOHOLS FOR BIODIESEL PRODUCTION

Glycerol (also called glycerin or glycerine) is a colorless, odorless liquid. Pure glycerol is widely used in foods and beverages (as a filler or thickening agent) and in medical, pharmaceutical and personal care preparations for lubrication. Glycerol is also used in the production of nitroglycerin and is a common solvent for reagents stored at temperatures below zero degrees.

Until recently, synthetic glycerol was manufactured on an industrial scale. However, since crude glycerol is a by-product of biodiesel, which is in heavier demand than ever before, it is more widely available. With every 100 pounds of biodiesel produced by the transesterification of vegetable oils, 10 pounds of crude glycerol are generated. Currently, more than 350,000 tons of glycerol per year are produced in the U.S. alone, creating an excess of glycerol on the market. As pressure increases to use biodiesel as an alternative to fossil fuels, the surplus of glycerol will only increase.

While once considered a desirable co-product, glycerol now represents a waste stream with a cost for its disposal a rising concern. Across the world, scientist and engineers are searching for other uses of glycerol, such as manufacturing value-added chemicals, to avoid the added expense, as well as potential harm to the environment.

Dr. Brian He and his research team believe that glycerol can be converted to alcohol and “recycled” back into the production of biodiesel. A thorough literature review on current studies in converting low-grade glycerol to value-added products reveal no existing research on the thermal conversion of glycerol to primary alcohols. Chemically, low-grade glycerol can be converted to short-chain primary alcohols of methanol, ethanol, and or propanols or their mix. He completed a feasibility study in 2006 in which he concluded that a hydro-thermal conversion of glycerol to alcohols seemed feasible.

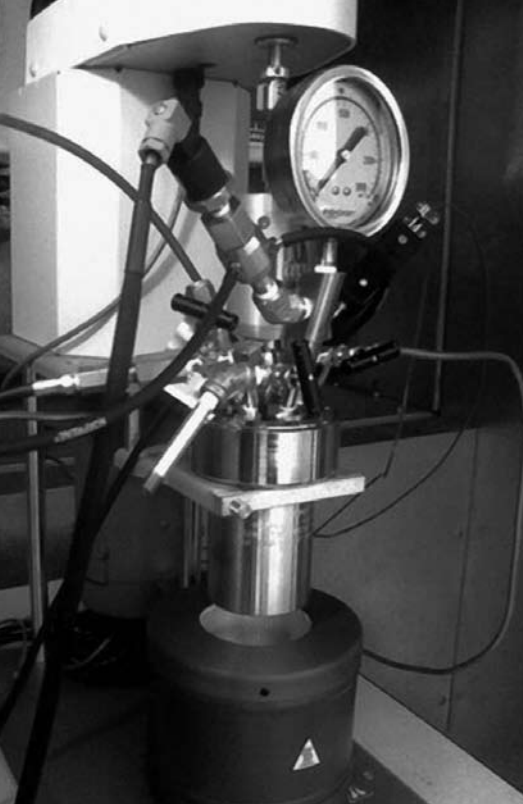
The results of this research (NIATT Report 06-19) were less than satisfactory: product yield was low; the reactions lacked consistency; the efficiency of the process itself needs improvement. Dr. He concluded that precise testing procedures needed to be designed and that better temperature control and a more powerful heating mechanism would be needed as well as the identification of an effective catalyst.

Therefore, the first task in this year's research was to develop and test a reactor system capable of conducting high temperature, high pressure chemical reactions of hydro-thermal conversion. A commercially available laboratory reactor was purchased for the Biofuels Research Laboratory. The reactor's features include precise temperature and pressure controls, adequate agitation with control. Liquid and gaseous sampling mechanisms, and a product condensation/removal device.

During the preliminary test of the reactor, Dr. He discovered that a long temperature lag time might be encountered during the thermal conversion of glycerol and could affect the results. Thus, a pump-type feed inlet system was designed and installed in the reactor.



Graduate student Randy Maglinao sets the reactor's temperature during an experiment.



As a safety measure, the reactor was installed in a metal-framed chamber with exhaust, carbon monoxide warning devices and gas and cooling pipe lines was assembled. The controller was set up outside. Modifications were made to streamline customized feeding, sampling and temperature/pressure controls. A preliminary run using water conducted to look for any problems such as gas leaks revealed no immediate problems.

Next, Dr. He and his graduate student Randy Magliano developed analytical procedures to analyze samples and to detect and analyze unknown substances in the glycerol besides the targeted alcohols. The glycerol they use is a by-product of the biodiesel production at the University of Idaho, which is used to fuel several UI vehicles (such as the BioBug and the Vandal Trolley) as well as some farm implements.

While there are established standard analytical procedures to determine the presence of alcohols such as methanol, ethanol and propanols, in glycerol, no standard procedures have existed for determining the amount of each component in the mixture. An essential task in this project was to develop a quantitative analytical procedure for determining the amounts of these compounds.

A procedure for detecting glycerol using a reversed phase High-Performance Liquid Chromatograph (HPLC) was established and calibrated. The HPLC uses the same principle as gas chromatography, but it separates and detects compounds in their liquid form. Instead of a carrier gas, a liquid solution was used to push the sample through the column at 45°C. The amount of glycerol was detected by an Evaporative Light Scattering Device. While developing this method, researchers recognized that because of the age of the column, there was some bleeding. In order to have full confidence on the analytic results of the project, a new HPLC column was purchased.

A procedure for using a Gas Chromatograph with a Flame Ionization detector was developed and used in the simultaneous analysis of methanol, ethanol, propanols and residual glycerol in a mixture. A new gas chromatograph column was purchased to be used in the analysis. Small, diluted samples were injected into the gas chromatograph and vaporized as the inlet port was heated to 250°C. Dilution was necessary to prevent overloading of the gas chromatograph. Helium was used as the carrier gas. The peak of ionization of each compound was recorded in a computer and the amount of each compound in the sample was calculated from the corresponding peak areas.

Valid analytical methods are the key to obtaining reliable information. Therefore, in the summer of 2008, He and Magliano will conduct a preliminary screening on the parameters affecting glycerol conversion process. Furthermore, they will review the analytical procedures to improve the analysis if unexpected substances are formed during the reaction. The testing procedures will also be fine-tuned in order to assure repeatability and sensitivity.

At the completion of this stage of the research, He will have documented the following:

1. A reactor operating procedure to be used for safe operation of the system
2. A standardized procedure for product analysis and data processing
3. A summary on key process parameters and an analysis on their relative importance

The use of UTC funds have enabled the researchers to investigate waste glycerol utilization thus contributing to the healthy growth of the biofuel industry, and to enhance the overall research capability at the Biofuels Research laboratory at the University of Idaho.

The experimental part of this research is planned for 2008-2009.

alcohol recovery system and are simply wasting 50 percent of the alcohol added to the reaction by sending it to the local sewage treatment plant. In some cases, to reduce the amount of waste, they are reducing the amount of alcohol added to the reaction, which tends to lower the quality of their final product.

Part of the research involves developing techniques for biodiesel production using ethanol that is totally bio-based, as opposed to most existing producers that use fossil-based methanol. Researchers at the University of Idaho have considerable laboratory-based experience using ethanol to produce biodiesel. Because of the higher cost of ethanol, the biodiesel industry has not embraced ethanol-based biodiesel production. However, high natural gas prices have raised the price of methanol, and oversupply has lowered the cost of ethanol to the point where it is comparably priced to methanol. There is now renewed interest in using ethanol to produce biodiesel and there is a need to demonstrate the technology at the pilot plant scale.

Our ability to demonstrate the use of ethanol in biodiesel production provides us with a unique capability in the U.S. and provides the opportunity to have a significant impact on the profitability of the industry. The stripper and distillation column that were fabricated for this project can be used for both ethanol and methanol.

OBJECTIVE 3:

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

- **Strategy 3.1:** Expand community of faculty regularly interacting on transportation problems
- **Strategy 3.2:** Increase opportunities to engage undergraduates in transportation problems
- **Strategy 3.3:** Increase opportunities to engage graduate students in transportation problems
- **Strategy 3.4:** Develop new ways for sustaining technical and organizational knowledge using research groups and student teams

Four activities illustrate how we are meeting this objective:

New Transportation Faculty Hired

One of NIATT's new initiatives is to support the University of Idaho's Building Sustainable Communities program. This program, one of three new Blue Ribbon initiatives funded through the Offices of the President and Provost in 2006, includes three components: a new degree program in Bioregional Planning and Community Design, a Learning and Practice Collaborative that engages University of Idaho faculty and students to assist communities with sustainable community planning and development, and a Center for Effective Planning and Governance that delivers non-credit training to local elected leaders and professionals to plan and manage community resources for a sustainable future.

NIATT worked with the College of Engineering and the Department of Civil Engineering to identify and hire a new transportation engineering faculty member that would support the Building Sustainable Communities program. Dr. Mike Lowry, now the fourth transportation faculty member in the Department of Civil Engineering, will begin work at the University of Idaho in January 2009.

Expanding Student Interest with a Multidisciplinary Approach

At most universities, transportation engineering activities are located within the department of civil engineering. However, bringing other engineering disciplines together to work on transportation problems is critical. NIATT has successfully reached out to other departments in the College of Engineering, including Electrical and Computer Engineering, Mechanical Engineering, Biological and Agricultural Systems Engineering, and Computer Science to bring a multidisciplinary approach to transportation solutions.

One such effort is the collaboration of Electrical and Computer Engineering faculty Richard Wall and Jim Frenzel with Civil Engineering faculty Ahmed Abdel-Rahim and Mike Dixon. Wall and Frenzel have developed a regular stream of electrical engineering students to work on traffic signal systems research and design projects. Currently a team of ten undergraduate and graduate students are working on the Smart Signals project described on page 12 of this report. All together, this collaboration has produced three master's theses on traffic signal issues. And, one former student, Dustin Devoe, now works with Econolite Traffic Control Products in Anaheim, California, continuing the work that he started with NIATT's research teams.

NIATT Internships Awarded to Undergraduates

Seventeen undergraduate students applied for and received internships in the 2007-2008 academic year to work with research teams on real problems: seven seniors, six juniors and four sophomores. Students worked on a variety of projects including the clean snowmobile, the fabrication of equipment for hybrid power-train testing, advanced microcontrollers, graph theory, and traffic controllers.

In their applications, students write of various reasons for seeking internships. Seniors who had previous internships wrote about finding the experience “beneficial” and providing the opportunity to “learn new material in a different way.” Many see internships as ways to get “practical experience” or “strengthen [their] overall educational experience.”

Two of the undergraduate interns, Uriah Jones and Ashley Hobbes, received the \$1000 Coral Sales/Douglas P. Daniels Scholarships as outstanding individuals who plan to pursue careers in highway/transportation engineering and showed outstanding leadership qualities and participation in extracurricular activities.

The IDEAWorks Lab Supports Design Projects while Building Institutional Knowledge

At the 2008 Detroit Auto Show, three out of four new automobile designs were created using Dassault System’s CATIA, a high-powered computer aided design (CAD) tool used by industry leaders and applied to such innovative projects as the Boeing 787 Dreamliner. CAD tools such as CATIA, as well as other powerful design analysis and simulation software (ABAQUS, FLOMERICS, and DELMIA), enable engineers to work collaboratively in the global workplace while realizing their creative potential. For many organizations, especially universities, knowledge management surrounding state-of-the-art design tools is accentuated by a large annual turnover of those who participate in research and development.

The Department of Mechanical Engineering and the National Institute for Advanced Transportation Technology at the University of Idaho have shown their commitment to maintaining a first-rate studio environment for learning and applying advanced computational design tools. Special emphasis has been given to systems and leadership models for capturing and refining CAD knowledge. A major accomplishment to date has been the creation of a library of locally authored and locally sustainable multimedia instructional modules for solid modeling and engineering analysis in CATIA. This educational resource will be major asset in supporting next generation vehicle projects that will train the transportation workforce of tomorrow.

Dr Edwin Odom and Dr. Steven Beyerlein, with the financial backing of the College of Engineering, the Mechanical Engineering Department, NIATT and supportive alumni, led the development of this laboratory where students turn ideas into reality.

IDEAWORKS

A brochure designed by the IEWorks (Idaho Engineering Works) graduate students, mentors for the undergraduate students who use the IDEAWorks lab for their study and research, describe the lab as “A Research and Teaching Laboratory for Mature, Complex and Innovative Thinking.” From a computer-rendered plan, the lab became a showcase for NIATT and the Mechanical Engineering Department. The lab is staffed by five mechanical engineering professors, as well as the IEWorks graduate students. The students describe their role as one of committing to personal and professional excellence and department stewardship, while earning their Master’s Degrees.

The brochure states: “Once you’ve worked through the challenging courses (such as the UI Core, chemistry, calculus, physics, fluid dynamics, thermodynamics and structural mechanics), then you have earned the chance to show us (and yourself) what you’ve got. IDEAWorks—where big expectations lead to big achievements that lead to bigger expectations.”

“The experience,” the students write, is that “graduate students, seniors and faculty use sophisticated software to

- Learn from great engineers and designers through reverse engineering
- Promote design visualization and team communication
- Unleash engineering creativity
- Animate and analyze breakthrough design concepts.”



*The IEWorks students: left to right
Front row: Brandon Folk; Tye Reid; Randy Storms; Nick Harker; Alberto Castro. Back row: Jason Sagen; Chris Huck; Jessica Sampson; Ben Hanks; Edwin Anderson; John Lacy*



Computer-based image of initial design



The completed lab



Dan Cordon, kneeling (right) with Dr. Steve Beyerlein and graduate students Randall Storms and Edwin Anderson with the engine dynamometer in the Small Engine Laboratory.

INVOLVING ME STUDENTS IN TRANSPORTATION

One of the benefits NIATT brings to the Mechanical Engineering department is funding for graduate student research and undergraduate student competition projects in the field of transportation. The SAE Clean Snowmobile Challenge (CSC) has been a great addition to the ME program. A team of undergraduate students works on solving some very real problems being faced by the recreational vehicle industry. These projects draw in students at various levels in their education by offering hands-on application of the material they are learning in the classroom. In many cases they get far more depth in their solutions than are covered in most classroom-based courses. Interaction with industry partners has opened up many job opportunities in transportation fields that would not be available without these competition projects.

Many of our graduate researchers decide to pursue their MS or Ph.D. degrees because of interaction with NIATT projects in their undergraduate program. We are constantly able to recruit strong graduate students to work on our CSC research, various projects in the Small Engine Laboratory and the Combustion Laboratory in Boise, Idaho.

– Dan Cordon, Doctoral Candidate and NIATT's Student-of-the-Year in 2006

OBJECTIVE 4:

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

- **Strategy 4.1:** Increase the effectiveness of our Local Technical Assistance Program in disseminating the results of our research
- **Strategy 4.2:** Increase the commercialization of our research products
- **Strategy 4.3:** Hold specialty conferences and workshops to disseminate our research results
- **Strategy 4.4:** Improve the electronic dissemination of our research results



Transferring the results of NIATT's work to other researchers and practicing professionals is an important part of the research process. It is also a requirement of the UTC program. We have undertaken the following activities in support of this objective.

Dr. Richard Wall and graduate student Dustin DeVoe (above) were invited to attend the ISIE 08 IEEE International Symposium on Industrial Electronics, held in Cambridge, England, in June 2008. Dustin presented their paper, "A Distributed Smart Signal Architecture for Traffic Signal Controls." While there, Wall and DeVoe participated in discussions with engineers and scientists from all over the world and were able to see how England manages pedestrian traffic. They also conducted an impromptu experiment at an intersection where a camera extended pedestrian crossing time to see how pedestrian signals work in England.

Wall and graduate student Sanjeev Giri have a paper ("A Safety Critical Network for Distributed Smart Traffic Signals") accepted for publication in the December 2008 issue of the *IEEE Instrumentation and Measurement Society Magazine* (See also pages 12 and 24.)

Dr. Judi Steciak and her team of graduate students gave presentations at two technical meetings of the Western States Section of the Combustion Institute, prepared a peer-reviewed paper accepted for publication by the American Society of Mechanical Engineers 2008 World Congress, and submitted a manuscript for publication to the journal *Combustion and Flame*. Their \$550,000 proposal to Idaho's Higher Education Research Council was approved for a two-year program to improve NIATT's sustainable engine and fuel research capability, especially with regard to the partnership with Automotive Resources, Inc.

Dr. Karen Den Braven and five students from the Clean Snowmobile team attended the International Snowmobile Congress June 12-14 in Boise, Idaho, and gave a presentation on the snowmobile and the work of their team. The Congress provides "a great time to communicate with Idaho and the world about the research we're doing," Den Braven said. Throughout the year, the snowmobile team visits local snowmobile chapters spreading the word about sustainable recreation. The team also prepared and presented two technical papers on their work at conferences held by the Society of Automotive Engineers and the American Society of Mechanical Engineers.



Josh Roy making adjustments to the reactor in the combustion lab. (See also page 14.)

Biological and Agricultural graduate student Randy Magliano and Dr. Brian He attended American Society of Agricultural and Biological Engineers annual international meeting in Providence, RI, in late June 2008.

NIATT researchers presented the following papers at the annual meeting of the Transportation Research Board in 2008:

1. "What's New in the Queue: Discovering More about Queue Discharge Characteristics and Their Effect on Signal Timing Using the New NG-SIM Data Set"
2. "Testing the Incremental Queue Accumulation (IQA) Method as a Replacement for the HCM Signalized Intersection Uniform Delay and Queue Method Using the Lankershim Boulevard NGSIM Data Set"
3. "Qualitative Approach to Analyze Security and Survivability of Intelligent Transportation System Networks"

EDUCATIONAL ACTIVITIES

NIATT actively participates in the transportation education program at the University of Idaho, through faculty teaching transportation courses as well as basic research in educational issues. The following projects illustrate some of the research and development that support our educational goals.

IMPROVING TRANSPORTATION EDUCATION: DEVELOPING AND APPLYING COLLABORATIVE TOOLS

Even as the need for more transportation engineers grows, the professional transportation workforce faces enormous challenges caused by a flood of retirements from state agencies and a rapidly changing work environment, characterized by swift technological advances, distance separated collaboration, and an increasingly complex socio-political context. The new generation of transportation engineers not only needs increased technical competency, but also new skills in partnership, collaboration, innovation and creativity. To ensure that the transportation system continues to support the nation's economic and social fabric, educational institutions must rise to the challenge of creating broadly educated well-trained transportation engineers who have the critical thinking and problem solving skills required for today's work environment.

The current civil engineering curriculum and teaching methods fall short of the mark for providing relevant materials and instruction in the essential skills needed by transportation engineering professionals. Most engineering curricula emphasize covering copious bodies of knowledge rather than concentrating on honing the thinking skills needed for complex problem solving, a hallmark of true engineering education and professional practice. In a good faith effort to teach engineering, instructors attempt to cover encyclopedic textbooks in the short span of a quarter or semester.

Civil engineering faculty at the University of Idaho have begun to design new curriculum materials for the introductory transportation course, a requirement for civil engineering undergraduates. Dr. Michael Dixon, Dr. Michael Kyte, and Dr. Ahmed Abdel-Rahim have teamed with Dr. Shane Brown from Washington State University to establish a learning community to develop materials and activities that support specific learning outcomes for transportation engineering students.

The Project Team is utilizing curriculum development methods described in *Understanding by Design* by Wiggins and McTighe. Brown adds value to the team with his background in engineering education. His main role is to assist the team in developing education assessments.

Dixon developed a Wiki site where instructors are able to share their ideas on course structure, objectives and outcomes. The team is also making use of Claroline™, an online collaborative platform allowing users to create classroom modules that target learning outcomes.

The team of civil engineers at the University of Idaho identified these abilities as the desirable outcomes for students taking an introductory course in transportation engineering.

Ideally, students would be able to

1. Design a safe and efficient two-lane highway
2. Assess the safety of a two-lane highway alignment
3. Determine the social, economic, and environmental impacts of a highway improvement project
4. Compare highway alignment alternatives based on construction costs, safety, efficiency, economic impacts, social impacts, and environmental impacts
5. Estimate freeway basic section performance in time and space, given capacity and demand volumes
6. Evaluate intersection performance for two-way stop, four-way stop, and signal control
7. Improve intersection performance by redesigning a two-way stop intersection
8. Improve intersection performance by redesigning a four-way stop intersection
9. Improve intersection performance by redesigning a signalized intersection
10. Select the most beneficial set of improvement projects, given budget constraints, economic forecast, social impacts, and political environment
11. Design a corridor transit system to alleviate freeway and arterial congestion
12. Assess the benefits and costs of a bus and rail transit system
13. Assess impact fees for a major single use development
14. Assess impacts of demand growth on the performance of existing and proposed infrastructure performance
15. Explain reasons for transportation system demand patterns

FEDERAL HIGHWAY ADMINISTRATION FUNDS REGION X EDUCATION PROJECT

In 2008, the Federal Highway Administration awarded four projects as part of their Transportation Education Development Pilot Project program. One of these projects was awarded to the Region X Transportation Consortium, with the University of Idaho/NIATT serving as the lead organization.

The project team, which includes consortium members from Portland State University, the University of Alaska, and the University of Washington, will create an active, problem-based learning environment conducted at a distance. The main goal of this project is to attract more students to the field of transportation, as well as help train and retain practicing engineers. The project is also based on sound educational research in engineering education.

The project team has established six objectives for the project:

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

The team will develop a set of four course modules, each addressing a critical topic in transportation engineering and planning in the Pacific Northwest. Each module will consist of a generative field-based problem, student learning materials, instructor support materials, and a well-defined learning environment/process. Each module will be delivered over a ten-week period through a distance-separated learning/work environment to both university students and practicing professionals. Each module will be designed as active and problem-based, using the lessons learned from the pedagogical research cited earlier in this proposal. Each module and its delivery method will be evaluated to determine the quality of the learning environment for each participant, and revised accordingly. The generative problems to be addressed in the course modules, which will set the context for participants to focus on specific transportation engineering and planning solutions.



Transportation Education Conference

Improve Transportation Engineering Education

Portland, OR
June 22-24, 2009

HELP PLAN THE FUTURE
OF TRANSPORTATION
ENGINEERING EDUCATION!

EDUCATION CONFERENCE PLANNED FOR JUNE 2009

The Region X Transportation Consortium is planning a conference on undergraduate transportation engineering education to be held in Portland, Oregon, on June 22-24, 2009. The conference will focus on the first undergraduate transportation engineering course offered in most civil engineering department programs.

NIATT Director Michael Kyte and OTREC Director Robert Bertini of Portland State University are co-chairing the conference.

Participants in the conference will learn about the latest ideas in transportation engineering education, address three important questions to help us improve how we deliver transportation engineering education, and help faculty improve their teaching skills. The three major questions identified by the conference planning team include

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?

A poster session will allow educators to share their current work and innovations in transportation education. Eight presentations will highlight current innovations in 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

OTHER ACTIVITIES

REGION X TRANSPORTATION CONSORTIUM MEMORANDUM OF UNDERSTANDING

After more than two years of discussion, the members of the Region X Transportation Consortium signed a memorandum of understanding. The MOU identifies five prime intentions of the member institutions:

1. Meet twice yearly to conduct the business of the consortium.
2. Regularly exchange information on research and educational needs, interests, and programs.
3. Promote interest in transportation related fields within the region.
4. Leverage research funding through pooled fund projects and other opportunities.
5. Develop shared educational and training programs.

The consortium has two major activities at present. The first is a new education research project described on page 30 of this report. The second activity is a new pooled fund project in which the four state departments of transportation in the consortium will identify one to two collaborative research topics that are important to the Pacific Northwest. The four University Transportation Centers in the consortium will prepare proposals to work on these research topics, encouraging more collaboration between member UTCs and making sure that the four state DOTs will get the best researchers in the northwest to work on these critical transportation problems.

The first request for proposals from this pooled fund is expected to be released in the spring of 2009.

Region X Transportation Consortium - Memorandum of Understanding

Washington



Oregon



Alaska



Idaho



This memorandum of understanding (MOU), a non-binding agreement, is entered into by and between the Washington State Department of Transportation, the Oregon Department of Transportation, the Alaska Department of Transportation and Public Facilities, the Idaho Transportation Department, the University of Washington, Portland State University, the University of Alaska and the University of Idaho, collectively referred to as the "parties to the MOU."

IDAHO SNOWMOBILE SHOW, BOISE AND SPOKANE WINTER KNIGHTS SNOWMOBILE CLUB

NIATT's Clean Snowmobile Team participated in the 27th annual Snow and ATV Show in Spokane, Washington in November 2007, and in the Idaho SnoShow in Boise, December 2007.

TRANSPORTATION NETWORK SURVIVABILITY WORKSHOP

NIATT researcher Ahmed Abdel-Rahim participated in a workshop on transportation network survivability in Boise, Idaho, in December 2007. Dr. Abdel-Rahim has led two UTC research projects on network security and survivability with computer science faculty member Paul Oman.

HOW OUR STUDENTS ARE DOING

One of the most important objectives of the UTC program is to develop new transportation professionals who are ready to participate in the 21st century transportation workforce. Following is an excerpt from a letter from Justin Crane, a recruiter for HDR, a national transportation engineering consulting firm, describing recent University of Idaho graduate Aziz Rahman.

Aziz's work ethic and engineering capabilities were beyond expectations. . . . Nothing but positive accolades were received by all those who had the privilege of working with him this summer. At the end of his internship we extended an offer of employment for when he graduates and we sincerely hope he accepts. It would be great to have such a young engineer return to HDR. We want to thank you for your support of Aziz in his educational and professional pursuits. It is people like you who help mold these talented minds into capable, eager young professionals.



Ahmad Abu Abdo with his Outstanding Graduate Student Teaching award.

OUTSTANDING GRADUATE STUDENT TEACHING AWARD

Civil engineering graduate student Ahmad Abu Abdo (left) was awarded the Outstanding Graduate Student Teaching Award from the University of Idaho's College of Graduate Studies. The award noted that Abdo, a doctoral student in the department of Civil Engineering, "teaches three lab sections a week in addition to assisting in homework and report grading. Colleagues said he works tirelessly to help his students inside and outside the classroom."

COLLEGE OF ENGINEERING FACULTY AWARDS RECOGNIZE NIATT RESEARCHERS

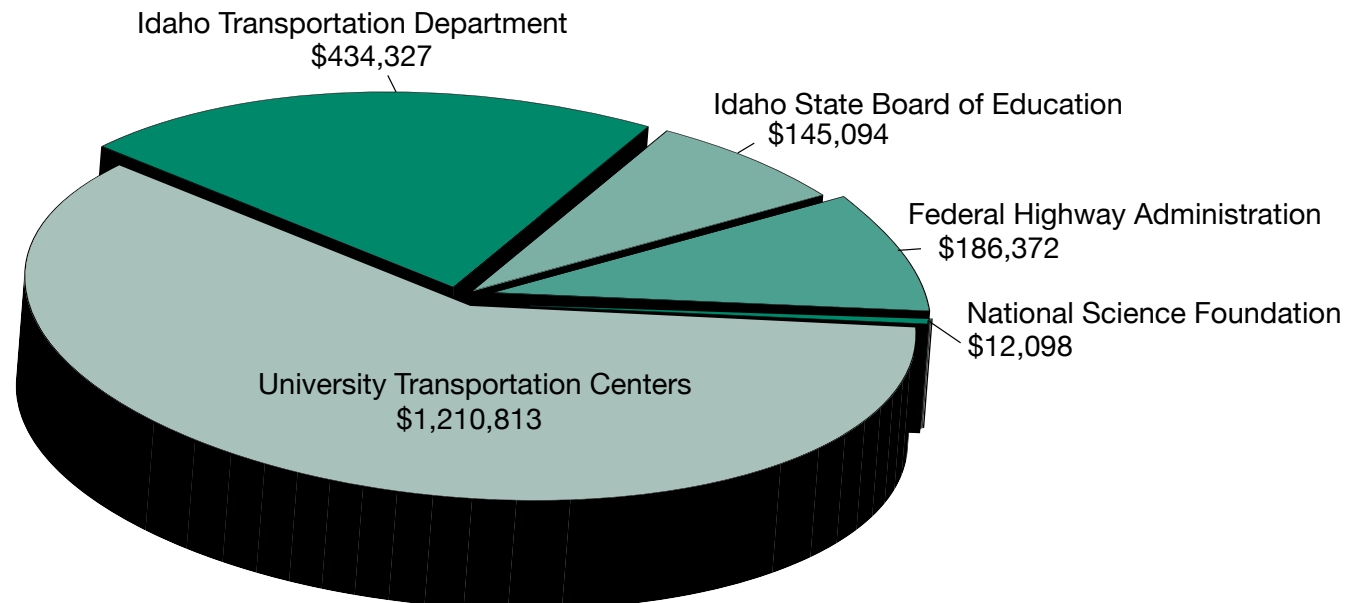
Four NIATT researchers were honored by the University of Idaho's College of Engineering in May 2008, at the college's annual awards banquet.

1. Karen Den Braven, outstanding research award
2. Edwin Odom, outstanding educator award
3. Steve Beyerlein, outstanding advising and service to students

FUNDING SOURCES AND EXPENDITURES

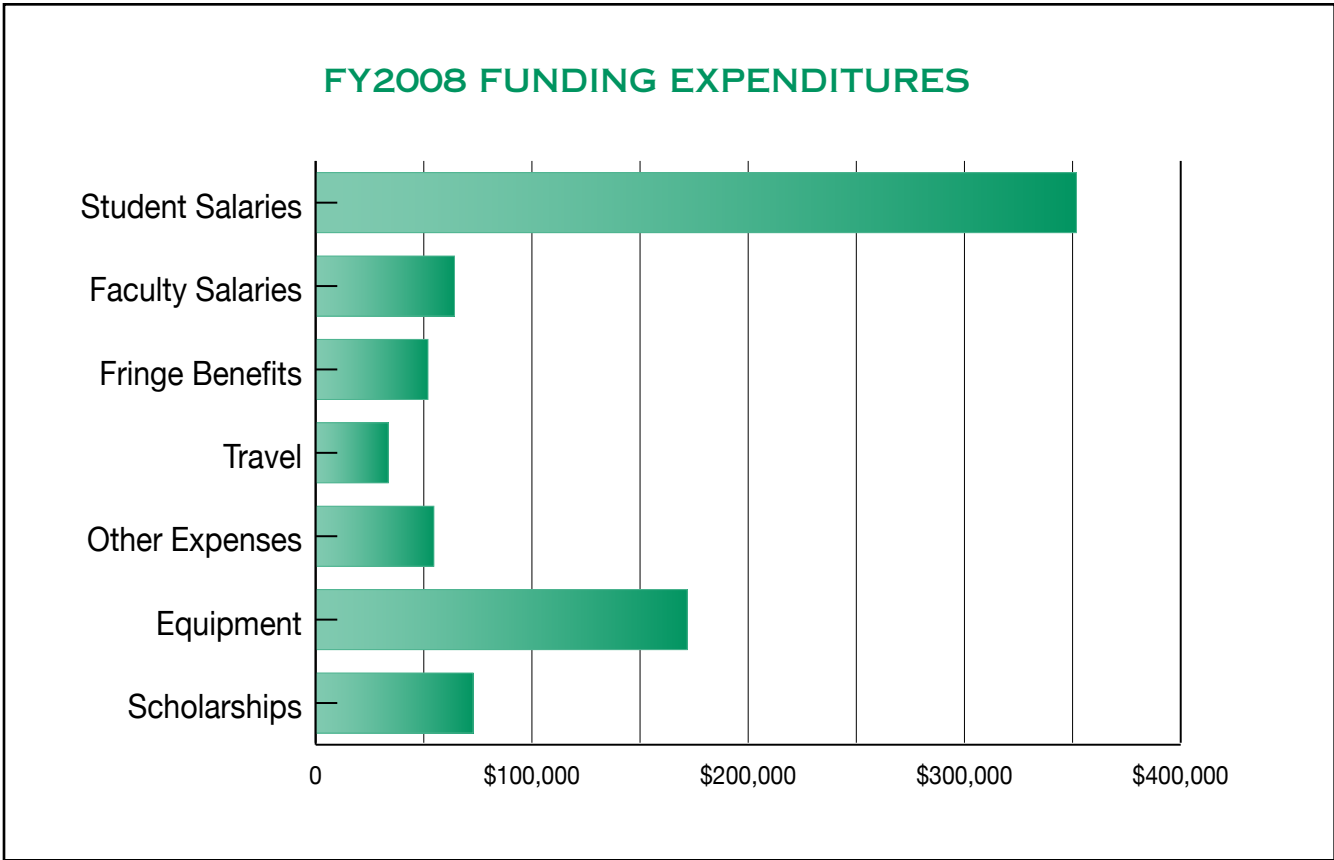
Research in NIATT is supported by a number of different agencies. For FY2008, University Transportation Centers funds represented 61 percent of grant dollars expended. Funding from the Idaho Transportation Department increased to 22 percent of expenditures, and new funding from the Idaho State Board of Education, the Federal Highway Administration, and the National Science Foundation accounted for the balance of grant dollar expenditures. The pie chart does not reflect internal expenditures and University of Idaho support used for cost-sharing.

FY2008 FUNDING SOURCES



Each fiscal year that NIATT has been a University Transportation Center, approved projects are selected from those submitted by research faculty from NIATT's Center for Traffic Operations and Control the Center for Clean Vehicle Technology. The proposals must clearly support one of the goals as set forth in the institute's *Strategic Plan*.

As a student-centered program that places a great value on student development and advancement in the field of transportation, a large percentage of expenditures go to support graduate and undergraduate student salaries and by awarding funds to pay their matriculation fees. In FY2008, 53 percent of UTC funds (excluding indirect costs) were spent in this way. Salaries for faculty, on the other hand, represent only eight percent of the UTC expenditures over the same time period. Research supplies and equipment account for 28 percent of the expenditures.



RESEARCH PROJECT STATUS

PROJECTS BEGUN IN FY08 —YEAR 1 OF DTRT07-G-0056

KLK710 Street Deployment of Pedestrian Control Smart Traffic Signals

Center for Traffic Operations and Control
Drs. R. Wall, J. Frenzel, & B. Johnson

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
Center for Traffic Operations and Control

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

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

KLK751 Compression Ratio and Catalyst Aging Effects on Aqueous Ethanol Ignition

Center for Clean Vehicle Technology
Drs. J. Steciak, S. Beyerlein & R. Budwig



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