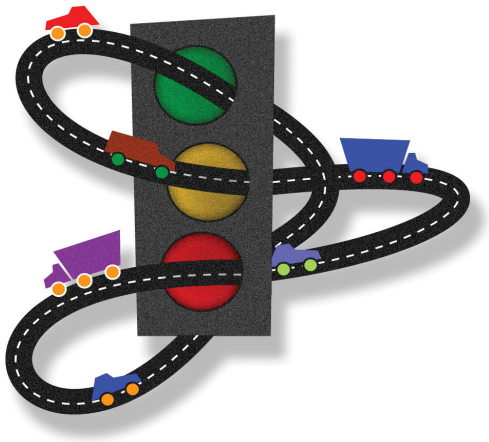
University of Idaho

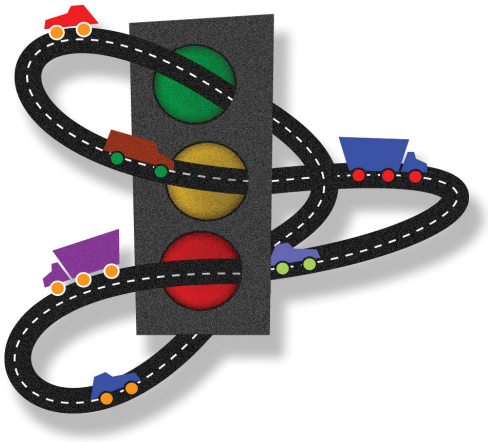
Annual Report 2004

National Institute for Advanced Transportation Technology



prepared for
University Transportation Centers Program
Research and Special Programs Administration
US Department of Transportation

NIATT



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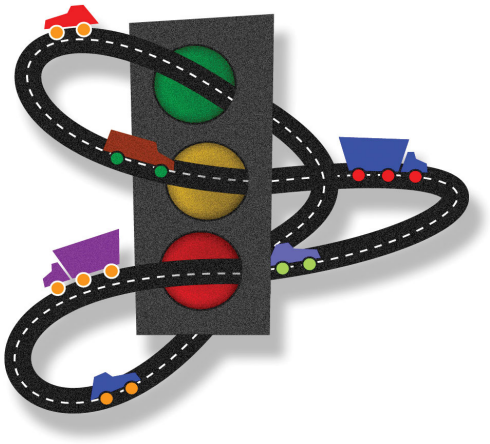


Nothing endures but change.

Heraclitus, Greek philosopher
(540 BC-480 BC)
from Diogenes Laertius,
Lives of Eminent Philosophers

Director's Letter of Introduction

The quotation above puts into perspective what has been happening in NIATT over the past year. For one thing, I am acting as the director. What a change in my role and responsibilities moving from Center Director to the Institute Director! I am learning many things about running a transportation institute, learning more about other Centers, and also learning about myself. I can honestly say that I am enjoying my time at the "helm," while at the same time, I look forward to another change—Mike Kyte returning from sabbatical in January.

As I write this introduction, I feel excited about our successes since we became a University Transportation Center. But as you read about this past year, I would like you to think—and dream—with me about how NIATT is changing.

For one thing, we have changes in our funding. We are proud to have been part of the UTC program for the past six, going on seven, years. And as many of you know, all of us in the UTC program have been in a state of limbo for more than a year, wondering what would happen with a new reauthorization. While we still are uncertain about future years, we are delighted to have received funding for FY05.

This uncertainty affected the way we run our center. We are evaluating and reevaluating the direction of our research. We want to ensure that our projects meet UTC objectives and that the investigators continue to look for additional and/or alternative funding sources. This is a positive: By successfully identifying other funding sources, we confirm that the direction of our research is meeting regional and national priorities.

No matter the outcome of the transportation bill, we will begin in earnest to update our strategic plan in January. There is no doubt that it will change—there's that word again—as we clarify our objectives, always making sure that our plan meets DOT/RSPA goals and that we will be prepared to use the next round of UTC funding effectively.

Our Center for Traffic Operations and Controls (CTOC) has been awarded two large congressional appropriations—a direct result of our accomplishments with UTC funding. Seven years ago, we would not have dreamed of receiving large appropriations to do traffic research and training.

The CTOC is working even closer with our Idaho Transportation Department. This is due in part to internal ITD changes. For example, ITD expects to appoint a full time research director. Mike Kyte spent over a year in Boise, Idaho, working with ITD staff to help them determine how they can most effectively administer limited SPR research funds.

The traffic center is also expanding their work into new research areas, reflecting the changing times. New projects place an increased emphasis on transportation security.

The Center for Clean Vehicle Technology is also experiencing change. The FutureTruck program, which has been a cornerstone of our vehicle program, has ended. So while we will still have an active undergraduate vehicle demonstration program, we are planning to use what we learned as we participated in the competition to develop new technology and products for heavy vehicles. For example, we are leveraging UTC funds with funds from the American Trucking Association (ATA) to use ultra capacitors to reduce emissions during idling. We are also teaming with our local government to develop a hydraulic hybrid for refuse collection.

Our involvement with the Clean Snowmobile Challenge is continuing, but with an emphasis on developing an effective direct injection, two-stroke engine. New faculty members—the new chair of the Biological and Agricultural Engineering Department, John Van Gerpen and Brian He—will be taking the lead in our alternative fuels research as our eminent researcher, Charles Peterson, has become Dean of Engineering. Another new faculty member, Karl Rink, is working the area of vehicle safety, specifically airbag deployment.

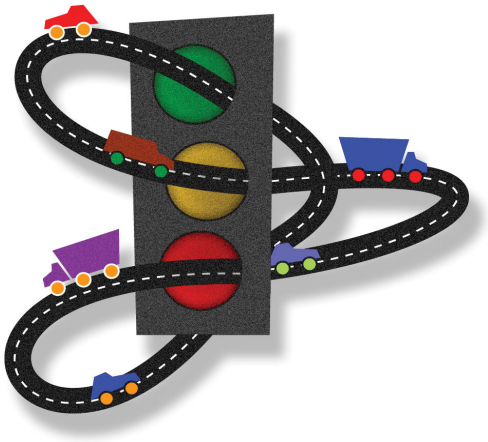
NIATT's Center for Transportation Infrastructure is planning to name a director who can clarify the center's mission and help researchers pursue additional funding. Our Idaho Technology Transfer (T2) Center, part of the national LTAP program, is also changing. While Doug Moore and his staff continue their excellent training programs, they have also been more active in obtaining outside funding for research programs. They obtained ATA funding for studying the effect of deicing compounds on both the roads and the trucks themselves and received a grant from the EPA to develop a Best Practices Manual for maintenance of rural roads. They hired an additional research scientist and several graduate students to help with these new projects.

The list of changes could continue: We are in the process of changing our website, planning to provide access to transportation research for the nation and perhaps the world. We are expanding our intern program to offer additional undergraduate opportunities. We are attempting to raise funds for a new vehicle research facility. Wow! There is much work to be done.

As you read about our accomplishments this past year, I encourage you to think with us about the future and how NIATT can do an even better job in meeting the demands of a changing time. In this regard please feel free to contact me or others within NIATT to offer suggestions that can help us change and grow into the future.

Best regards,

Donald Blackketter
Director



NIATT Theme, Mission and Vision

Theme: Advanced Transportation Technology

Mission

NIATT's mission is to work with industry, government and research institutions to develop, evaluate, and market technologies that will improve the design and operation of transportation vehicles and systems.

Vision

NIATT will be a center of excellence in advanced transportation technology. The following statements describe our vision of who we are and what we want to become:

- We are a center of excellence for research and development of transportation technologies in the state of Idaho, the Pacific Northwest and Intermountain regions, and in the United States.
- We educate and train university students and the professional engineering community in vehicle, infrastructure, and traffic control technologies.
- We assist the Idaho Transportation Department and other governmental agencies in meeting their responsibilities for the design, construction, and operation of transportation facilities.
- We work with industries and research institutions to develop and evaluate new transportation technologies and bring these technologies to the marketplace.
- We seek collaborative research and development projects with members of the Idaho Transportation Consortium (ITC) and other organizations.
- We work with university faculty to help them to develop their transportation research agendas and obtain funding for transportation research projects.
- We seek to educate the public at all levels about new transportation technologies.

Management Structure & Principal Center Staff

The National Institute for Advanced Transportation Technology, originally known as NCATT, was established in 1991 under the Intermodal Surface Transportation Efficiency Act (ISTEA). In July 1998, NIATT became the sixth research institute on the University of Idaho campus, reporting directly to the Vice President for Research (Dr. Charles Hatch currently holds that position.). That status reflects NIATT's interdisciplinary nature. NIATT affiliate faculty and students come from various departments in the College of Engineering and other colleges. Along with three research centers, with specific focuses, NIATT is also the home of Idaho's Local Technical Assistance Program (LTAP) center.

NIATT

Administrative Staff

Director
Michael Kyte

Acting Director/ Assistant Director
Donald M. Blackketter

Assistant to Director
Judy B. LaLonde

Finance Technician
Deborah Foster

Center for Clean Vehicle Technology

The mission for the Center for Clean Vehicle Technology is to develop, test, and evaluate technologies that reduce the impact vehicles have on the environment.

Center for Traffic Operations & Control

The mission of the Center for Traffic Operations and Control is to develop, test, and evaluate technology products supporting advanced traffic control systems.

Center for Transportation Infrastructure

The mission of the Center for Transportation Infrastructure is to develop, test, and evaluate technologies that can be used to improve the highway infrastructure in the state of Idaho, the Pacific Northwest, and the nation.

Idaho Technology Transfer (T2) Center

The mission of the T2 Center is to provide leadership to support and enhance the overall effectiveness of local transportation agencies through communication, consultation, technical support and training programs.

Program Overview

Funding

This Annual Report covers activities completed in NIATT's sixth year of funding from the Research and Special Programs Administration of the US Department of Transportation under the University Transportation Centers program.

Transportation education and research at the University of Idaho have increased dramatically since 1998, largely as a result of the University Transportation Centers grant. The initial UTC investment of $1.7 million was used to develop a comprehensive program of education, research and technology transfer activities design to produce needed and relevant technology products and to train the workforce of the 21st Century.

Following a 2001 competition among TEA-21 Groups B and C, NIATT was one of ten successful centers to receive additional funding.

Research Selection

Project selection for year 6 began in the spring of 2003 with the release of an RFP to NIATT affiliate faculty. Specifically, proposals were required to be in accord with NIATT's strategic plan as approved by the US DOT in April 1999. They were also required to be supportive of the major areas described in NIATT's proposal to RSPA for years 5 and 6 funding and supportive of the theme and mission of either the Center for Traffic Operations and Control or the Center for Clean Vehicle Technology.

After the deadline for submission, the proposals were reviewed by the members of each Center's peer review panel members. The proposals were ranked according to the criteria addressed in the following questions:

- Does the proposal document how the project is consistent with NIATT's strategic plan?
- Does the proposal document how the project supports NIATT/UTC six program goals?
- Does the proposal identify one of the three federal or state priorities that this project will support?
- Does the project team/individual, through the work plan and budget, have a high probability to produce the identified products and/or deliverables?
- Does the proposal identify past, present, or future funding sources that might be available for this work or describe how this project might leverage other funding sources?
- Does this project enhance the research and instructional capabilities of NIATT and the University of Idaho?
- What is your overall rating of the quality of this proposal?

Fifteen proposals were submitted for fifth year funding of which 11 were approved. In the Center for Traffic Operations and Control, $400,000 was funded out of the $590,540 requested. $407,973 was awarded out of the $446,606 requested in the Center for Traffic Operations and Control.

Research Project Status

Projects Begun in FY04--Year 6

KLK230 Development of Traffic Signal Operations Case Studies
Principal Investigator: Michael Kyte

KLK231 Applying the TRANSIMS Modeling Paradigm to the Simulation and Analysis of Transportation and Traffic Controls Systems
Principal Investigators: Michael Dixon; Karl Chang

KLK232 Maximizing Data Quality to Optimize Traffic Signal System Performance
Principal Investigators: Michael Dixon; Ahmed Abdel-Rahim

KLK233 Applying Safety-Critical Fault Tolerant Principles to Survivable Transportation Control Networks
Principal Investigators: Axel Krings; Paul Oman

KLK234 Assessing Intelligent Transportation System Educational Needs
Principal Investigators: Ahmed Abdel-Rahim; Michael Dixon; Brian Johnson

KLK235 Expanded Controller Interface Device I/O and Software Capabilities
Principal Investigators: Ahmed Abdel-Rahim; Brian Johnson

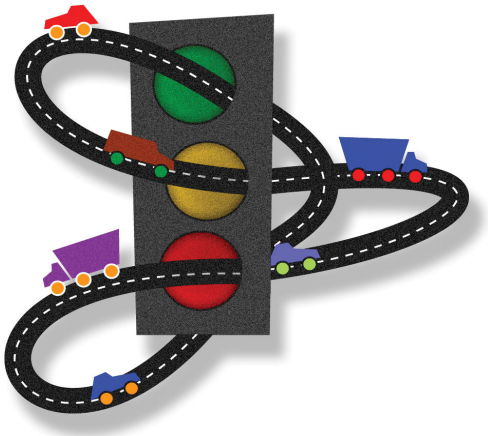
KLK341 Design and Construction of a Direct-Injection Two-Stroke Snowmobile for Competition in the 2004 SAE Clean Snowmobile Challenge
Principal Investigator: Karen Den Braven

KLK342 Small Engine Laboratory Support for Multi-Fuel Performance and Emissions Testing
Principal Investigators: Judi Steciak; Steve Beyerlein

KLK343 A Novel Continuous-Flow Reactor Using a Reactive Distillation Technique for Economical Biodiesel Production
Principal Investigator: Brian He

KLK344 A Parallel-Hybrid Electric-Hydraulic Sport Utility Vehicle: FutureTruck 2004
Principal Investigators: Don Blackketter; Steve Beyerlein; Frank Albrecht

KLK345 Failure Mode Investigation and Ballistic Performance Characterization of Pyrotechnic Initiators Used in Automotive Supplemental Restraint Inflation Systems
Principal Investigator: Karl Rink



Research Project Status

Projects Continuing in FY04--Year 6

KLK206 Traffic Controller Laboratory Upgrade
Principal Investigator: Ahmed Abdel-Rahim

KLK209 Next Generation Controller Interface Device
Principal Investigator: Brian Johnson

KLK210 Modeling Real-Time Highway Traffic Control Systems
Principal Investigators: Richard Wall; Brian Johnson

KLK212 Development of Guidelines for Designing & Implementing Traffic Signal Control Systems
Principal Investigators: Michael Dixon; Ahmed Abdel-Rahim

KLK213 Engineering Design Problems
Principal Investigator: Michael Kyte

KLK214 A Remote Access Hardware-in-the-Loop Simulation Laboratory
Principal Investigators: Brian Johnson; Richard Wall

KLK215 Assessing the Security and Survivability of Transportation Control Networks
Principal Investigators: Paul Oman; Axel Krings

KLK216 CID Road Map
Principal Investigators: Brian Johnson

KLK328 Comparison of Esterified and Non-Esterified Oils from Rapeseed, Canola and Yellow Mustard as Diesel Fuel Additives
Principal Investigator: Charles Peterson

Research Project Status

Projects Completed

KLK201	Development of Controller Interface Device for Hardware-in-the-Loop Simulation
KLK202	Actuated Coordinated Signalized Systems: Phase I—Oversaturated Conditions; Phase II: Cycle-by-Cycle Analysis
KLK203	Development of Video-Based and Other Automated Traffic Data Collection Methods, Phase II
KLK204	Development of Internet-Based Laboratory Materials: Phase II—Computer-Assisted Traffic Analysis Training
KLK205	Traffic Signal Summer Workshop II
KLK207	Development of Traffic Signal Training Materials Integrating Hardware-in-the-Loop Simulation
KLK208	Software Maintenance Support for Current Generation Controller Interface Device
KLK211	Traffic Signal Summer Workshop III
KLK217	Traffic Signal Summer Workshop IV
KLK302	Advanced Vehicle Concepts Team Electric Vehicle: Phase II: FutureTruck 2000, 2001
KLK303	Alternative Powered Snowmobile Development (FY01)
KLK304	Alternative Power Snowmobile Development (FY02)
KLK305	Vehicle Performance Simulation, Phases I-II
KLK306	Vehicle Performance Simulation, Phase III
KLK308	A Parallel-Hybrid Sport Utility Vehicle (FutureTruck 02)
KLK309	Clean Snowmobile 03
KLK310	Biodiesel Fuel from Yellow Mustard Oil, Phase I
KLK311	Biodiesel Fuel from Yellow Mustard Oil, Phase II
KLK312	Catalytic Ignition
KLK314	Mentorship and Performance Assessment of Design Teams in Transportation-Related Projects
KLK315	Spark Ignition Engine Conversion to Aquanol Fuel
KLK317	Diesel Engine Conversion to Aqualytic Fuel—Phases I-II (Homogeneous Charge Combustion of Aqueous Ethanol)
KLK318	Reactor Studies of Water-Alcohol Mixtures, Phase II
KLK319	Catalytic Ignition of Aquanol in Reactor, Engine and Vehicle Environments
KLK320/ KLK321	Optimal Design of Hybrid Electric-Human-Powered Lightweight Transportation
KLK323	Idaho Engineering Works
KLK325	FutureTruck 03
KLK327	Essential Elements in Teaming: Creation of a Teaming Rubric
KLK330	Advanced Lead Acid Battery Development
KLK331	High Performance Auxiliary Power Units, Phase II

Final reports are available on the NIATT website in both html and Adobe Acrobat.

NIATT's Educational Program

Internships--Encouraging Experiential Learning

A key feature of NIATT's undergraduate educational program is its internship program. NIATT awards internships each academic year to undergraduate students pursuing degrees in transportation technology-related areas. These internships provide students with practical experiences as they work with research faculty on projects funded by University Transportation Centers or the Idaho Transportation Department.

Internships put little pressure on freshmen or sophomores, who are still learning to adjust to college and need to focus on their courses. Internship pique their interests and broadens their knowledge of the field.

Juniors and seniors, who are closer to deciding what they want to do after graduation, can be given greater responsibilities. They often work on the projects alongside graduate students, These undergraduates are more likely to value the practical experiences they get contributing to actual transportation projects than they do the theoretical situations they are more likely to experience in classrooms. Many students who have internships as undergraduates come to recognize the value of a graduate education and continue as graduate research assistants.

Outstanding Student Contributors--Reflecting Excellence

Nathan Bradbury and **Tamara Cougar**, two NIATT undergraduate interns in the 2003-04 academic year, were selected by the University of Idaho as “Inspiring Grads.” The two were featured on the UI’s Commencement 2004 website and news releases. Both undergraduates were active participants in UTC projects (see Appendix B).

Nathan Bradbury has been one of the backbones of the Clean Snowmobile team for the past two years. As a team 2002 and 2003 team member, Bradbury received a NIATT internship.

While at the 2004 Clean Snowmobile Competition, he met and impressed employees from Bombadier/ Ski-Doo at the 2004 competition. As a result, the company offered him a summer internship, which he

gladly accepted. While there, he took an existing outboard engine and developed a strategy to make more power, while meeting emissions standards.

Challenged by his work for Dr. Karen Den Braven, Bradbury will return as a graduate student this fall. He will continue working on the newest snowmobile project.

Tamara Cougar's enthusiasm helped generate outside interest in NIATT's FutureTruck and in their heavy-duty, hydraulic tow truck, as well. Cougar worked on the Advanced Vehicles Concept Team for two years. Prior to that, she had a NIATT internships focusing on the collection and analysis of freeway traffic and incident data.

UI Intern Guillermo Madrigal Receives US DOT STIPDG

After completing two years in civil engineering at Idaho State University, Guillermo Madrigal transferred to the University of Idaho. Attracted to transportation engineering by the offer of an undergraduate internship, Guillermo worked for Dr. Ahmed Abdel-Rahim during his junior year on two projects in the Center for Traffic Operations and Control.

Encouraged by his advisor, Madrigal applied for and received a summer internship through the DOT/FHWA Summer Transportation Intern Program for Diverse Groups. He headed for New York at the end of the school year where he served his internship working for Parson Brinkerhoff, a construction management team.

Madrigal worked with the group of 25 men and women, overseeing the reconstruction of the Third Avenue Bridge, single direction bridge permits approximately 70,000 vehicles a day from the South Bronx to cross the Harlem River and the Harlem River Drive and arrive into Manhattan. Having the opportunity to be associated with this $118 million project sponsored by the New York City DOT, according to Madrigal, was "unbelievable." He learned about the many aspects of such a transportation project--structural, environmental, financial, political, public and managerial.

Student Competitions--Innovations in Transportation

UI's FutureTruck Finishes in Sixth Place

In the fourth year and final year of the national **FutureTruck** competition, the University of Idaho team brought home prize money in recognition of their sixth place finish. The UI team was one of teams from 15 schools at the national competition held at Ford's Proving Ground in Houghton, Michigan, from June 9-17, 2004.

In response to international outcries concerning the potential of greenhouse gas emissions (GHG) to cause global warming, the goal of this competition was to encourage and promote the design and development of advanced clean vehicle technology. FutureTruck brought to light new technologies, as well as preparing a new fleet of automotive engineers in their application. The focus of the challenge was twofold: reduction of emissions and improvement of energy efficiency. An additional stipulation was that the original design intentions of the vehicle not be altered.

This was the second year the team worked on "Summit," the 2002 Ford Explorer. The competition itself was only a small fraction of the efforts behind the FutureTruck. The team takes pride that their entry successfully completed all categories of competition (and all teams were not able to do so). However it took a year that included many long hours, serious planning, multidisciplinary team building, and weekly skill sessions to turn the commercial vehicle into a mild hybrid that met all FutureTruck requirements.

This final year of the FutureTruck project was, for the students involved, a culmination of lessons learned from the previous four years of FutureTruck, Clean Snowmobile Challenge, and Formula SAE. The emphasis for this year's team was to apply theories learned in the classroom to design and build a better vehicle while, at the same time, increasing the knowledge base for clean vehicle technologies.

The objectives of this year's University of Idaho FutureTruck project were to

- Research and implement clean vehicle technologies that reduce the impact of transportation on the environment.
- Educate students and provide them with practical experience.
- Increase awareness and support of clean vehicle initiatives and progress.

The FutureTruck competition shows that the cooperation of industry, government, and academia is the best approach to develop more energy-efficient and "greener" automotive technologies, to improve our economy and our environment, and to keep North American technology competitive on a global basis. The competition also helps develop hundreds of highly skilled engineers with a greater awareness of these technologies, preparing them to lead the automotive industry in the 21st Century.

Details of the competition can be found on the FutureTruck official site (http://www.futuretruck.org). Final reports, describing in detail the reengineering involved in the four

FutureTruck competitions, can be found on NIATT's website (http://www.webs1.uidaho.edu/niatt). The AVCT experiences turned a group of students and faculty into a high performance team that overcame obstacles to demonstrate the quality engineering and education of the University of Idaho (See Appendix C.)

Clean Snowmobile Competition Impetus for Classroom Coursework

Research projects funded by UTC have led to development of special topics courses for University of Idaho engineering students. One of the newest special topics courses offered by the mechanical engineering department has been the technical elective on clean snowmobile design, taught by Dr. Karen Den Braven.

Such technical elective courses allow upper classmen to receive academic credit for the work they do related to the research project. For the clean snowmobile, leaders of the various subgroups (i.e., electrical, cooling, exhaust, chassis groups) have generally enrolled in the classes. The students have specific requirements they must meet to pass the class which includes tracking their work, completing a notebook that includes for example, weekly goals, evaluations of whether the goals have been accomplished or need to be carried over, the trouble they may be having or how they solved problems.

“The science really pushes them,” according to Den Braven, as they work with a typical trail snowmobile to make it cleaner and quieter. Students end the two-semester course paying greater attention and gaining a better understanding of the design process involved in the redesigning of the snowmobile.

Traffic Signal Summer Workshop--Professional Training

NIATT's fourth annual Traffic Signal Summer Workshop (TSSW) took place in August 2003, bring 12 more individuals to the University of Idaho for intense instruction and hands-on experiences using the equipment that professional traffic engineers use in the field.

This past year, the group included a transportation specialist with the Federal Highway Administration, an assistant traffic engineer from Ada County, Idaho, and an associate professor of civil engineering from the University of Arkansas. The group of twelve also included seniors from Washington State University, the University of Portland, Michigan Technological University, and four new NIATT graduate students.

UTC funds enable us to offer the weeklong workshop for the participants, who pay a minimal registration fee and their own transportation to and from Moscow, Idaho. Many of the participants receive financial assistance from their employers and schools to help cover those costs. Students from MTU, for example, are expected to write a report for their professors back in Michigan after the workshop.

Lewis Kay, a TSSW IV participant, had this to say in his report:

> The experience of working with some of the leaders in the field of transportation engineering was a great learning atmosphere and the vast amount of information that we processed in a mere five days was extraordinary. I would recommend this workshop to anyone pursuing a job in the field of transportation engineering as the technical knowledge coupled with the design aspects work well together to give the future engineer a holistic view of the system.

As the summer of 2003 approached, plans were well underway for TSSW V. Instructors were especially pleased to hear from past participants who still visit the NIATT website and contacted NIATT to express their good wishes for the upcoming workshop. Scott Arnold, a TSSW II participant, wrote Michael Kyte to say,

> It’s good to see the Traffic Signal Summer Camp is still going strong. I attended back in August 2001 and this summer camp really helped me stand out from other applicants when I was searching for my job. I work for Kimley-Horn and Associates in Fort Worth, Texas and have been working for just over 2.5 years now

Reinforcing our claim that the workshop also provides invaluable "networking," Arnold asked for recommendations for qualified candidates who might be interested in several open positions in Texas.

Scholarships--Recognizing the Engineers of Tomorrow

NIATT annually recognizes those engineering students involved in NIATT projects who are “the cream of the crop” through scholarship awards. This year's scholarships went to:

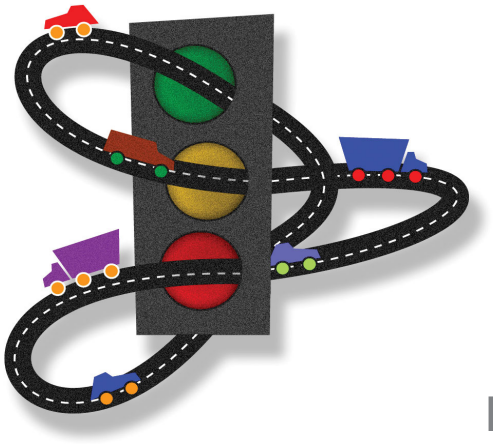
Leah Kelsey: Coral Sales/ Douglas P. Daniels Scholarship

Clayton Forsmann: Coral Sales/ Douglas P. Daniels Scholarship

Lisa Arellano: Institute of Transportation Engineers Scholarship

Guillermo Madrigal: Road Builders' Clinic Scholarship

Dan Cordon: NIATT UTC Student of the Year



NIATT's Research Program

Center for Clean Vehicle Technology

Peer Review Panel Gets Update

Researchers from the Center for Clean Vehicle Technology met with members of their peer review panel on April 5, 2004, to bring them up to date with the progress of their research and to share ideas about the direction future research should take.

Combustion Modeling--Dr. Judi Steciak & Dr. Steven Beyerlein

The most theoretical work being done by NIATT researchers involves detailed ethanol-water combustion modeling. Continued development of the Small Engine Research Facility has given Drs. Steciak and Beyerlein and their students the ability to perform the modeling work and collect data, opening new research possibilities. This new ability to model detailed combustion kinetics permits the researchers to determine the optimal ignition and combustion conditions needed to reduce the formation of toxins and environmental contaminants from renewable transportation fuels.

The team has progressed towards its ultimate goal of developing catalytic igniters for aqueous ethanol as a transportation fuel with three different actions: 1) developing a test matrix to compare the performance of a passenger van operating with gasoline with the same van operating with aqueous ethanol; 2) determining the average temperature when surface reactions occur on a heated platinum wire catalyst; and 3) theoretically modeling the impact of water on the gas-phase oxidation of ethanol.

Comparisons of alternative fuels with conventional fuels used on the same vehicle platform are required to quantify differences in performance and emissions. To make comparison tests possible, researchers developed a test matrix using a steady-state chassis dynamometer approximating urban and rural driving cycles. The matrix was evaluated using a passenger van operating with gasoline. The van was converted for dual-fuel use with a programmable dual fuel computer and injectors replacing the carburetor, and catalytic igniters instead of sparkplugs. The van conversion resulted in a robust, reliable vehicle platform for evaluating alternative fuel handling system that shows no sign of corrosion. Furthermore, gasoline fuel economy and

emissions are far improved over the original carbureted configuration with a 95 percent reduction in NOx and a 67 percent reduction in unburned hydrocarbons. The test matrix developed in this work will be used to compare vehicle performance on gasoline and ethanol-water.

Ignition of fuel/oxygen/nitrogen mixtures over a platinum wire was studied using microcalorimetry. Experimental results were compared with predictions from a steady-flow finite element (FEA) model. The FEA analysis indicated that axial conduction dominated heat losses from the Pt catalyst in comparison with radial convection. This finding suggested that thermal breaks and/or substrates with lower thermal conductivity will reduce heat losses from catalytic igniters. Future work will determine the threshold-heating rate of the Pt wire at which the ignition of aqueous ethanol fuel-air mixtures occurs. This work is expected to support design improvements for catalytic igniters to help alleviate cold starting problems.

Four hundred chemical reactions are involved in ethanol-water combustion. The thermal decomposition and combustion kinetics of gas-phase ethanol oxidation were modeled with a computer code based on work by Lawrence Livermore and Princeton University. Model results showed that combustion temperature dropped as water content increased. Because dilution masked the impact of water on decomposition and combustion kinetics, an analysis is underway to “dry” model results. The computer code is being modified to include the kinetics of catalytic surface reactions.

Developing a Clean Snowmobile--Dr. Karen Den Braven

More than 50 mechanical and electrical engineering and computer science students actively participated in the redesigning and reengineering of the UI SAE Clean Snowmobile Challenge entries, of which 38 completed the special topics course for academic credit.

For the first three years of the competition, the team used the same platform--a snow-cross chassis with a BMW motor. The first year of competition, the students were unable to test the sled. A 3/10 decibel of sound kept the team in 5th place.

Using UTC funds, NIATT was able to purchase testing equipment, and the development of the sled progressed by leaps and bounds. Conquering the rough terrain at Jackson Hole, Wyoming, the team took the valued "King of the Hill" award the second year. With less than three points difference in total points, SAE awarded first place to both UI and Kettering University.
But the UI team easily stood alone in first place the third year of competition, with separate awards for best fuel economy, quietest snowmobile, best performance, lowest emissions and best value.

With nothing to gain by using the same platform in the 2004 competition, the team began developing a direct injection engine. Although the work was very complex, the team completed the new sled in time for the competition. Sponsors commended the team for not resting on their laurels, but taking up the challenge of developing an even cleaner and quieter sled.

A Mild Hybrid Electric SUV--Dr. Don Blackketter and Frank Albrecht

The product of the FutureTruck research, involving 67 students in 2003-2004, was a hybrid drive train that operates like any other vehicle. The vehicle's primary fuel was gasoline, an energy source that could be implemented with today's infrastructure. The team decided to venture away from the standard of a parallel high-voltage hybrid. A low-voltage system was safer, cheaper, and easier to maintain. To overcome the low-voltage constraint and still produce output power high enough for a noticeable increase in efficiency, the system utilized an AC induction motor with an inherently low resistance. For reliability and power reasons, the energy storage mechanism was ultracapacitors. The fuel choice was Reformulated Gasoline (RFG).

The secondary power source for the hybrid was electric. It provided power assist during acceleration and regenerative braking during deceleration. The hybrid components were lightweight, representing only 5 percent of the mass of the vehicle, small enough to be easily integrated into other platforms.

Along with the hybrid powertrain, several innovations were implemented to help reduce the emissions and engine load. To control the engine temperature and reduce regulated emissions, a micro-controller based system used two electric pumps to direct the flow of engine coolant and two electric fans to help cool the radiator. To reduce cooling loads, accessory loads, and vehicle road load, major heat sources were removed from the front of the engine. Finally, to reduce cold start emissions, the catalytic converter was redesigned to reduce the rate of heat loss during times when the vehicle was parked and not running.

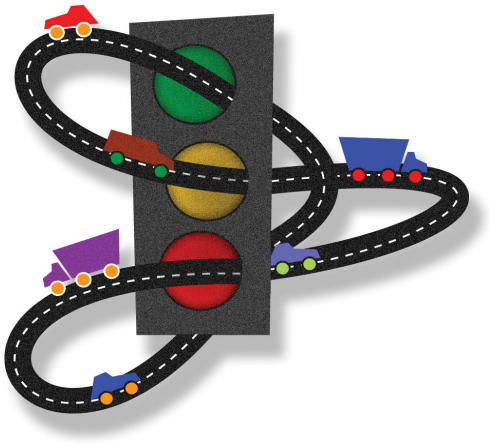
Key to the challenge, the converted Ford SUV had reduced emissions and improved fuel economy while maintaining safety, utility, convenience, and performance similar to the stock vehicle. Future research will emphasize the transfer of the technology to regional vehicles such as delivery, refuse, and logging trucks meeting the needs of the northwest's geography, culture and weather.

Old Airbags Could be a Problem--Dr. Karl Rink

The inflation of airbags relies on a hermetically sealed, pyrotechnic initiators. These initiators contain a 20 micron bridge wire electrodes that, in microseconds, heat, ignite, burn and produce the gas to inflate the bag.

How long do these seals last? An important question, for entering moisture could affect the ignition--or lack of it! How much moisture? These are the questions that intrigue Karl Rink. UTC funds are helping provide some unique equipment with which he will be able to bombard initiators with krypton and measure the rate of leakage.

The work is relevant not only to automotive safety, but has possible applications for the military's weapons delivery ejection systems.



Center for Traffic Operations and Control

NIATT's CID Adopted by Idaho Transportation Department

While on sabbatical, Michael Kyte continues to work on an ITD-funded project to integrate NIATT's controller interface device (CID) into ITD's traffic signal program. The purpose of this project is to develop and implement procedures for using real-time hardware-in-the-loop simulation as part of ITD's traffic signal timing program. Changes to ITD's *Traffic Manual*, as it relates to signal timing practices, will be identified and recommended to ITD.

A two-day workshop in Boise on using the CID to improve signal timing was conducted in May. CIDs have now been distributed to five ITD districts and headquarters.

CID Use Grows Nationwide

NIATT's CID continues to add value to other research efforts across the country. PTV America, the firm developing VISSIM, was contracted by P. B. Farradyne in Rockville, Maryland, to use the CID as an element in a testing platform for testing the interaction of two separate pieces of software on two separate processor boards running at the same time. Dean Pfaender of PTV America reported that they were able for the first time to have VS-PLUS and OPAC operate together in a laboratory setting.

They were able to isolate and analyze two behaviors seen in the field and test alternative settings in VS-PLUS. Pfaeder noted, "We are prepared to make field parameter modifications now with confidence." They were planning to update controller settings with the changes that were tested.

PTV America is also using the CID Suitcase software for static testing.

TRANSIMS Modeling--Dr. Michael Dixon

The primary focus of the UTC TRANSIMS project has shifted from general travel demand modeling to area-wide supply-side simulation. A significant effort has been placed on simulating systems of signalized intersections, which is consistent with the focus of a second UTC project aimed at maximizing data quality to optimize traffic signal system performance.

TRANSIMS is a new micro-simulation paradigm, and an objective of this project has been to create several networks. TRANSIMS has been implemented to simulate the entire city of Moscow, Idaho, which will be used as a test bed. Current work is underway to calibrate and validate this model using field data.

Two publications will be submitted this fall: one paper will be a validation and suggestions for improvement of the TRANSIMS modeling paradigm (traffic signal systems) and the other paper will discuss improved methods for system-wide automatic measurement of traffic signal system performance.

Two graduate students are working on the project--one preparing the simulation model and the other validating it using field data and existing simulation.

Survivable Systems Analysis--Dr. Paul Oman & Dr. Ahmed Abdel-Rahim

NIATT has partnered with the Federal Highway Administration (FHWA) and the Idaho Transportation Department to develop and build an integrated traffic signal system for the city of Moscow, Idaho. The project aims to improve safety and efficiency of the city's traffic signal system, to provide an access to the signal system from NIATT students and researchers, and to test the feasibility of using the National Transportation Communication for ITS Protocols (NTCIP) standards in small and medium-size cities rural environment.

A security and survivability analysis was integrated into the project design process and is being supported with UTC funds. The standard approach for evaluating transportation systems has traditionally focused exclusively on operational, safety, and security aspects, while ignoring issues of system survivability. A literature search for applications of the SSA method to real-time control systems for critical infrastructures yielded only a few results of works in progress, and none for intelligent transportation systems. Such an application of the SSA method to an intelligent transportation system requires a complementary strategy to address a broader class of influences and constraints, including a litany of well-known physical threats to system components and corresponding mitigation techniques.

Naturally, experts responsible for protecting critical infrastructures have already accumulated expansive background information about threats and mitigations for these systems, primarily directed toward resistance and recovery strategies for physical components. All that remains is to combine the threats and mitigations for physical components with the SSA for cyber threats, and to establish recognition strategies for identifying faults in physical components.

A NIATT research team, headed by computer science professor Paul Oman and civil engineering associate professor Ahmed Abdel-Rahim developed a seven-stage vulnerability/ survivability analysis process, which was applied to the City of Moscow's traffic signal system. The proposed approach could be applied during the planning and design phase of new ITS projects to evaluate different design alternatives or to assess the vulnerability and survivability of existing ITS systems.

The analysis completed for the City of Moscow system, as a case study, identified attack scenarios and threats, threat mitigation as well as survivability map with improved or additional threat mitigation strategies for different design alternatives. The proposed approach provides a significant addition to the current design practices of ITS systems by integration system vulnerability and survivability in the design process. While the case study represents a traffic signal system for small size cities, the approach could be implemented effectively to large scale ITS projects. A cost-benefit analysis of the proposed mitigation strategies should provide transportation officials with a decision making tool to evaluate different design alternatives and to improve the overall survivability of ITS systems.

Developing Transportation Case Studies--Dr. Michael Kyte

A UTC funded project involves developing traffic signal case studies, such as the ones used by the participants in NIATT's Traffic Signal Summer Workshop. The case studies will be refined during the fall and put together as a workbook for use as part of traffic engineering courses.

Traffic Signals Focus of Several Research Projects--Dr. Michael Kyte

Kyte worked on a number of other signal timing projects, providing technical assistance with data collection and analysis and the use of several traffic simulation programs, including CORSIM, TRANSYT 7F, SYNCHRO, and PASSER II/IV.

He participated in a two day peer review of Ada County Highway District's traffic signal timing program along with a panel of national experts in traffic signal timing and helped to prepare a report of recommendations to ACHD traffic engineering staff.

NIATT's Technology Transfer Efforts

Workshop to Examine Advantages of Biodiesel Use

http://www.biodieseleducation.org.

The advantages of using biodiesel fuel for public or private transportation will be the topic of a national workshop to be held Thursday and Friday, Sept. 9-10, in Boise's Centre on the Grove. The workshop is the kickoff event of a five-year, national USDA grant awarded to the University of Idaho totaling $950,000, to bring nationwide education to the public about biodiesel fuels made from oil crops.

Representatives of state departments of transportation, the general public and engineering students can learn about biodiesel production, availability and use from leading experts and users nationwide. Barriers to the use of biodiesel in transportation fleets also will be discussed.

Kyte Advises Idaho Transportation Department

NIATT Director Michael Kyte takes affiliation with the Idaho Transportation Department (ITD) seriously, as indicated by his choice to spend the first six months of his sabbatical in Boise, Idaho, working closely with ITD Director Dave Ekern and other ITD senior staff.

One goal was to identify ways in which research could play a more effective role for ITD, as part of Ekern's "transforming transportation in Idaho" program.

Kyte also worked with ITD senior staff to identify strengths and weaknesses of the existing program. He produced a report with a set of findings and recommendations that is currently under review by ITD's executive team.

Partnerships

NIATT has been fortunate in establishing a number of partnerships that have a positive impact on our research capabilities and our abilities to provide positive learning experiences for our students. Partnerships provide opportunities for joint research, in-kind donations, and promote professional capacity building.

The Center for Traffic Operations and Control has established its expertise in the area of traffic signal systems by using UTC funds, first to develop the Controller Interface Device and then continuing researching that area, constructing a state-of-the-art laboratory, and providing training to students and professionals. The resulted has been additional funding to work in this area meeting the demand for improved surface transportation

Likewise, the researchers in the Center for Clean Vehicle Technology, focusing on environmental and quality of life issues, has had an impact on national park policy through its work with biodiesel fuel and snowmobiles using best practice technology. Their work with catalytic ignition has contributed to the growth and success of an Idaho business.

We are grateful to our many partners and contributors, such as the following:

Idaho Transportation Department (ITD)
NIATT has an ongoing relationship with ITD. Each year, ITD's Research Advisory Committee extends an RFP for new projects to be funded with SPR funds. The projects are evaluated according to three issues:

1 Did the proposed project meet the definition of research?
2 Did the project address a Department need?
3 Had the problem been addressed previously either internally or by some other agency?
4 Was the project the subject of current research at the regional or national level?

A total of $464,101 for new research projects were allocated for NIATT affiliate faculty, a large proportion of ITD's research funds.

Each research project has its own technical team, with whom the researchers keep in close contact. The researchers, and often the graduate students working on the projects, appear before the Research Advisory Committee at least once a year to provide updates on their research.

Projects often include training for ITD personnel. For example, graduate student Melissa Cleveland met with the ITD planning staff recently to teach them how to use S-Plus to create categories needed for estimating average annual daily traffic (AADT) growth factors.
ITD's District 2 management provides the time for Dale Moore, the District's Traffic Signal Foreman, to participate in NIATT's Traffic Signal Summer Workshops. Moore directs the session on loop detection theory and operation, one of the popular hands-on activities of the week's workshop. Dale brings one of ITD's working traffic controllers to the workshop and

also provides access to the students to equipment in the field for other days' experiences. He also makes arrangements for the first day of the workshop when students go into the field.

Principal investigator Judi Steciak and her team also benefit from a partnership with ITD. An ITD-funded project, "Fleet Vehicle Demonstrations of Alcohol-Water Fuel and Catalytic Ignition System," supplements the work the catalytic ignition work the team is doing with UTC funding. The team's most recent tasks involve over-the-road durability data, emissions monitoring, and plans for the integration of converted vans into public transit and vehicle fleets.

Federal Highways Administration
The research completed with UTC funds in the Center for Traffic Operations and Control helped NIATT establish a reputation with FHWA and resulted in a grant of nearly $1 million to work on intelligent transportation system components and infrastructure for research and implementation of traffic control systems in small and medium-sized cities in Idaho.

FHWA funds also went to the Center for Clean Vehicle Technology for a project that also involved another transportation institute, the Western Transportation Center at Montana State University. These funds helped NIATT improve its Snowmobile Research and Development Laboratory, which now includes a small engine dynamometer for engine testing and a snowmobile chassis dynamometer.

Wholesale Hydraulics; Moscow, ID
A local business generously supported the efforts of NIATT's Advanced Vehicles Concepts Team (AVCT) as they prepared their entry in the 2004 FutureTruck competition. Wholesale Hydraulics first provided space and tools for the students' use. As students worked on the FutureTruck's innovative hydraulic system , they were able to draw on the knowledge and experience of working professionals.

Kent Fluid Power (Kent, Washington); Parker-Ford Motor (Pullman, Moscow); Ramsey Products Corporation (Charlotte, North Carolina)
Students working on the FutureTruck team forged close relationships with business operators, explaining the concept of the competition and of their specific vehicle. Their enthusiasm and knowledge resulted in donations, for example, of a hydrastatic transmission with an electronic stroke control valued at $7500 from Kent Fluid Power and a 50 percent discount on carpeting and the use of a tow vehicle from the local Ford dealer.. Ramsey Products , out of North Carolina, donated for chains and sprockets for the AC induction motor drive train. They also used information about the FutureTruck in their promotional material. (see Appendix A).

FutureTruck Sponsors
Being part of the FutureTruck competition, sponsored by the **US Department of Energy** and the **Ford Motor Company**, provided students with direct access to automotive professionals. Other corporate sponsors of the national FutureTruck competition had a direct impact on NIATT's research program. For example, **MathWorks, Inc**., provided a 10 seat concurrent MatLab license with a market value exceeding $2 million. Students used the software to model vehicle performance so that powertrain components could be sized for optimum efficiency. **National Instrument'**s donation of LabVIEW software was valued at $13,235. LabVIEW was used to control all vehicle systems through the National Instruments' computer. Replacing redundant processors on the stock vehicle, our single computer with labview software controlled our new electric hybrid, engine cooling, passenger compartment cooling, transfer case, entertainment, and telematics systems.

Valley Transit; Lewiston, Idaho
Tom LaPointe, director of Valley Transit and a member of the peer review panel, has been an avid supporter of the work of the Center for Clean Vehicle Technologies. He provides the van used by the research team working on combustion modeling to improve air quality and fuel consumption on fleet vehicles. He has used his contacts in the transit industry to help publicize the research at NIATT.

Performance Coatings; Auburn, Washington
Performance Coatings has been a supporter of the Clean Snowmobile Team, and this year, provided the ceramic coating on the snowmobile's exhaust at no cost. The team chose a ceramic coating system to keep heat within exhaust system away from the engine. The ceramic coating also enhanced the snowmobile's appearance, one of the competition's judging criteria.

Automotive Resources, Inc.
Mark Cherry, CEO of Automotive Resources, Inc., of Sandpoint, Idaho, and a member of the peer review panel, works closely with Dr. Judi Steciak and Dr. Steve Beyerlein and the student members of their research team. The partnership benefits not only the students who are able to work with the engineers at ARI, it also benefits Idaho economic development. Based on the joint efforts of NIATT and ARI, the firm received SBIR funding to continue developing uses for the patented catalytic igniter, the key to the combustion of very lean fuel mixtures, reducing automotive emissions.

American Trucking Association (ATA)
Four NIATT affiliate faculty are conducting research into issues of value to the American Trucking Association, including studies of safety issues involving longer combination vehicles, asset management and load securement.

Purdue University
Over the past five years, Purdue University has assisted the University of Idaho in the development of a second generation Controller Interface Device (CID) and the development of educational material related to that device. Darcy Bullock of Purdue is also a consultant for the ITS project funded by FHWA and has been an instructor in our Traffic Signal Summer Workshop.

Boise State University; Washington State University; Michigan State University;
NIATT researchers continue partnerships with principal investigators from other universities, working on a variety of research projects.

Engineering Expo 2004

NIATT has continued sponsorship of the annual Engineering Expo held on the campus of the University of Idaho each spring. The highly publicized event attracts local high school and elementary students and the public. Approximately 2000 visitors attened the Expo.

The Expo also brings back to the UI campus practicing engineers and other alumni to assist with the judging and to interact with the students.

NIATT had a significant presence at the April 30, 2004 Engineering Expo. Ten of the 27 booths, three technical sessions, four posters and two judging tours were the result of capstone design classes associated with NIATT research projects.

BOOTHS

1. 2002 Ford Explorer/FutureTruck and the F-350 Ford Pickup tow vehicle
2. Aquanol-Powered Van—booth exhibit: flexible fuel operation with catalytic igniters to sustain ignition of aqueous ethanol and gasoline; comparable thermal efficiency and net decrease in emissions while maintaining desirable performance
3. Biodiesel Demonstration Vehicles: 2001 1.9 liter TDI VW BioBug and the 1999 Dodge 24-valve electronic injection Cummins engine ¾ ton pickup and the Vandal Trolley running on 100% biofuels
4. Automotive Resources: catalytic ignition; improved combustion efficiency and ability to burn alternative fuels
5. Homogeneous Charge Catalytic Compression Ignition of JP-8 fuel in a Reciprocating Piston Engine JP8 fuel used in generators—little conversion cost and higher power density than diesel (although lower than gasoline)
6. FutureTruck custom transfer case—coupling the AC induction machine to the powertrain.
7. Idaho Engineering Works (IEWorks)
8. No-Smoke Two-Stroke—gasoline direct-injection two-stroke Clean Snowmobile
9. Clean Snowmobile
10. Clean Snowmobile: new exhaust system and emissions control for the 600 DFI CSC engine

TECHNICAL SESSIONS

1. CID: remote access traffic controller laboratory
2. FutureTruck hybrid electric assist system: (ultra capacitor storage bank; three-phase induction machine; and industrial motor controller)
3. FutureTruck—the Ford Explorer and the Ford Truck

JUDGING TOURS

Remote Access Traffic Controller Laboratory and FutureTruck

POSTERS

CID
FutureTruck hybrid electric assist
Pyrotechnic Initiator in automotive passive restraint systems

Website Nominated for ITE Award

(http://www.webs1.uidaho.edu/transed/)

An on-line directory of transportation engineering course materials developed by NIATT under the auspices of the Education Council of the Institute of Transportation Engineers was nominated for the ITE Coordinating Council Award. The website's purpose is to provide a web-based index to transportation engineering courses that are taught in colleges and universities throughout the U.S. The site allows university faculty to more effectively share information regarding the courses that they teach, and is particularly helpful to new faculty who are developing their own course materials.

According to Dr. Gary B. Thomas, Chair of the ITE Education Council, the materials on this site are the first public compilation of course syllabi and "serve to raise the knowledge base for instructors seeking a base for their own syllabi."

As of February 1, 2004, the site included materials/syllabi/course links for 70 transportation courses from 33 instructors at 25 institutions. In the first three months of the web's completion, there were over 240 visits. Unsolicited comments were positive:

- "Should be a useful resource."
- "It is a valuable resource that will grow with time and become even more valuable."
- "I am pleased to see so many courses on so many different subjects listed."

Graduating Students Transfer Technology

Two mechanical engineering students who graduated in spring 2004 will be taking their experiences and knowledge gained working on the FutureTruck with them to their new jobs. Both Jeremy Forbes and Richard Statler, undergraduate team members who received BS degrees, were contacted by companies, interviewed, and hired as a direct result of their FutureTruck experiences. Both are now design engineers.

Statler was hired by NEOPLAN USA of Denver, Colorado, after being recommended by one of the FutureTruck mentors. The company is currently producing dual-mode buses similar to the series hybrid technology pioneered on the Future Truck. As Statler reported back to NIATT: "My hands-on experience with NIATT and the Enriched Learning Environment gave me an edge when selecting a career, but it really paid off when I hit the shop floor the first week and knew what I was talking about."

Forbes' first contact with his employer, Micron Corporation of Tullahoma, Tennessee, was at the display of the FutureTruck at the SAE Congress. Impressed with the work he did on the ultracapacitors, they stayed in contact with him until graduation. He is continuiing to work with energy storage for Micron.

Publications and Presentations at Conferences

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Klein, M. K. and K. K. Rink, "Pyrotechnic Initiator Research at the University of Idaho," presented at the 19th International Colloquium on the Dynamics of Explosions and Reactive Systems, July 27-August 1, Hakone, Japan, 2003.

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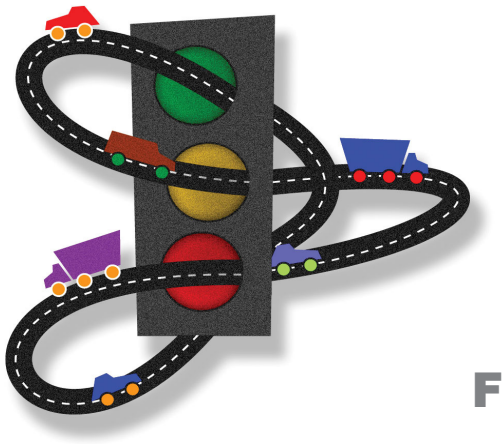

FINANCIAL REPORT

FY04 Expenditures

NIATT expenditures in FY04 reached nearly $2.5 million and came from a variety of sources. Although the amount of UTC funds has increased over the 6 years NIATT has been a UTC center, the percentage of the UTC funds to NIATT total expenditures has not increased. UTC funds have spurred growth in our transportation program, attracting funding from both government and private sectors.