



NIATT

National Institute for Advanced Transportation Technology

ANNUAL REPORT • AUGUST 2001



PREPARED FOR UNIVERSITY TRANSPORTATION CENTERS PROGRAM

RESEARCH AND SPECIAL PROGRAMS ADMINISTRATION

U.S. DEPARTMENT OF TRANSPORTATION

FUNDING PERIOD JULY 1, 2000 THROUGH JUNE 30, 2001 - FY01

Theme: Advanced Transportation Technology

Mission

Our 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 is a Center of Excellence for research and development of transportation technologies for the state of Idaho, the Pacific Northwest and Intermountain regions, and 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 to bring these technologies to the marketplace.
- We seek collaborative research and development projects with the Idaho Transportation Department and other organizations.
- We work with university faculty to develop transportation research agendas and obtain funding for transportation research projects.
- We seek to educate the public about new transportation technologies.

Because of our geographic location, NIATT is able to serve a unique segment of the population. A number of other UTCs focus on transportation issues impacting metropolitan areas. NIATT, along with the regional University Transportation Center TransNow, serves the Pacific Northwest, where population centers are significantly smaller than in other parts of the country. With that in mind, NIATT's Center for Traffic Operations and Control chose to direct its research toward local government agencies and practicing engineers in medium to small cities with populations less than 150,000.

Much of the work completed by our Center for Clean Vehicle Technology relates to the area's environmental concerns of preserving national parks and other pristine areas, while continuing to provide for recreational uses of those same areas. We invest our research dollars in projects involved with alternative fuels and the next generation of vehicles in an attempt to protect and enhance communities and the natural environment affected by transportation.



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This *Annual Report* highlights the activities and accomplishments of NIATT under the University Transportation Centers Program during fiscal year FY 2001—July 1, 2000 through June 30, 2001. The first *Annual Report* was published in 1999; this report is the third such report. The information presented here was gathered through interviews and correspondence with NIATT faculty, staff, students, and peer review panel members. The report describes the major research projects and programs and the progress made in FY2001 in the U.S. Department of Transportation program areas of education, research, and technology transfer. Each research project is listed according to the program area it best advances. The report also describes NIATT's management structure.

To access this report on the Internet, please visit NIATT at <http://www.its.uidaho.edu/niatt>.

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Jeff Olson
Beth Case



Director's Message

I am pleased to introduce to you, through our annual report, some of the more than 130 faculty, staff, and students who have helped to make this year a successful one for the University of Idaho's National Institute for Advanced Transportation Technology. Our strategic plan, with its focus on transportation technology, has served as a guide as we have completed projects in education and research, and moved our technology to end users through our outreach program.

Our education and training program is a cornerstone in preparing our students for the transportation profession.

- In August 2000, we hosted 12 civil engineering students, representing each geographic region of the United States, at our first-ever Traffic Signal Summer Camp. The camp provided a weeklong hands-on environment for students to learn about and use the basic element of today's ground transportation system, the traffic controller and its components. Ten experts led discussions and exercises in traffic signal design, traffic signal timing, video detection, actuated traffic control systems, loop detector construction and testing, and real-time hardware in the loop simulation. Based on the success of last year's camp, we are finalizing plans to host Traffic Signal Summer Camp II in August 2001.
- Through new funding provided by Idaho's governor, the university hired two new faculty members in traffic operations to support NIATT's program.
- NIATT's clean vehicle technology students presented their hybrid electric SUV and alternative-fueled vehicles at demonstrations throughout the state.
- Idaho Engineering Works provided leadership and mentoring programs for undergraduate and graduate students working on NIATT's FutureTruck and Clean Snowmobile Challenge vehicles.

Our research program focuses on priorities established by federal and state transportation agencies and is monitored by our peer review panels.

- NIATT researchers developed and refined technology products to reduce vehicle emissions and decrease fuel consumption. Mechanical, electrical, and biotechnology engineers developed biodiesel fuels, water alcohol ignition systems, hybrid electric powertrains, and software support tools for electric vehicle operations.



- NIATT's peer review panels provided project review and quality control through intensive project review meetings conducted in October 2000. Student involvement in the peer review panel meetings was important to both students and faculty. Geoffrey Judd, NIATT's student of the year, noted, "*The best part of my degree was the interaction I had with both the professors and professionals.*"

Our outreach program ensures that the results of our education and research programs are delivered to transportation professionals.

- At the request of the Federal Highway Administration's Research and Development staff, we developed a key technology for the design and implementation of today's Intelligent Transportation Systems. NIATT's Controller Interface Device, or CID, enables transportation engineers to test advanced traffic control algorithms in the laboratory before they are deployed in the field. Through a license to a traffic controller manufacturer, the CID will be available to the transportation profession in fall 2001.

David Thompson, the University of Idaho's Dean of Engineering, recently recognized NIATT's importance:

NIATT is a critical element in the multidisciplinary program within the College of Engineering and throughout the university. It not only serves as a major research thrust area, engaging faculty within many disciplines; it is also a key academic program that serves our undergraduate students through work and research experiences. Many graduate students similarly gain an exposure to leading edge research as well as to courses that eventually derive from NIATT's endeavors.

I encourage you to read this report to learn about the innovation that our researchers, educators, and students have brought to our transportation program.

Michael Kyte
Director

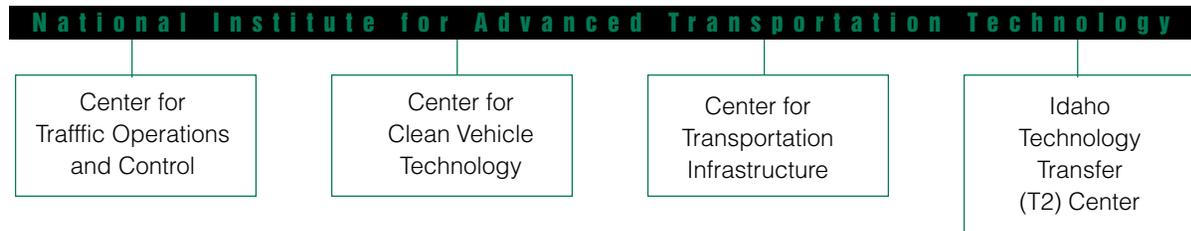
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Management Structure and Principal Center Staff

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, Idaho Department of Water Resources, the U.S. departments of Energy and Defense. The research in the Center for Transportation Infrastructure is supported mainly by the cooperative agreement between NIATT and ITD. The Idaho T2 Center receives major funding from the Federal Highway Administration's Local Technical Assistance Program.

Management Staff

Michael Kyte
Director, NIATT
Professor, Civil Engineering

Donald Blacketter
Director, Center for Clean Vehicle Technology
Professor, Mechanical Engineering

Judy B. LaLonde
Management Assistant, NIATT

Jane Estocin-Klaiber
Financial Technician, NIATT

Thomas Jacob
System Administrator/Software Development Engineer, NIATT

Gene Calvert
Director, Idaho Technology Transfer (T2) Center

Bruce Drewes
Training and Research Manager
Idaho Technology Transfer (T2) Center

Ruthie Fisher
Administrative Assistant II
Idaho Technology Transfer (T2) Center

Kathy Busch, Office Specialist
Andrew Waterson, software developer
Nick Orr, software developer
Craig Dierling, student assistant
Stacy Smith, work-study student assistant
Jessica Kniola, work-study student assistant

NIATT Affiliate Faculty

Ahmed Abdel-Rahim
Visiting Assistant Professor, Civil Engineering

Fouad Bayomy
Professor, Civil Engineering

Steven Beyerlein
Professor, Mechanical Engineering

Kang-Tsung (Karl) Chang
Professor, Geography

Karen DenBraven
Professor, Mechanical Engineering

Michael Dixon
Assistant Professor, Civil Engineering

David Drown
Associate Professor, Chemical Engineering

Dean Edwards
Professor, Mechanical Engineering

John Finnie
Associate Professor, Civil Engineering

James F. Frenzel
Associate Professor, Computer and Electrical Engineering

Donald F. Haber
Professor Emeritus, Civil Engineering

James H. Hardcastle
Professor, Civil Engineering

Brian Johnson
Associate Professor, Computer and Electrical Engineering

James R. Jones
Professor, Agricultural Economics/Marketing Economics

Zaher Khatib
Assistant Professor, Civil Engineering



James Kingery
Associate Professor, Range Resources

David McIlroy
Assistant Professor, Physics

Stanley M. Miller
Professor, Geological Engineering

James R. Nelson
Professor, Agricultural Economics/Rural Sociology

Richard J. Nielsen
Associate Professor, Civil Engineering

Edwin Odom
Associate Professor, Mechanical Engineering

Charles Peterson
Professor, Biological and Agricultural Engineering

Kelly Sale
Lecturer, Computer Science

Edwin R. Schmeckpeper
Assistant Professor, Civil Engineering

Judi Steciak
Assistant Professor, Mechanical Engineering

Richard B. Wells
Associate Professor, Computer and Electrical Engineering

Peer Review Panel Members

Center for Clean Vehicle Technology

Basil Barna
Idaho National Engineering and Environmental Laboratory

John Boesel
WestStart/CalStart

Mark Cherry
Automotive Resources, Inc.

John Crockett
Idaho Department of Water Resources

Donald Durkee
Federal Transit Administration

Gerry D. Galinato
Idaho Department of Water Resources

Tom LaPointe
Valley Transit

James A. McClure
U.S. Senator, Retired

P. T. Moseley
International Lead Zinc Research

Tim Murphy
Idaho National Engineering and Environmental Laboratory

William Siegel
Federal Transit Administration

Rogelio A. Sullivan
U.S. Department of Energy

Harry Townes
Engineer; Professor Emeritus

David E. Walrath
University of Wyoming

Jerry Whitehead
Western Trailers

Center for Traffic Operations and Control

Ken Courage
University of Florida

Raj Ghaman
Federal Highway Administration

Wayne Kittelson
Kittelson & Associates, Inc.

William C. Kloos
City of Portland

Greg M. Laragan
Idaho Transportation Department

Jim Larsen
Ada County Highway District

George List
Rensselaer Polytechnic Institute

Paul Olson
Federal Highway Administration

Jim Pline
Pline Engineering

William Reilly
Catalina Engineering

Carlton Robinson
Consultant

Stan Teply
University of Alberta

NIATT Peer Review Panels Provide Independent Evaluation of Projects

Two peer review panels were established early in NIATT's strategic planning efforts—one associated with the Center for Clean Vehicle Technology and the other with the Center for Traffic Operations and Control. Peer review panel members meet at least once a year to help guide NIATT's activities, provide technical review of our research, champion our technology products, and help identify potential partnerships.

Guidelines for the operation of the panels were adopted from a 1990 publication of the American Consulting Engineers Council and the American Society of Civil Engineers.

- Project peer review is conducted by peers of the agency managers and staff personnel to whom they can relate professionally and technically.
- Project peer review is conducted by individuals who are totally independent of the agency.
- Project peer review is an extra effort, not a normal part of the agency activities.
- Project peer review has specific objectives, scope, format, budget and duration.
- Project peer review is designed to develop and produce practical results.

Panel members, meeting in October 2000, learned about ongoing projects through presentations from graduate students and principal investigators. The members met in executive sessions and in joint sessions. A published report (*Peer Panel Report and Project Review: Center for Clean Vehicle Technology; Center for Traffic Operations and Control*) conveyed their views on the quality of NIATT research and made suggestions for change.



Peer Input Results in Change in NIATT Procedures

Several peer panel members suggested the panel be included in research project selection. As a result, fourth year funding commitments will be made only after a review period that includes peer review panel member participation. A request for proposals for fourth year funding was released in April 2001. The panel members will submit evaluations of the proposals, based on seven criteria, by June 30, 2001.

“The Panel is interested in considering future projects at the ‘embryo’ stage . . . to provide some ideas, contacts, pertinent research, and some direction from the user viewpoint.”

James L. Pline, peer review panel member

“The Clean Vehicle Technology peer panel members were again very impressed with the quality of the project summary presentations, especially the poise and professionalism of the participating students.”

David E. Walrath, Acting Chair, November 13, 2000

“I firmly believe that the university's direct involvement in catalytic ignitor and alternative fuels research and development can be of significant economic and environmental impact in the not too distant future.”

William J. Burnett, former peer review panel member

NIATT RESEARCH PROJECT STATUS

New (selected and begun during FY01)

- Idaho Engineering Works
Edwin Odom (KLK323)
- Alternative Powered Snowmobile Development
Karen Den Braven (KLK303)
- Vehicle Performance Simulation
Donald Blackketter (KLK306) (incorrectly titled KLK305, Phase III, in *Year 3 Projects*)

Ongoing (from FY99 and/or FY00)

- Development of Controller Interface Device (CID) for Hardware-in-the-Loop Simulation
Brian Johnson; Richard Wells; Michael Kyte (KLK201)
- Actuated Coordinated Signalized Systems
Ahmed Abdel-Rahim; Zaher Khatib (KLK202)
- Development of Video-Based and other Automated Traffic Data Collection Methods
Michael Kyte (KLK203)
- Development of Internet-Based Laboratory Materials
Michael Kyte (KLK204)
- Traffic Signal Summer Camp
Michael Kyte (KLK205)
- FutureTruck Hybrid Vehicle Demonstration
Donald Blackketter (KLK302)
- Biodiesel Fuel from Yellow Mustard Oil
Charles Peterson (KLK310)
- Reactor Studies of Water-Alcohol Catalysis
Judith Steciak (KLK317)
- Diesel Engine Conversion to Aquanol
Steven Beyerlein (KLK318) (incorrectly titled KLK316 in *Year 3 Projects Descriptions*)

*Clean
Snowmobile
Challenge*



Completed

- Advanced Lead Acid Battery Development
Dean Edwards (KLK330)
- Homogeneous Charge Combustion of Aqueous Ethanol
Steven Beyerlein (KLK316)
- Catalytically-Assisted Combustion of Aquanol in Demonstration Vehicles
Steven Beyerlein; Judith Steciak (KLK315)
- Logic-Based, Performance Driven Electric Vehicle Software Design Tool
Donald Blacketter (KLK305)
- Optimal Design of Hybrid Electric-Human Powered Lightweight Transportation
Edwin Odom (KLK320; KLK321)

NIATT Offers a Strong Educational Program

NIATT offers a multidisciplinary program of coursework and experiential learning that reinforces its transportation theme. Program elements include:

- a strong educational program that provides undergraduate students and graduate students with a broad range of practical and real-life educational experiences in transportation;
- an undergraduate and graduate program in which students gain an appreciation for the environmental impact of transportation;
- a nationally recognized graduate research program in traffic operations and control and clean vehicle technology;
- a transportation engineering program that provides practicing engineers, especially those in cities of 150,000 or less, with a broader knowledge base and expanded opportunities for experiences in transportation;
- an undergraduate program that educates transportation engineers in intelligent transportation systems and related technologies, such as information processing, communications, control, and electronics;
- an undergraduate program that provides training for mechanical and electrical engineers in vehicle engineering; and
- the Idaho Technology Transfer Center, which is broadened in its responsibilities and a recognized provider of continuing education for practicing engineers.

Our research is supported by nearly 100 students at graduate and undergraduate levels. Student involvement in transportation research often begins with an internship, during which students work with faculty members on research projects. Our research supplements engineering course materials and is used to interest students in transportation engineering. All of our UTC-funded projects support graduate students seeking advanced engineering degrees.

UI's Clean Snowmobile team members pose with Olympic wrestler and gold medalist Rulon Gardner (on snowmobile) and Dr. Lori Fussell, co-organizer of the Clean Snowmobile Challenge (right)



Student Experiences Provide Bridges to Their Futures

With the demand for engineers in today's market, it has become increasingly difficult to convince undergraduate students to postpone beginning their "real lives" in order to pursue graduate degrees. After graduation, students are easily lured into accepting jobs from employers who can offer relatively high salaries and other benefits. Being able to use UTC funds to pay a graduate student's fees along with an assistantship allows us to be more competitive in attracting students to our program than we have been in the past.

Because NIATT's mission is to develop, evaluate, and market technology products that meet national, regional and local goals, UI graduate and undergraduate students are often able to see the end result of their research. Their satisfaction and excitement helps generate a greater interest in the transportation engineering fields among other students.

In addition, we believe that the kinds of experiences we offer both graduate and undergraduate students—opportunities to work directly with industry,

government representatives and transportation practitioners, conduct and participate in project design and review, negotiate with vendors, solicit supplementary funds, mentor fellow students, and develop leadership skills—make them exceptionally well-prepared for the future workforce.

In the next few pages, we highlight the stories of some of our students and demonstrate the ways they participate in our research. Following that, we present success stories from our projects that place a high emphasis on education.

RESEARCH PROJECTS WITH EMPHASIS ON EDUCATION

Project No.	Page
KLK205	24
KLK323	26
KLK204	28
KLK302	30
KLK303	32
KLK315	34

Access to Professors Attracts Graduate Students

Finding his interest progressing from bridges to pavements and finally to traffic engineering, Phil Rust had an important decision to make as he was completing his undergraduate degree in civil engineering—where would he go to graduate school? His professor/mentor at Washington State University convinced Phil he was “master’s material.”

His offer from the University of Idaho included the promise of a research assistantship, working on a specific project, and the opportunity to study under Michael Kyte, director of NIATT. The University of Idaho was unique in two other ways that appealed to Phil. He liked the location—the UI campus is located

in Moscow, Idaho, an attractive university town in a rural setting. And he had heard from other UI students that he could expect to work closely with the transportation engineering faculty. Phil’s grad school experience got a jump-start when he attended NIATT’s first Traffic Signal Summer Camp (*see p.24*).

As he nears the end of his first year of graduate school, Phil emphatically states that he would make the same choice. “I’m glad to be doing research,” Phil says. “I’m getting to see some meaningful results.” Phil is working with Dr. Ahmed Abdel-Rahim on an ITS project, modeling possible detour routes that will optimize the movement and safety of vehicles during freeway incidents.

Phil is spending the summer as an intern with Six Mile Engineering in Boise, Idaho. He will return to UI in August to assist with Traffic Signal Summer Camp II.



Phil Rust (center) gets input from NIATT faculty (Ahmed Abdel-Rahim, Michael Dixon and Michael Kyte)

*Dave Alexander at FutureTruck
2000 Competition*



Non-Traditional Graduate Student Contributes to Society

When David Alexander left California for Idaho, he brought along his wife and a continuing interest in conserving and protecting the environment. Three children and six years later, Dave's Ph.D. in mechanical engineering is in sight, and SmartHEV (see p.46), a software tool he has been developing, will be used to model energy consumption in hybrid electric vehicles.

Three years after receiving his bachelor's degree in physical science at California State University, Chico, and working in soils and hydrology, Dave chose the University of Idaho, partly for its rural setting, to continue his education. His work with UI professor Ron Smelser concerning the feasibility of a distance-delivered sophomore mechanical engineering class helped him earn his M.S. in mechanical engineering.

Dave's current work developing a modeling tool for efficient energy management combines traditional

mechanical engineering skills with mathematics and computer science, a perfect illustration of the versatility of today's new engineers. His mathematical tool will be used first to provide design information for the UI FutureTruck 2001. But the final goal will be to use the logic-based, computer algorithms to model energy consumption in a more general vehicle model.

"Incredible" is the word Dave uses to describe the educational program in mechanical engineering at the University of Idaho. He finds his professors "approachable" and "down to earth." According to Dave, the University of Idaho's engineering program does not yet receive the recognition it deserves.

"The best part of working on my degrees at UI was the interaction I had with both the professors and professionals."

Geoffrey Judd, NIATT

Student of the Year

“I’m glad for the internship experience. I understand a lot more about engineering.”

Sarah Haderlie, intern

Internship Program Provides Experience with Real Projects

NIATT is committed to providing a strong educational program for undergraduate students. As a result of the University Transportation Centers grant, we expanded our internship program. NIATT interns—undergraduate students—work closely with faculty members who are involved in a variety of transportation projects. Students are paid on an hourly basis, working as many hours as they can handle along with their classroom responsibilities.

Student interns presented results of their research at NIATT’s Fourth Annual Internship Colloquium held on May 10, 2001. The interns told how their research had provided them with an appreciation for engineering that surpasses the normal undergraduate curriculum. “I never would have thought about

wondering how a bridge performs in the long term,” said Jarrod Milligan. As a result of Jarrod’s research, Dr. Edwin Schmeckpeper will report back to ITD personnel on the importance of proper storage and handling of materials during staged bridge construction.

Jeremy Boles, a mechanical engineering undergraduate, experienced both the joys and woes of leadership during his internship experience. As president of the Advanced Vehicles Concepts Team (AVCT), Jeremy organized weekly team and officers’ meetings for students working on the FutureTruck project. He served as the conduit for information from FutureTruck officials to AVCT members, reporting changes in regulations as the team reengineered the UI’s FutureTruck. At the colloquium, Jeremy explained how the choice of new batteries and a redesigned battery pack was predicted to affect the performance of the Suburban at this year’s competition in June at the GM Proving Ground in Milford, Michigan.



Jeremy Boles, mechanical engineering, shows fellow interns (Gary Vance, chemical engineering, Gary Haderlie, civil engineering, Sarah Haderlie, civil engineering and Jarrod Milligan, civil engineering) some of the improvements made to FutureTruck components as part of his internship

Professional Meetings Introduce Students to Private and Public Sector Engineering

UTC funds helped send four NIATT research assistants to Washington, D.C., to attend the 80th Annual Meeting of the Transportation Research Board. Over 8,000 transportation professionals participate in the yearly meeting, providing the students with a variety of perspectives about transportation engineering.

“With thousands of people who are interested in transportation and related fields in one place, the Annual TRB Conference was a different world. It is definitely a good place to share our ideas with transportation professionals from around the world,” said Kris Jagarapu, NIATT graduate student, civil engineering.

UI Students Set the Pace at the ITE Traffic Bowl

A team of University of Idaho engineering students from NIATT captured first place in Traffic Bowl—a transportation engineer’s version of “Jeopardy.” “The University of Idaho not only won the Northwest Regional Traffic Bowl, they annihilated the competition in the process,” according to Kathleen Johnson, vice president of Coral Sales Company in Milwaukie, Oregon, and moderator of the Traffic Bowl. “UI students withstood the pressure and dominated with their accuracy and very quick timing.”

UTC Funding Provides Special Training

In April 2001, Dan Gerbus attended the University Technical Systems (UTS) Gear Design and Manufacturing Training in Rockford, Illinois. The three-day course included basic and advanced gear theory as well as approaches to optimizing gear train designs. Another portion of the course dealt with using UTS’s custom gear design software to aid in the design process. The class provided information he will use not only for his Ph.D. dissertation, but also for the gear design in the 2002 FutureTruck. “I found the course very worthwhile,” reported Gerbus. “In a semester class, there is not a significant amount of time to go as deep into gear design. This class was an excellent step toward increasing the knowledge base of gear design here at UI. Just learning about the different references available and meeting the leaders in the field would have been a good enough reason to go to the class. It helped establish contacts in the gear manufacturing world for various NIATT projects, but especially FutureTruck” (see pp.30, 52).

“We not only gave presentations, but we went to other presentations that were related to our research. I even got to meet several of the authors that I cited in my paper.”

Eric Clarke, graduate student, mechanical engineering, on attending the Second Joint Meeting of the U.S. Sections of the Combustion Institute

“ Being selected as student of the year was a great honor. It is not only a schoolwide but also a nationwide honor, and helps to highlight some of the work that can be accomplished at UI. I keep my award in my office.”

Geoffrey Judd

Student Honors



Judd received Student of the Year Award from DOT Deputy Secretary Mortimer Downey

Geoffrey Judd Accepts Student of the Year Award

Geoffrey Judd was one of 33 students honored at the Tenth Annual Outstanding Student of the Year Awards ceremony held on Monday, January 8, 2001, at the 80th Annual Meeting of the Transportation Research Board in Washington, D.C. Judd is employed by consultants Kittelson & Associates, Inc., Portland, Oregon. His current work involves analysis and report preparation for traffic impact studies and transportation system plans. He will receive his Master of Science degree in civil engineering in summer 2001.

Scholarship winners Amy Schroeder, Binu Abraham, Christina Ryan and Michael Conn (absent-Gary Haderlie)



Scholarships Awarded

The **2001 Ellis L. Mathes Scholarship Award** was presented to civil engineering graduate student **Binu Abraham** by the Intermountain Section of the Institute of Transportation Engineers (ITE). Binu's award was presented to her at their annual meeting in Jackson, Wyoming, in May 2001.

Binu also received the first **Dan Fambro Memorial Transportation Scholarship** awarded by NIATT. Binu is finishing her master's degree, studying operations of two-way stop-controlled intersections (*see p.44*). She serves on the UI Presidential Task Force on Parking and Transit. She was a key member of the UI team that won the ITE Traffic Bowl.

UI students **Amy Schroeder** and **R. Michael Conn** received **Douglas P. Daniels Scholarships**, awarded yearly by the Coral Sales Company of Milwaukie, Oregon. Kathleen Johnson, Coral Sales vice president, presented both students checks for \$1000 and encouraged them in their pursuit of transportation careers.

Amy is president of the UI Society of Women Engineers and has an overall GPA of 3.5. During the summer of 2000, Amy worked as an engineering intern with Washington Group International in Seattle.

Mike Conn, president of the UI chapter of American Society of Civil Engineers, has been a member of the Steel Bridge Team since he was a freshman. He served as captain for this year's team, which **captured first place at the ASCE competition** in Pocatello, ID.

The **Road Builders Clinic Scholarship** went to **Christina Ryan**. Christina was honored at a banquet during the annual Road Builders' Conference in Coeur d'Alene, Idaho, March 5 and 6, 2001. Christina has been a NIATT intern and will be serving her second year as president of the ITE chapter. She hopes to find a position in highway design and construction management. During the summer, she is working on a project for NIATT's T2 Center.

Gary Haderlie was chosen by the **Idaho Chapter of the ITE** as its annual scholarship winner. Gary came to UI from Ricks College where he maintained a 3.95 GPA. Gary worked during the academic year as a NIATT intern (*see p. 16*). In addition to a bachelor's degree in civil engineering, Gary's plans for the future include entering a graduate program in transportation or structural engineering.

Increased Faculty Participation in Research and Outreach

Idaho Governor's Initiative Increases UI Transportation Faculty

Zaher Khatib was designated as the Governor's Initiative faculty member at the University of Idaho. Khatib earned his Ph.D. in transportation engineering at the University of Illinois in Chicago.

The position, designated for a civil engineer in transportation, was established by state funding received as part of Gov. Dirk Kempthorne's Initiative for Excellence in Higher Education.

The aim of the initiative is to attract and retain high quality faculty. \$442,000 was awarded to the UI, and the portion dedicated to transportation engineering faculty illustrates the high regard as a research institute afforded to NIATT by the governor, the Idaho Legislature, and the UI administration.

Khatib has been working on a UTC-sponsored project concerning actuated coordinated signal systems (see p.40). He is coauthor with graduate student Geoffrey Judd of a paper resulting from the project. The paper was presented at the 2001 Transportation Research Board annual meeting.



Michael Dixon Joins NIATT Faculty

Michael Dixon accepted a tenure-track assistant professorship in transportation engineering in June 2000.

Dixon earned his Ph.D. from Texas A&M University and his master's in Civil and Environmental Engineering from Brigham Young University. Dixon's research interests include the use of existing and emerging ITS information technologies for improved traffic control, transportation modeling, and traveler information systems.

Dixon is currently working on three research projects sponsored by the Idaho Transportation Department. One involves using the TWOPAS simulation model to provide design and operations information on the performance of Idaho's two-lane rural highways. A second involves evaluating the impact of Idaho legislation regulating truck speed on Idaho's interstate highways; and the last is developing a statewide transportation model.

He also served as faculty sponsor for the UI Institute of Transportation Engineers chapter this year.



Ahmed Abdel-Rahim Specializes in Intelligent Transportation Systems

Ahmed Abdel-Rahim, who earned his Ph.D. in transportation engineering at Michigan State University in 1998, accepted a postdoctoral position with NIATT in August 2000. Abdel-Rahim's research interest lies in Intelligent Transportation Systems (ITS), traffic simulation and modeling, traffic flow theory and operations, public transportation issues, safety impacts of ITS technologies, and engineering education.

This year, he has been working with graduate student Kris Jagarapu on the second phase of the UTC project on optimized timing strategies for oversaturated intersections (*see p.40*).



Sale Contributes to CID Project

Kelly Sale earned his B.S. in computer science at the University of Idaho in 1995. After five years in industry working for Chrysler, MCI WorldCom and First Step Internet, he returned to the UI. He is lending his expertise to the Controller Interface Device project (*see p.38*) and helping to bring professional standards to NIATT software development efforts. "Kelly gives students a practical approach to software engineering," according to Michael Kyte, NIATT director.



T2 Staff Expands to Provide More Service

NIATT's Idaho Technology Transfer (T2) Center expanded its service with the appointment of Bruce Drewes, a longtime employee of the Idaho Transportation Department. Bruce started working in April as the T2 training and research manager and will be based in Boise.

"Bruce's mission is to help cities, counties and highway districts throughout Idaho find and obtain the technology best suited to solve their transportation problems," said Gene Calvert, director of the Center. "The T2 Center has served the entire state from Moscow for the past five years; Bruce's hire gives us an additional resource that is more centrally located."

Drewes has more than 20 years' experience in the transportation/construction industry. Most recently he worked as a training specialist for the Idaho Transportation Department.



"The governor's initiative really has statewide impact. We will use the funds to bolster faculty expertise in areas pivotal to the Idaho economy—environmental cleanup, the emerging industry of computer security, and transportation design."

UI President Robert Hoover

Combining UTC Projects and Design Classes Enhances Student Experience

Principal investigators for UTC projects in the Center for Clean Vehicle Technology have incorporated tasks involved in their funded research projects into a variety of design classes. Doing so enhances our educational program by providing students with hands-on experiences and opportunities to develop leadership and communication skills. Hardware prototypes are displayed at the Idaho Engineering Design Expo each May.

During the second phase of the project “Catalytically Assisted Combustion of Aquanol in Demonstration Vehicles,” a group of senior mechanical engineering students designed an aqualytic fueling station (see pp.34, 36). Other senior design classes worked on a variety of UTC-funded projects involving electrical systems, and fabrication. Students see the results of their individual projects integrated into a finished product.

Diesel Project Supports Four Design Projects in Biological and Agricultural Engineering

Three students enjoyed the assignment to design and enhance the exterior of a new Volkswagen that will run on biodiesel fuel (see p.42). The goal of the project was to enhance the appeal of the vehicle to urban dwellers and secondary school students. A second assignment was to investigate how to carry additional fuel to extend the range of the vehicle. The bright yellow Beetle made its debut at the 2001 Idaho Engineering Design Expo (pictured below). A showcase for the biodiesel fuel being developed, the VW will be used in on-road testing to verify the suitability of biodiesel for urban transport use.

As part of developing a continuous flow biodiesel production pilot plan, other students constructed a stripping column that removes the excess alcohol from the mixture of vegetable oil and alcohol before adding water and the subsequent separation of biodiesel from the water/glycerol phase. A third group of students recovered alcohol, water, and glycerol from the waste stream of the biodiesel production process. They worked closely with UI environmental health and safety personnel and identified procedures and methods to safely recover excess process alcohol.

The purpose of the fourth design project was to make a simple step-by-step laboratory procedure and exercise for use in high school chemistry classes where students would be able to make fuel using chemicals and materials readily available.



Facilities Support Education and Technology Transfer



Highway Design Lab Provides Training Facilities

UTC funds helped leverage support from the Idaho Transportation Department and UI's Civil Engineering Department to upgrade NIATT's Highway Design Laboratory. The 13 computer stations, first used by NIATT's Traffic Signal Summer Camp participants, were equipped with the most current traffic engineering software. The laboratory is used by UI civil engineering classes and for training sessions held for ITD and other practicing engineers.

Traffic Control Lab Sets New Standard

Seven workstations with the most current software available were only the beginning of NIATT's new Traffic Control Laboratory (pictured above). We were able to add Autoscope video detection systems from Econolite Control Products, traffic controllers from Northwest Signal Supply and the Ada County Highway District, cables from McCain Traffic Supply, and prototypes of NIATT's new Controller Interface Device. This high-tech traffic control lab, with its emphasis on equipment used in the field, sets a new standard for university research and training programs.

Gauss - Johnson Laboratories Upgraded

The rededication of the Gauss and Johnson Engineering Laboratories highlighted the opening day of Idaho Engineering Design Expo 2001. A \$9 million renovation combined the two buildings into one facility with new laboratories, classrooms, offices, a wind tunnel, and an engine bay for the FutureTruck and the Advanced Vehicle Concepts Team's winning hybrid electric Camero.

Chassis - Dynamometer Supports Alternative Fuels Research

The installation of a SuperFlow 601 Chassis Dynamometer in the Martin Engineering Laboratory represents a significant investment in infrastructure for NIATT's transportation and alternate fuels research. It promises to be a significant educational tool for power, machinery, and transportation-related instruction. The \$116,340 price tag to install the dyno came from a combination of UTC program funds and support from the UI colleges of Engineering and Agriculture, the Idaho Energy Division, the U.S. Department of Energy and the Pacific Regional Biomass Energy Program.

Traffic Signal Summer Camp

(KLK205)

Michael Kyte, Principal Investigator

mkyte@uidaho.edu

participants:

Shane Binder, Pennsylvania State University

Carrie Falkenrath, University of Washington

Brent Gillette, Michigan Technological University

Michael Hofener, University of Oklahoma

Gene Hong, University of California, Irvine

Amara Ibeji, Arizona State University

Ryan Klug, Michigan Technological Institute

Matthew Martimo, North Dakota State University

Matt Melkerson, Virginia Tech University

Carlos-Andrés Ramirez, University of Florida

Philip Rust, Washington State University

Sharon Schutz, Tennessee State University

Hands-On Instruction Highlight of Traffic Signal Summer Camp

NIATT's 2000 Traffic Signal Summer Camp (TSSC I) featured intensive hands-on experience with advanced traffic control systems. The 12 students, hailing from across the United States, learned the skills that engineers need to conduct Intelligent Transportation System (ITS) projects. Students earned three continuing education credits for completion of the week's work at the University of Idaho campus.



Students walked through intersections in an arterial section under construction in the city of Moscow, and developed traffic signal designs that would maximize traffic operations and improve safety.

They learned to use traffic controllers and their components. They measured geometric elements of an intersection and developed field plans for traffic signal timing they were able to test in the lab. They designed their own loop detectors and tested them.



“I now know how the equipment works and not just the theory behind it.”

Gene Hong; UC Irvine

Experienced Counselors Directed Camp

Darcy Bullock of Purdue University and Ken Courage from the University of Florida were two of the top university engineers from around the country who donned Traffic Signal Summer Camp T-shirts as counselors for the week in Moscow, Idaho.

Joe Marek of Clackamas County, Oregon, and John Ringert of Kittelson & Associates, Inc., Portland, joined practitioners from the Idaho Transportation Department, Ada County Highway District, and faculty from the University of Idaho to round out the teaching staff for the week.

TSSC II Scheduled for Summer 2001

The first of what could be many camps, TSSC I received unanimous praise. “A great initiative. Super job!!!!” writes William Sproule of Michigan Tech, adviser of two graduate students who attended TSSC I. That encouragement strengthened our plans for TSSC II, which will be held in August 2001.

Peer review panel members have suggested that we offer the same type of experience to practicing engineers or take the camp “on the road.” The Idaho Transportation Department has shown an interest in providing their engineers with a greater understanding of traffic signal planning and the newest hardware and software. Plans to hold a TSSC for these professionals are in the initial stages.

Publication

“Traffic Signal Summer Camp Manual,” University of Idaho, August 2000.

Idaho Engineering Works

(KLK323)

Edwin Odom, Principal Investigator

eodom@uidaho.edu

participants:

Nick Peck, graduate student, mechanical engineering

Dan Gerbus graduate student, mechanical engineering

Nathaniel Allen, graduate student, mechanical engineering

Matthew Cunningham, graduate student, mechanical engineering

Eric Clarke, graduate student, mechanical engineering

Dan Cordon, graduate student, mechanical engineering

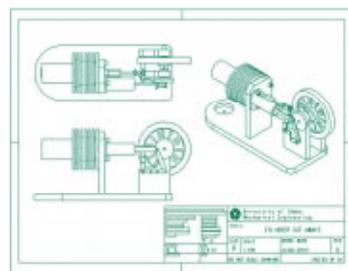
Heather Jones, graduate student, mechanical engineering

Levi Westra, graduate student, mechanical engineering

Idaho Engineering Does Work

Engineering educators in all disciplines are challenged to develop key competencies in product realization, to do more with less, and to provide a quality graduate student experience. At first glance, these challenges appear to be at odds. However at the University of Idaho, the Idaho Engineering Works (IEWorks) creatively addresses all three challenges. IEWorks involves the entire senior class, a half-dozen graduate student mentors, design faculty, shop technicians and industry sponsors in a highly interactive environment reminiscent of the Lockheed Skunk Works.

Instead of focusing only on the production of research or engineering hardware, the IEWorks stresses human dynamics, communication, teamwork, personal reflection, and professionalism. By investing in the human side of engineering, professional and technical excellence can be more efficiently obtained.



Stirling engine design

Students Enthusiastic about IEWorks Experience

It's difficult to capture in words the enthusiasm and dedication that one senses when talking to graduate students who serve as mentors in IEWorks. When asked to identify the benefits of being in the program, mentor Nick Peck's list included leadership and project management skills, interaction with professors and fellow graduate and undergraduate students, greater responsibility, and the ability to communicate about his work without inhibition.

IEWorks 2001 mentors display Stirling engine components. Front - Eric Clarke, 1 to r- Dan Cordon, Nathaniel Allen, Dan Gerbus, Levi Westra, Nick Peck, Matthew Cunningham, and Heather Jones, all graduate students in mechanical engineering



Hands-On Engineering Provides Incentive

IEWorks provides early hands-on design and manufacturing experience. This year, the team of mentors produced 60 kits containing 24 components necessary to produce a Stirling steam engine. It took sophomore students more than 150 machining operations to complete the project.

Senior Design Projects Support NIATT Research

Each member of IEWorks mentors at least one senior design team. Some capstone projects are supported by industrial sponsors, but many support NIATT research projects funded partially by the UTC program (*see p.22*). Matt Walker, a senior mechanical engineer, worked under the mentorship of graduate student-IEW member Dan Cordon. Dan is involved with two projects supported by UTC funds that involve aqueous fuel and catalytic ignition (*see pp. 34, 50*). For his senior design project, Matt studied the performance of a specialized Honda small gas engine and generated baseline measurements that will be used for comparison with the catalytic system under development.

Publications/Presentations

"A Skunk Works Model for Integrating Undergraduate Design Education, Graduate Student Leadership, and Manufacturing Assistance," 2001 Boeing Outstanding Educator Award Nomination.

Odom, E.M., S. Beyerlein, B. Tew, R. Smelser, and D. Blackketter, "Idaho Engineering Works: A Model for Leadership in Design Education," *Frontiers in Education (FIE) Conference Proceedings*, San Juan, Puerto Rico, 1999.

Blackketter, D., "The University of Idaho Model for Graduate and Undergraduate Education," presented to the University of Brisbane Engineering Faculty, Brisbane, Australia, March 2001.

Blackketter, D., "Idaho Engineering Works: A Model for Graduate Education," presented at the University of Idaho Electrical Engineering Faculty Seminar, March 2000.

Duncan-Hewitt, W. C., D. L. Mount, S. W. Beyerlein, D. F. Elger, and J. Steciak, "Using Developmental Principles to Design Mentoring Experiences for Graduate Students," submitted to the *Journal of Engineering Education*, 2001.

"I'm not the same person I was one-and-a-half years ago. I'm much more aware of a world of things bigger than me."

Nickolas Peck, graduate student, mechanical engineering, and IEWorks mentor.

"As an outside observer, my experience leads me to conclude that there is something very special in the senior design program at the UI's mechanical engineering department, which is led by the Idaho Engineering Works. These efforts are what's required to train the engineers of tomorrow."

Warren Graber, executive of the Daniel Woodhead Company

Development of Internet-Based Laboratory Materials

(KLK204)

Michael Kyte, principal investigator

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participants:

Murali Basavaraju, graduate student, civil engineering

Steve Dahl, undergraduate, civil engineering

Melissa Lines, technical writer



Murali Basavaraju

Ready to Learn Transportation Engineering? Training Materials are Available On-Line

That's the philosophy behind NIATT's internet-based training materials. In cooperation with researchers from Oregon State University and Portland State University, NIATT developed a set of training modules designed for use in the introductory transportation engineering course offered in most civil engineering programs across the country.

Eight modules, listed below, contain discussions of important theories and concepts, demonstrations of many of the concepts, information about how these concepts are applied in professional practice, example problems with solutions, links to other web sites for more information on the topic, and a glossary of terms.

- Bus Service Planning
- Capacity and LOS Analysis
- Geometric Design
- Parking Lot Design
- Roadway Design
- Signal Time Design
- Traffic Flow Theory
- Travel Demand Forecasting

NIATT researchers are developing a new set of materials that provide on-demand training on highway capacity. These materials focus on capacity analysis methods for two-way stop-controlled intersections, based on the newly released *Highway Capacity Manual 2000*.

Video clips will be used to illustrate fundamental principles such as critical gap, follow-up time, impedance, and two-stage gap acceptance. Fifteen case studies will show actual intersection operations and the comparable *Highway Capacity Manual* procedure calculations.

Publications

Developing Laboratory Materials for the Introductory Transportation Engineering Course. M. Kyte, S. Dahl, K. Hunter-Zaworski, B. K.Lall, J. Fowler, M. Lines. NIATT Report 99-13; University of Idaho, 1999.

http://www.its.uidaho.edu/niatt_labmanual/



“We will definitely incorporate some of this material into our courses. Congratulations on a job well done.”

*Melissa Tooley; Director,
Mack-Blackwell Transportation
Center*

“Although the materials in the chapters on geometric and roadway design are intended for junior-level transportation engineering courses, some of our less-experienced designers may also find the materials interesting and useful. Example problems and lab exercises are included. I particularly liked the exercises that utilized Excel spreadsheet examples.”

*Greg Laragan, Idaho
Transportation Department,
Assistant Chief Engineer,
Operations.*

Advanced Vehicle Concepts Team Electric Vehicle

(KLK302)

Donald Blacketter, Principal Investigator

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Steven Beyerlein, Co-Principal Investigator

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participants

Frank Albrecht, Technical Assistant

David Alexander, graduate student, mechanical engineering

John Becker, graduate student, mechanical engineering

Dan Gerbus, graduate student, mechanical engineering



James Richards, graduate student, mechanical engineering

David Reiche, graduate student, mechanical engineering

Advanced Vehicle Concepts Team (AVCT) (pictured above)

Students Challenged to Increase Fuel Efficiency

UI is one of 15 schools in the nation selected to participate in a unique program that brings together the resources of industry, government and academia to cooperatively solve important environmental and technical problems posed by the growing demand for light-duty trucks, such as pickups, sport utility vehicles and vans. The U.S. Department of Energy and General Motors-sponsored FutureTruck competition challenges our budding engineers to re-design a conventional, full-size Chevrolet Suburban—increasing energy efficiency, reducing emissions, and continuing to meet customer expectations for performance, utility, safety, affordability and comfort.

The Advanced Vehicle Concepts Team (AVCT), a multidisciplinary student organization, has a strong history of

designing and building electric vehicles. The team had less than six months to design, fabricate and test the Suburban to prepare for the first competition in June 2000. According to Heather Jones, the team took pride knowing that the UI Suburban was “ the only FutureTruck that drove off the trailer when it was delivered to the test grounds.”

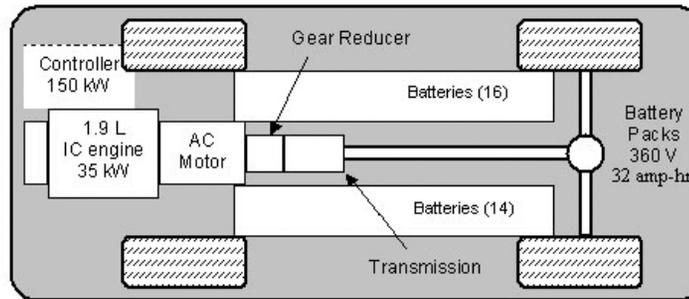
This year the team made the controls more sophisticated and integrated a completed gear reducer. The second competition took place June 4 through 13, 2001, at the General Motors’ Proving Ground in Milford, Michigan. Based on modeling results, the entry is predicted to achieve 50 miles per gallon during typical city driving and 31 miles per gallon for typical highway driving, while maintaining emission levels lower than a comparable vehicle equipped with a 1.9 liter diesel engine.

Training Future Engineers

The value of NIATT's FutureTruck research lies in its success in training future transportation engineers and in generating public awareness of alternative vehicle technology. Industries seek our graduates because of their hands-on learning opportunities and design team experience. The series hybrid SUV has been used in conjunction with a variety of laboratory and design projects within the mechanical and electrical engineering departments.

The FutureTruck and the award-winning zero emissions Camaro attract crowds wherever and whenever they are displayed. During the past year, public education remained an important objective. In addition to generating newspaper articles and television news stories, the team visited local schools. Display and demonstration of the vehicle enabled people to visualize how an alternative vehicle can look and function like its stock counterpart. The AVCT members took part in the following public education activities:

- Women in Engineering Day, University of Idaho, November 2000
- Presentation and display for Idaho legislators visiting UI, December 2000
- "Vandal Friday," recruiting day on UI campus, March 2001
- Earth Day—presentation and display at North Idaho College Student Union Building, April 18, 2001
- Moscow High School science classes, April 20, 2001
- Idaho Engineering Design Exposition, May 2001



Undercarriage diagram of the FutureTruck

FutureTruck Generates Financial Backing

Interest in the development of the next generation vehicle helps stimulate financial support for the AVCT project. Generous sponsors include Ed and Mary Schweitzer, the Idaho Department of Water Resources, Boeing Industries, Avista Utilities, Chipman-Taylor Chevrolet/Oldsmobile, Associated Students of the University of Idaho, and the Congestion Mitigation and Air Quality Improvement Program.

Publications

"Design of the University of Idaho Series Hybrid Future Truck," J. Becker, E. Clarke, H. Jones, D. Reiche, D. Scott, S. Beyerlein, and D. Blacketter. Prepared for the Society of Automotive Engineers, Inc. for FutureTruck 2000 competition.

"Design and Evaluation of the University of Idaho Series Hybrid FutureTruck," D. Alexander, S. Anderson, Z. Choate, O. Edwards, N. Swain, D. Welling, F. Albrecht, S. Beyerlein, and D. Blacketter. Prepared for the Society of Automotive Engineers, Inc. for FutureTruck 2001 competition.

NIATT TECH BRIEF series, "FutureTruck: The Clean SUV," University of Idaho, May 2001.

"Programs such as the FutureTruck hold the promise of benefiting all Americans by developing newer technologies that can power our vehicles, and even our homes, more efficiently in the near future."

Thomas J. Gross, Deputy Assistant Secretary for Transportation Technologies, Energy Efficiency and Renewable Energy, U.S. Department of Energy

Alternative Powered Snowmobile Development

(KLK303)

Karen Den Braven, Principal Investigator

participants:

Phil Auth, graduate student, mechanical engineering

Undergraduate team members:

Seth Millhorn, Team Leader Shawn Kimbley

Zack Beeler, Team Co-Leader Heber Lemmon

James Angell Matt Marks

Don Hancock Jeremy Staab

Patrick Hess



Ready for competition! Left to right - Heber Lemmon, Phil Auth, Karen DenBraven, Jeremy Staab, Seth Millhorn, Patrick Hess, Don Hancock, Zack Beeler

Using and Preserving Our National Parks

Although an international icon, Yellowstone National Park is far from adequately protected from environmental harm. Thousands of snowmobiles in the park produce more pollution in a single weekend than all cars traveling in the park emit in a year, generating carbon monoxide levels that often exceed those present in Los Angeles. The geographic location of our University Transportation Center provides us with a unique opportunity to focus on preservation of national parks such as Yellowstone and help educate the public and future engineers about the challenges involved.

The UI team was selected by the Society of Automotive Engineers (SAE) to be one of 15 participants in the Second Annual Clean Snowmobile Challenge (CSC). The competition allowed us to put research dollars to educate and to protect and enhance communities and the natural environment affected by transportation. Likewise, we were able to utilize our

expertise in demonstrating environmentally friendly technologies such as alternate fuels.

The team purchased a commercially available snowmobile chassis and modified a four-stroke 750 cc BMW motorcycle engine. The challenge was to re-engineer the sled for improved emissions and noise, but maintain the performance of the stock vehicle. Handling, acceleration, and hill climbing were other elements of the March 2001 CSC competition. The U.S. Department of Energy and the Environmental Protection Agency, national parks, snowmobile associations, and a variety of manufacturers provided financial support for the CSC.

The NIATT snowmobile captured fifth place in the competition in Jackson Hole, Wyoming. The prize of \$1,000 will help engineer next year's competing snowmobile. The team was notified in May of its successful bid to compete in 2002. They also have been invited to provide a paper to SAE describing their research.

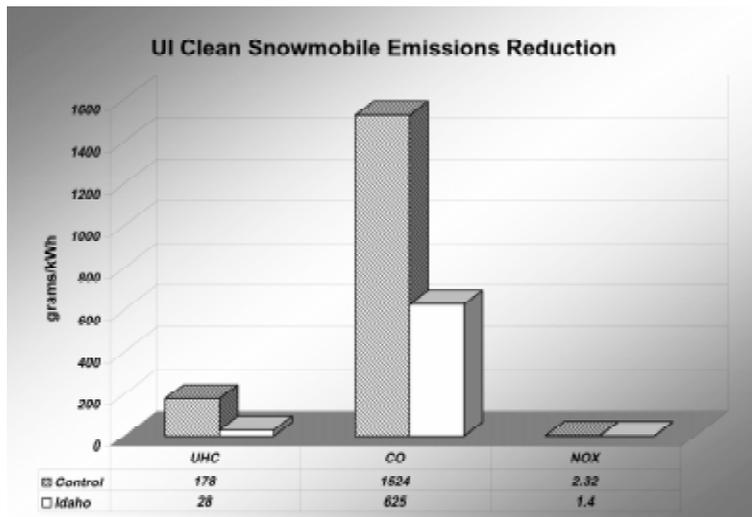
Students Have the Experience; The Public Learns of Choices

We believe, along with the SAE, that the following benefits of the competition go beyond the challenge of engineering a successful design:

- The CSC provides a hands-on, team-oriented experience to students.
- The CSC encourages the research and development of advanced snowmobile technology.
- The CSC helps facilitate a solution to the controversy surrounding snowmobile use in environmentally sensitive areas.
- The CSC gives snowmobilers, outfitters, land managers, government officials, and environmentalists the opportunity to work together to reach a common goal.
- The CSC provides positive publicity opportunities for CSC sponsors and the Pacific Northwest.

Additional Funding

“Idaho State Bioenergy Program: Clean Snowmobile Challenge,” \$5,000, Idaho Department of Water Resources.



Emissions from the NIATT snowmobile compared with those of a control sled (a typical two-stroke touring snowmobile currently used in Yellowstone National Park). In each case the UI sled reduced emissions well below the required minimum reduction of 25 percent CO (carbon monoxide) and 50 percent UHC plus NOx (unburned hydrocarbons and nitrous oxides). Measurements are in grams/kWh of power to the snow.

“Collegiate research competitions give students the opportunity to put their classroom training to use to help solve real-life technical problems facing society.”

Bryan Wilson; Associate Professor, Mechanical Engineering; Colorado State University

Jeremy Staab, member of the UI Clean Snowmobile team, talked about his impression of the competition:

“It was great to walk through the demonstration tent—our snowmobile was cool, the cleanest looking one there; no tin foil and gunk!” He talked about the team’s goals to make the snowmobile look as appealing as one with a two-stroke engine and keep the weight down. “Ours was the smallest 4-stroke to make it up the hill climb. And if it had been only 0.3 decibels quieter, we would have won!”

Catalytically Assisted Combustion of Aquanol™ in Demonstration Vehicles

(KLK315)

Steven Beyerlein, Principal Investigator

sbeyerlein@uidaho.edu

participants

Eric Clarke, graduate student, mechanical engineering

Andron Morton, graduate student, mechanical engineering

Dan Cordon, graduate student, mechanical engineering

Undergraduates: Matt Walker; Zach Choate; Rex Aman

Josh Wilson; Mike Geyer; Jeff Ward



Demonstration van

Project Demonstrates Potential for Environmentally-Friendly Fuels

In the first phase of this project, a mechanical engineering senior design team converted a transit vehicle, owned by Valley Transit of Lewiston, Idaho, from a gasoline type engine to one operating on alcohol-water fuel. The adaptation entailed retrofitting the cylinders with total seal piston rings, installing corrosion-proof components in the fueling system, and reprogramming the fuel computer.

Catalytic ignition of high-water content alternative fuels, in this case, Aquanol™—a mixture of 70 percent ethyl alcohol and 30 percent water, shows great promise for meeting transportation needs efficiently and cleanly. The high-water content biofuel is possible because of the catalytic ignition: the water and catalyst together lower combustion temperature and result in very low emissions of nitrous oxide, carbon monoxide, hydrocarbons and particulates. To overcome combustion problems in earlier attempts to burn aqueous fuels in over-the-road vehicles, we worked with SmartPlug®, catalytic igniter technology developed by Automotive Resources, Inc., of Sandpoint, Idaho.

During the second phase of the project, a senior capstone design project challenged students to develop an aqualytic fueling station for the converted van. Mechanical engineering senior Zach Choate explained that normal fueling time for the van was 1-1/2 to 2 hours, and that the current method of mixing the water and ethanol was inexact, at best. The completed fueling station, demonstrated at the 2001 Idaho Engineering Design Expo, reduces fueling time to eight minutes and verifies the mixture. "Our work means that they'll be able to do some fuel optimization work in the future by dialing in the percentage of water," reported Zach.

This project enables us to provide the technical and economic information needed to show the potential of using environmentally friendly vehicles and to implement alcohol-water alternative fuel systems in public transportation and state vehicles. Future work will involve further modeling and emissions testing.

Publication

Catalytically Assisted Combustion of Aquanol in Demonstration Vehicles, S. Beyerlein, J. Steciak, D. McIlroy, D. Blackketter, E. Clarke, D. Cordon, A. Morton; NIATT Final Report N01-08; University of Idaho, January 2001.

Public Exposure of Converted Van

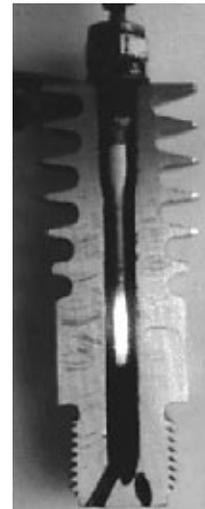
Renewable Energy Fair, July 7-8, Coeur d'Alene, Idaho. Sponsor: Idaho Department of Water Resources

Ethanol Workshop, Boise, Idaho. January 11, 2001. Sponsor: Idaho Department of Water Resources.

Additional Funding

University of Idaho Graduate Student Association Travel Awards presented to Eric Clarke and Heather Jones for travel to the 2nd Annual Combustion Institute.

"Fleet Demonstrations of Alcohol-Water Fuel and Catalytic Ignition Systems," Idaho Transportation Department, \$59,200.



ARI's SmartPlug

"The University of Idaho's outreach efforts on biodiesel and Aquanol have been outstanding."

John Crockett, Renewable Energy Specialist, Idaho Energy Division, Idaho Department of Water Resources and peer review panel member

Research Focus Areas

NIATT uses University Transportation Center program funds to conduct research in three areas:

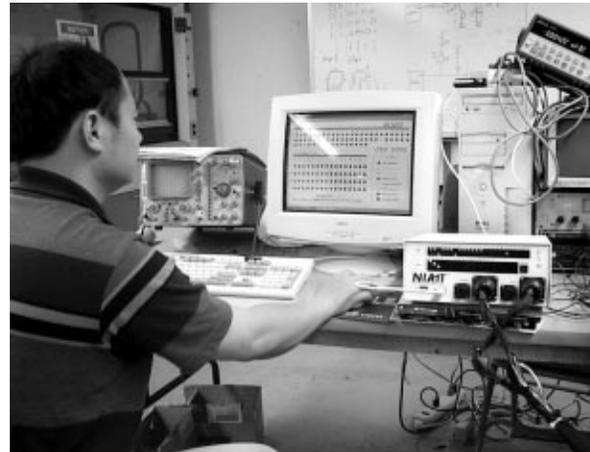
- Traffic control system technologies that are essential to national intelligent transportation infrastructure
- Technologies that support the development of the new generation vehicle
- Capacity building for transportation engineering professionals working in both vehicle and traffic control technology industries

The projects described in this section, while including elements that also meet our educational and technology transfer goals, directly relate to one of the research areas.



Aqualytic fueling station developed by NIATT undergraduates

Graduate Student Zhen Li works on NIATT's Controller Interface Device



Through our ongoing program of basic and applied research, we advance the body of knowledge in transportation:

- We have established a research and technology program that gives rise to new and improved technology products for traffic control and vehicles.
- We have created concrete, viable products that are judged to be useful by industry, government, and universities.
- We have established a good working relationship with the U.S. departments of Transportation and Energy because of the high quality of our work; and an even more vigorous relationship with our most important partner, the Idaho Transportation Department.
- We have been successful in receiving additional external awards for further research in transportation technology in recognition of our successful research.
- We showcase at the annual Idaho Engineering Design Expo the result of capstone design classes in which our students collaborate to solve real transportation engineering problems.

**BASIC AND APPLIED
RESEARCH PROJECTS**

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Development of Controller Interface Device for Hardware-in-the-Loop Simulation

(KLK201)

Brian Johnson, Co-Principal Investigator

Richard B. Wells, Co-Principal Investigator

participants:

Michael Kyte, University of Idaho

Darcy Bullock, Purdue University

Zhen Li, graduate student, civil engineering

Ying Zhou, graduate student, electrical engineering

Thomas Jacob, graduate student, computer science

James Richards, graduate student, mechanical engineering

J. J. Remus, undergraduate, electrical engineering

Dan Gordon, undergraduate, electrical engineering

Tricia Veeder, undergraduate, mechanical engineering

Kenton Veeder, undergraduate, electrical engineering

Darin McKee, undergraduate, electrical engineering

Ivan Anderson, undergraduate, electrical engineering

Geoffrey Beider, undergraduate, electrical engineering

Michael Adams, undergraduate, electrical engineering

Cody Miller, undergraduate, civil engineering

Barry Klas, undergraduate, computer science

Greg Klemesrud, electronics specialist, electrical engineering

Kelly Sale, lecturer, computer science

Controller Interface Device a National Priority

In 1998, the Federal Highway Administration (FHWA) asked NIATT to develop a next generation version of the controller interface device (CID). The CID, pioneered by Darcy Bullock of Purdue University, is a communications device that allows the traffic engineer to tie a traffic controller to simulation models such as CORSIM.

NIATT's new CID has the following advantages over earlier models:

- The CID uses a universal serial bus (USB), significantly increasing communications speed.
- The CID increases the number of intersections that can be studied, up to 20 individual intersections.
- The CID can be easily manufactured.
- The CID is much smaller and more portable.
- The CID is easily configured through a software interface.

CID Undergoes Beta Testing

Engineers across the country put NIATT's CID to the test in March, April and May 2001. Beta testing helped us identify changes in software tools needed to make the CID even more useful to practitioners. The 12 beta sites participating in the study were

- Florida Department of Transportation
- City of Portland
- Kittelson and Associates, Inc.
- University of Florida
- Siemens Energy and Automation, Inc.
- University of Illinois
- Purdue University
- University of Arizona
- Northern Arizona University
- Idaho Transportation Department
- Ada County (Idaho) Highway District
- Texas Transportation Institute

Traffic Engineers' Jobs Made Easier

Today, traffic engineers are unable to test newly developed signal-timing plans before they are implemented in the field using actual traffic controllers. Current testing in the field usually requires several days of fine-tuning. Traffic flow can be severely disrupted during the testing, causing delay to travelers and unsafe conditions. The CID, developed by NIATT under the University Transportation Centers Grant program, changes that.

The CID will allow traffic engineers to test their signal-timing plans using the actual traffic controller before they are deployed in the field. The key to this testing is hardware-in-the-loop simulation. The traffic engineer uses CORSIM to simulate traffic flow; the actual timing conditions are fed back to CORSIM from the controller. In addition, researchers who develop new traffic control strategies can use the CID to test these new strategies with an actual controller.

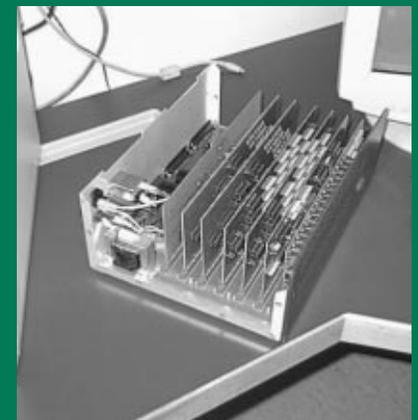
Publications

Darcy Bullock, Brian Johnson, Richard B. Wells, Michael Kyte, and Zhen Li, "Hardware in the Loop Simulation," submitted to *Transportation Research Part C: Emerging Technologies*, Apr. 30, 2001

Ying Zhou, John Fischer, Zhen Li, Brian Johnson, Richard B. Wells, Michael Kyte, Darcy Bullock "Hardware and Software Requirements for Real Time Traffic Simulation," submitted to *IEEE IECON '01*, May 14, 2001.

NIATT TECH BRIEF, "Controller Interface Device," University of Idaho, April 2000.

"The CID is a fine example of FHWA, the UI, and McCain Traffic Supply working together to bring a product to reality," according to Raj Ghaman, Research Engineer for FHWA. **"For quite a small investment, the CID can make major improvements in the way we manage our transportation systems."**



Inside NIATT's CID

Actuated Coordinated Signal Systems

(KLK202)

Ahmed Abdel-Rahim, Co-Principal Investigator

Zaher Khatib, Co-Principal Investigator

participants:

Geoffrey Judd, graduate student, civil engineering

Krishnakanth Jagarapu, graduate student, civil engineering



Kris reviews strategies with Dr. Abdel-Rahim

Project Utilizes NIATT's CID

For the first time, the Controller Interface Device, a tool developed by NIATT with UTC funding (*see p.38*), is being used to develop optimized timing strategies for oversaturated intersections. The CID allows us to use a simulation model operating in real time with a traffic controller to test different signal control logic for actuated controllers.

A section of Idaho's Highway 8 in Moscow provides the data for a cycle-by-cycle analysis of actuated coordinated signal systems. Traditionally, control strategies have been tested using traffic simulation packages. These models employ traffic signal controller emulators that function in a different manner than actual controllers. Using the CID with CORSIM simulations, NIATT researchers are able to test and retest various approaches for signal optimization in a real-world environment.

Moscow Case Study to be Part of ITS Deployment Project

A project conducted jointly by the Idaho Transportation Department, the City of Moscow, and NIATT will utilize portions of this UTC-funded research. A DOT ITS grant of \$695,944 is available for the Traffic Signal Systems Integration and Deployment project that will integrate traffic control system elements using National Transportation Communications for ITS Protocol standards, improving traffic flow and safety in the city.

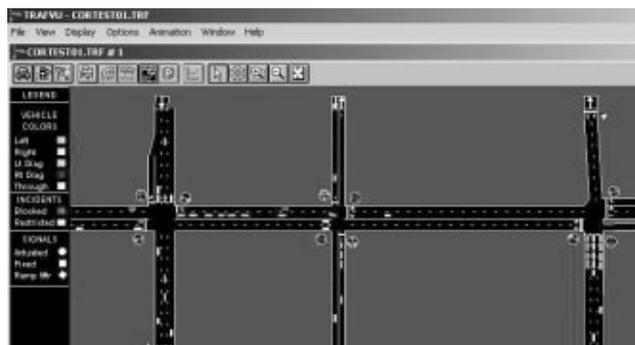
First Case Study Used Linear Optimization

During the first phase of the project, Geoffrey Judd, who will receive his M.S. in civil engineering in August 2001, collected data from a five-intersection corridor in Idaho Falls. Using LINDO, the data were used to develop an optimization strategy. The approach was tested with simulation software. Judd presented a paper "Control Strategy for Oversaturated Signalized Intersections" at the January 2001 Transportation Research Board meeting.

Presentation

Judd, G., and Z. Khatib, "Control Strategy for Oversaturated Signalized Intersections," presented at Transportation Research Board annual meeting, January 2001.

CORSIM Simulation



"I have an opportunity to work with real cutting edge technology."

Kris Jagarapu, who has been working on the second phase of this two-year project

Biodiesel Fuel from Yellow Mustard Oil

(KLK310)

Charles Peterson, Principal Investigator

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Joseph Thompson, Engineering Technician

participants:

Marc Wotring, graduate student, biological and agricultural engineering

Sam Jones, graduate student, biological and agricultural engineering

Senior Design undergraduate students:

David Hollenback

Ray Jentges

Dan Zuckschwerdt

Danny Browning

Teresa Luong

Tan Tran

Kiana Bush

Andrew Becker

Caroline Kawaguchi

Joe Kaufman

Colin McCoy



Biodiesel van undergoing testing on chassis dynamometer.

UI Biodiesel Used in Yellowstone National Park

Used by rangers in Yellowstone National Park, a 1995 Dodge runs on 100 percent biodiesel fuel produced from yellow mustard, canola, and rapeseed at the University of Idaho. Using biodiesel fuel not only lowers harmful emissions, but also causes less harm to the environment in case of spills. The vehicle stimulates interest and helps educate the public about the use of alternative fuels. Park officials expanded their use of UI biodiesel to transport three buses and seven garbage trucks.

Pioneers in Alternative Fuels

University of Idaho researchers have been working with vegetable oil as an alternative to diesel fuels since the late 70's. Biodiesel fuel has been shown to lower hydrocarbons and carbon monoxide by as much as 50 percent. Carbon dioxide production in biodiesel combustion is offset by the carbon dioxide use of the plant in photosynthesis. Nitrous oxides and particulate matter changes depend on the particular test conditions; however exhaust toxicity and mutagenicity have been shown to be reduced.

The plant breeding work of Dr. Jack Brown, professor in UI's Plant, Soil and Entomological Sciences Department, which has the capability of developing genotypes specific for biodiesel, was the impetus for the most recent research with yellow mustard varieties. Oil from yellow mustard has several advantages over other sources of the vegetable oil used with ethanol for the production of biodiesel fuel. First, since the mustard oil is a by-product of the meal for which it is grown, it is less expensive than oils such as canola or rapeseed. Because of its natural pesticides, yellow mustard is cheaper to grow. It is a good rotation crop, especially in more arid areas such as the Northwest, because its long taproot helps aeration. Finally, biodiesel using yellow mustard oil has good cold flow properties.

Testing Continues on Yanmar Engine and 1999 Dodge Truck

In the first phase of this project, a Yanmar 24-horsepower engine was installed on a test stand. Graduate students Marc Wotring and Sam Jones helped complete computer programming for a 160-hour Engineering Manufacturing Association (EMA) durability test conducted on the Yanmar running on yellow mustard biodiesel. Results are similar to tests using rapeseed biodiesel.

Tests have also been conducted on a 1999 Dodge truck that has been running for 5,000 miles on 100 percent yellow mustard biodiesel fuel. The truck is used primarily for delivering biodiesel to Yellowstone Park and for hauling the various components needed for its production—mustard oil from Montana Specialty Mills in Great Falls, Montana, and alcohol and potassium hydroxide from Simplot Industries in Caldwell, Idaho. The truck has been tested for power, torque, opacity and brake fuel consumption. Power and fuel consumption are well within expected limits.

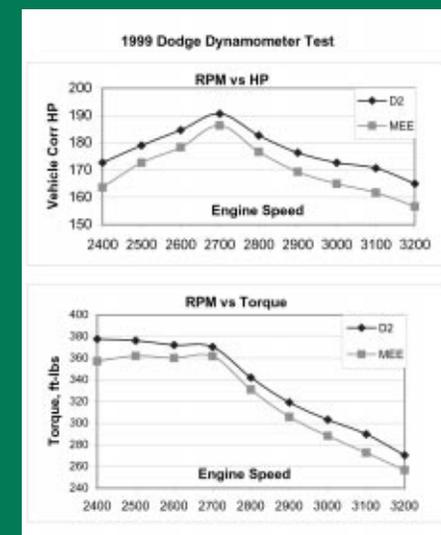
Publication

Peterson, C. L., J. S. Taberski, J. C. Thompson, and C. L. Chase,
"The Effect of Biodiesel Feedstock on Regulated Emissions in
Chassis Dynamometer Tests of a Pickup Truck," *Transactions of
the ASAE*, vol. 43, pp. 1371-1381, 2001.

Additional Funding

UI College of Agriculture, Agriculture Experiment Station
Idaho Department of Water Resources and the Pacific
Regional Bioenergy Program
National Park Service—Yellowstone National Park

The figures show the results of testing the 1999 Cummins-powered Dodge pickup on the chassis dynamometer. The fuels used in the test were biodiesel produced from yellow mustard oil (MEE) and No.2 commercial diesel fuel (D2). Power and torque with the biodiesel are reduced compared to fueling with diesel, reflecting the 10 percent reduced energy content of the biodiesel fuels.



Development of Video-Based and Other Automated Traffic Data Collection Methods

(KLK203)

Michael Kyte

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participants:

Binu Abraham, graduate student, civil engineering

Steve Dahl, undergraduate, civil engineering

Phil Matheson, undergraduate, computer science



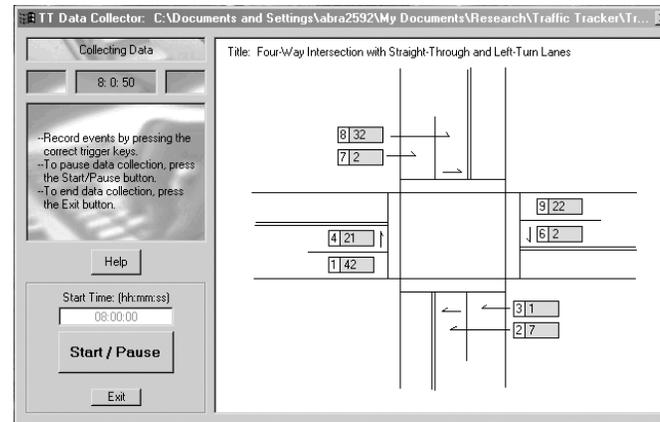
Binu Abraham, graduate student, civil engineering

No More Counting Cars

Most civil engineering students are introduced to traffic engineering by “counting cars”—literally standing in the field and recording the number of vehicles that pass by a given point on a street or highway. While traffic counts are extremely important in planning new facilities and evaluating existing ones, collecting the data is tedious and error prone.

NIATT research assistant Binu Abraham is developing a software tool that will improve the process. Traffic Tracker provides an efficient way for traffic engineers to collect a variety of flow rate, headway, and delay data. The software tool runs on any Windows-based computer and can be used in the field to directly count vehicles or in the laboratory using videotapes that have been made in the field.

Traffic Tracker data collection screen



“It really boosts my confidence to be involved in research that other people are going to use.”

Binu Abraham

Traffic Tracker Provides Faster Data Collection

Traffic Tracker is easily configured to a particular facility under study. The user can draw an intersection or arterial using drawing tools provided in Traffic Tracker and can locate the places at which data are recorded. Once the data collection has been completed, the user can prepare summaries using time increments that fit the particular study. “For example, an engineer can prepare summaries of intersection delay every five minutes or freeway flow rates every 30 seconds,” reported Abraham.

The tool also has the capability to evaluate some of the *Manual of Uniform Traffic Control Devices* (MUTCD) signal warrants. Abraham notes that MUTCD warrants 1 and 2 are now included in Traffic Tracker.

Vehicle Performance Simulation

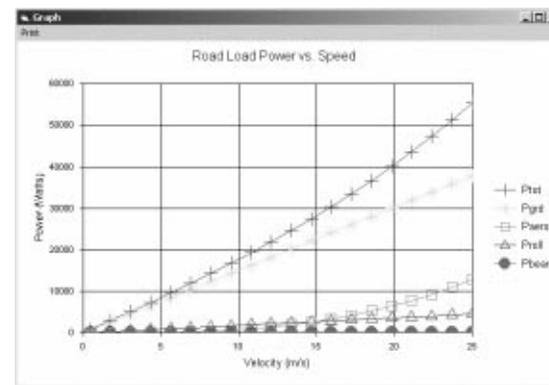
(KLK305)

Donald Blacketter, Principal Investigator

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participant:

David Alexander, graduate student, mechanical engineering



Dave Alexander (right) confers with faculty adviser, Don Blacketter

SmartHEV Software Takes the Guesswork Out of Vehicle Design

The first goal of the Vehicle Performance Simulation project was to develop a performance-driven, steady state, hybrid electric vehicle (HEV) software design tool that would provide design information for the Advanced Vehicle Concepts Team (AVCT) and their work on the FutureTruck project (*see p.30*).

SmartHEV was used for both the 2000 and 2001 FutureTruck competitions to predict the best operating levels of the UI series hybrid vehicle during each dynamic event. Understanding optimum vehicle performance and energy management during acceleration, towing and long-distance driving is critical to the UI team's success in the competition. This information is also being used to make improvements to the vehicle in the future.

Modeler Able to “Pick and Insert”

The design software is a flexible and robust model of steady state HEV operation. Using the road load power equation flow, SmartHEV models the following vehicle components:

- drive shaft/differential
- transmission
- electric motor
- battery pack
- alternator
- auxiliary power unit
- wheels

The tool allows users to “pick and insert” vehicle components and place these on a platform, thereby returning performance predictions on partial or complete vehicle systems. The program is based on algorithms that help manage equations and variables and improve convergence characteristics.

Algorithms that help manage variables and their values can be of tremendous help. Several of the design algorithms that were developed for SmartHEV provide structure to a user for selecting known and unknown variables and assigning values that are transparent to the user. It does, however, significantly enhance the ability of the user to meet the design requirements of an HEV.

Publications

Logic-Based, Performance-Driven Electric Vehicle Software Design Tool, D. Blacketter and D. Alexander, NIATT Final Report N01-10, February 2001, University of Idaho.

A Logic-Based, Performance-Driven Electric Vehicle Software Design Tool, D. Blacketter and D. Alexander, *Proceedings of ADVISOR User Conference*, August 23-24, 2000; Costa Mesa, CA.

Other computer-based algorithms improve the success and rate of convergence of systems of equations. They can also prevent systems of equations from being improperly defined during the unknown variable identification process. Because of the large number and complexity of components in an electric vehicle, modeling and simulation can result in large systems of equations that can be difficult to solve. Depending on the known and unknown variables, some systems require initial guesses to be close to their actual value. Other systems produce multiple answers, some of which would be physically impossible to use in a design. Still others produce answers that are near singular or were improperly derived, resulting in numerical instability.

Work on SmartHEV will continue with the goal of developing log-based, computer algorithms that can be used to outperform numerical solvers currently available. Additional features will further reduce the dependency on providing accurate guess values for unknown variables and add power and flexibility to the design process. SmartHEV will be incorporated into an on-road vehicle simulation program called Clean Vehicle Energy Management (*see p.55*), which was developed at the University of Idaho.

Alexander, D. and D. M. Blacketter, “Logic-Based Numerical Algorithms for Management of Equation Systems,” submitted to *Journal of Simulation*, September 2000.

Reactor Studies of Catalytic Combustion

(KLK317)

Judith Steciak, Principal Investigator

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Steven Beyerlein, Co-Principal Investigator

David McIlroy, Co-Principal Investigator

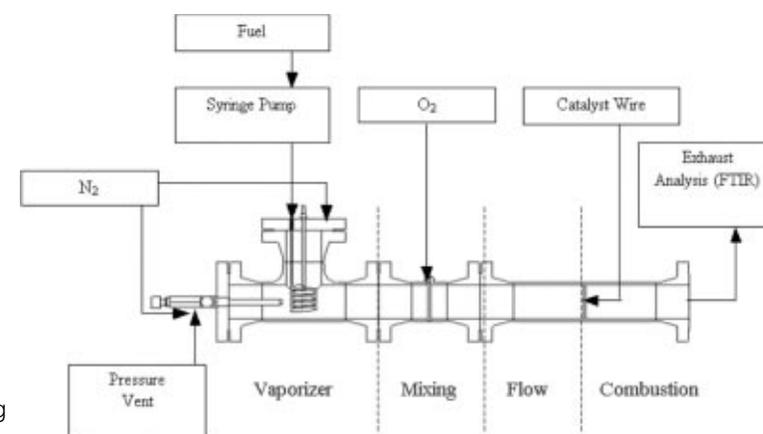
participants:

Heather Jones, graduate student, mechanical engineering

Xiangyang Wang, graduate student, mechanical engineering

Steve Kramer, graduate student, mechanical engineering

Yankov Kranov, graduate student, chemistry



Schematic of the plug-flow reactor

Fundamental Experiments Support Catalytic Engine Development

This UTC-sponsored project is one of three complementary NIATT projects involving alcohol/water fuels, catalytic ignition mechanisms, long-lived catalytic materials, system optimization, and over-the-road demonstration. Over the last ten years, UI researchers have explored alternative fuel production and its combustion in internal combustion (IC) engines. Alternative fuels are significant because they provide new avenues for achieving lower emissions in combustion engines. Catalytically assisted ignition of gaseous hydrocarbons permits engines to run reliably on a broader range of fuels and air/fuel ratios.

This project will clarify the principles underlying catalytically assisted combustion. One approach is to study catalytic

reactions in a pressurizable reactor. The design and construction of a plug flow, pressurized reactor is well underway. Components for the vaporizer section are under assembly. The modular design permits accommodating fuels with different vaporizing temperatures. The design will include pressure relief valves, over-temperature controllers and back-flow prevention devices to ensure safe operation of the reactor system. The reactor will provide a stable, repeatable means of studying surface and gas-phase reactions without the uncertainty caused by engine dynamics.

Combustion Modeling Clarifies Reaction Mechanisms

Graduate student Heather Jones is modeling thermodynamic equilibrium calibrations. She has been able to verify the influence of the water-gas shift reaction on the increased oxidation of carbon monoxide with increased fuel water content. Nitrogen oxide (NO) measured in an engine operating on 70 percent ethanol and 30 percent water was an order-of-magnitude lower than expected, which agreed with calculations using the Zeldovich mechanism. The impact of water on NO formation can be roughly explained by the sensitivity of the thermal NO mechanism to decreasing combustion temperature with increasing water-fuel content.

Good progress has been made in the understanding of the gas phase and surface reactions of ethanol. Of the 18 possible initial gas-phase combustion reactions identified for ethanol, only one dominates at the temperatures found in internal combustion engines. In the presence of the catalyst, instead of the weaker carbon-oxygen bond breaking, hydrogen atoms are stripped off the ethanol molecule because of the proximity effect of the platinum

surface. Reaction of hydrogen and oxygen atoms from the surface could cause a desorption of hydroxyl radicals into the gas-phase radical pool that accelerates ethanol decomposition.

Graduate student Xhiangyang Wang is studying the detailed chemical kinetics modeling of gas-phase ethanol-water reactions with the HCT (hydrodynamics, chemical kinetics, and transport) code developed by Lawrence Livermore National Laboratories. HCT supports the hundreds of elementary chemical reactions needed to model combustion. Modifications to HCT will be made to model heterogeneous ethanol-water-platinum reactions.

This project is generating a base of experimental and analytical data that can be used to support the implementation of low-emission engine concepts on vehicular demonstration platforms. The performance of these vehicles is being studied in on-road and dynamometer testing as part of related NIATT projects.



Xhiangyang Wang models combustion kinetics with HCM code.

Publications

Clarke, E., Cordon, D., Steciak, J., Beyerlein, S., and Cherry, M., "Catalytic Ignition of Aqueous Ethanol in Conventional SI and CI Engines," Drexel University Mechanical Engineering Symposia Series, November 2000.

Jones, H., Kramer, S. Jones, H., Steciak, J., Beyerlein, S., and Cherry, M., "Theoretical Behavior of Platinum Catalyzed Ethanol-Water Oxidation," 2nd Joint Meeting of the U.S. Sections of the Combustion Institute, Oakland, CA, March 26-28, 2001.

Additional Funding

"Catalytic Ignition as a Tool for Converting Small Engines to Efficient JP-8 Operation," DOD Grant DAAD19-00-1-0134, \$384,000.

Donation of FTIR Gas Analysis Equipment (valued at \$10,000) from Micron Technology, Inc.

NASA Fellowship of \$6,000 awarded to Heather Jones.

"A Catalytic Reactor for Alcohol-Water Combustion," \$5,999; University of Idaho Seed Grant Program.

Diesel Engine Conversion to Aquanol™

(KLK318)

Steven Beyerlein, Principal Investigator

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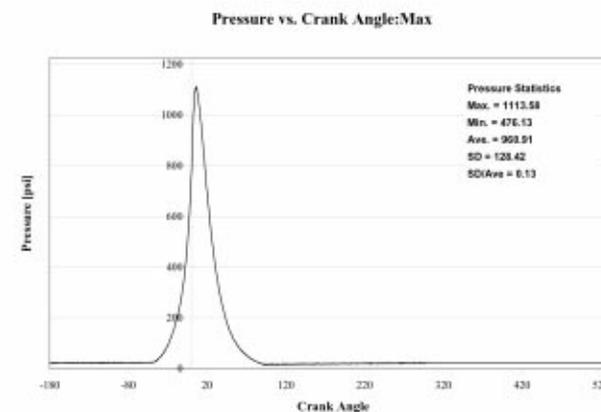
participants:

Eric Clarke, graduate student, mechanical engineering

Dan Cordon, graduate student, mechanical engineering

Andron Morton, graduate student, mechanical engineering

Matt Walker, undergraduate, mechanical engineering



Instantaneous in-cylinder pressure vs. crank angle for a converted Yanmar engine. The upper trace is with ignition; the lower is a motoring curve without ignition.

Partnership Established with Automotive Resources, Inc.

NIATT researchers are collaborating with Automotive Resources, Inc. (ARI) to investigate long-term catalytic engine performance as well as catalyst durability. SmartPlug®, an improved catalytic igniter developed by ARI's Mark Cherry, has provided the increased power input, lower fuel consumption, extended lean-burn limits, and reduced emissions needed to facilitate conversions of alternatively fueled engines.

Catalytically assisted combustion of fuel-water mixtures represents a new paradigm for piston engine development. Instead of reducing pollutants with after-treatment systems at the expense of engine performance, the formation of pollutants is controlled at the source by chemical and gas dynamic modifications of the in-cylinder combustion process. The goal of

this project has been to demonstrate the feasibility of retrofitting a diesel engine for catalytic operation, to study the operation of the engine, and to develop a model for optimizing catalytic ignition timing.

The lure of working on an engine project and the reputation of UI's mechanical engineering department convinced Eric Clarke to leave his five-year position as a mechanic, complete his undergraduate degree and begin working towards his master's degree. "The hands-on mechanic stuff brought me here, but graduate school has forced me to think analytically. And by being a member of IEW (see p.26), I'm also working on my leadership skills."

During the first year, a 20-horsepower diesel Yanmar engine was converted to alcohol-water operation. Several modifications made the Yanmar engine compatible with Aquanol (produced by Simplot Corporation of Caldwell, Idaho). Graduate student Andron Morton worked closely with an experimental apparatus to collect and record performance data on engine speed, engine output, coolant temperature, exhaust temperature, emissions and fuel consumption. His master's thesis was based on this work.

Work continues to model the ignition process to predict performance. The catalytic combustion process studied in this research consists of four steps:

- catalytic surface oxidation
- accumulation of combustion products and active radicals
- multi-point compression ignition
- rapid torch ignition

As a first attempt, the igniter was divided into three zones for a lumped-parameter model. Equations were implemented in a mathematics equation solver. Solutions began at the start of compression and proceeded until the sensible heating from homogeneous reactions equaled the sensible heating from heterogeneous reactions. Running the model with parameters from the test engine, we were able to produce results that agree with previously recorded test data. Our model represents the first three steps in this combustion process. Our long-term goal is to expand this ignition model to include all four steps in the combustion process.

Additional Funding

"Catalytic Igniters for Clean-Burning, Flexible Fueled Aircraft Engines," \$25,000; NASA EPSCoR Preparation Grant, 1999.

"Catalytic Ignition as a Tool for Converting Small Engines to Efficient JP-8 Operation," "DOD Grant DAAD19-00-1-0134, \$384,000.

Publications/Presentations

Andron Morton, "Homogeneous Charge Combustion of Aqueous Ethanol in a High Compression Catalytic Engine." (MS Thesis, University of Idaho, February 2000).

"Modeling Catalytic Ignition Timing of Ethanol-Water Fuel in Internal Combustion Engines," E. Clarke, D. Cordon, A. Morton, S. Beyerlein, J. Steciak, and M. Cherry. Society of Automotive Engineers Paper 01FL-388.

"Homogeneous Charge Combustion of Aqueous Ethanol," S. Beyerlein; D. McIlroy; D. Blacketter; J. Steciak; E. Clarke; A. Morton, NIATT Final Report N01-09; University of Idaho, February 2001.

"Ethanol-Water Fuel Catalytic Ignition Timing Model for Internal Combustion Engines," E. Clarke, D. Cordon, A. Morton, S. Beyerlein, J. Steciak, and M. Cherry. Presentation at the 2nd Joint Meeting of the U. S. Sections Combustion Institute, March 26-28, 2001, Oakland, CA.

"The most recent issue of *Scientific American* details the significant effort and resources being devoted to the successful development of an HCCI engine and all the obstacles that still need to be overcome such as control of timing avoiding detonation and NOx. The NIATT Yanmar diesel conversion has demonstrated all of these objectives and with far less funds expended and with a very inexpensive fuel that can be made from waste cellulose."

*Mark Cherry, President,
Automotive Resources, Inc.
(June 5, 2001)*

Optimal Design of Hybrid Electric-Human Powered Lightweight Transportation

(KLK320/321)

Edwin Odom, Principal Investigator

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participants:

Dan Gerbus, graduate student, mechanical engineering

Nick Peck, graduate student, mechanical engineering

Robert Sachtjen graduate student, mechanical engineering



Nicholas Peck (right) displays gear set to fellow interns

Lightweight and Efficient Hybrid Bicycle Designed

Electric bicycles are not new—many companies are developing hybrid bicycles. As a low emissions transportation alternative and an excellent source of physical exercise, people in metropolitan areas are commuting to work on bicycles. A hybrid bike provides the assistance needed by the segment of the population that lacks a degree of physical stamina but wants to achieve a portion of those benefits.

Three graduate students worked on phases of a project to design, build, and test a hybrid bicycle that would outperform models currently available. A prototype design was showcased at the Idaho Engineering Design Expo.

Many hybrid designs incorporate a battery-powered motor using a chain driven rear wheel and some friction-roller driven wheel. The most common detriment in these designs is the inherent weight added by the assist system. Most electric bikes currently on the market weigh 60 pounds or more, an obvious disadvantage over the average 30-pound production bicycle.

The assist system design also is a detriment to most of these current designs because of the use of and sensors to control the assist motor input. This sets up a perfect situation for component failure because electronics are generally fragile and bicycles can be subjected to violent vibrations.

The UI prototype couples the power from the rider and the electric motor within a purely mechanical system. A double planetary gear drive was designed to accommodate multiple power sources and then incorporated onto a common bicycle. Efficiency increased by utilizing a power coupler combining pedal power input and motor power input in a completely enclosed system. The mechanical power addition replaces the need for complex electronics.

Another concern in the development of the hybrid was to determine engineering properties of composite materials that would reduce the weight and increase strength for ease of use and greater safety. Graduate student Robert Sachtjen developed UI Composites, a software program written in MS Visual Basic that assists in the design of lightweight structures fabricated with laminated composite materials. The software works by coupling a genetic algorithm to a standard laminate point stress analysis program. UI Composites then finds possible lamina orientations and material selections to meet these required inputs.

The dissertation of Ph.D. candidate Dan Gerbus will be based on his work on the hybrid bike. UTC funds paid for his attendance at UTS Gear School where he continued his study of power train design (*see p. 17*).

A number of manufacturers have shown an interest the hybrid bicycle prototype. The Idaho Research Foundation has offered disclosure to interested parties. Further development of the prototype will include an even more refined power train and be optimized to reduce weight.

Publication

Sachtjen, Robert J. "Designing Ply Orientations of Composite Laminates with Genetic Algorithms."
(MS Thesis, University of Idaho, May 2000).



*UI hybrid bicycle
power coupler*

High Performance Auxiliary Power Units

(KLK331)

Dean Edwards, Principal Investigator

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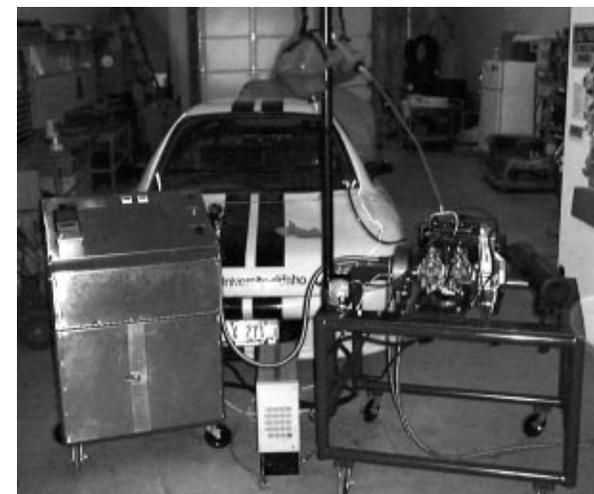
participants:

Steven Beyerlein, Co-Principal Investigator

James Richards, graduate student, mechanical engineering

Zhang Song, graduate student, mechanical engineering

David Reiche, graduate student, mechanical engineering



Small engine test stand

Software Supports Testing of Small Engines

A small engine test stand for a two-stroke engine developed under this project has been used to determine the performance and emissions of small engines. The two-stroke engine is a promising candidate for a high performance auxiliary power unit (APU) because of its inherent, high power-to-weight and volume-to-weight ratios. Controlling the internal combustion (IC) engine so that its power is constant and independent of the road load is the key to meeting our objectives. The design strategy is to run the engine at high speed because as the operating speed increases, the ratio of power to weight and volume of both the engine and alternator improve. Graduate student James Richards is completing a dynamic model for small, high-speed engines that will be useful in selecting the engine to be modified for the APU. His work provides the basis for an MS thesis Richards is scheduled to defend in August 2001.

Graduate student David Reiche has integrated a simplified engine model into a complete vehicle simulation package known as Clean Vehicle Energy Management (CVEM). CVEM supports over-the-road testing of a hybrid electric vehicle (HEV) in the absence of an EPA certified vehicle-testing facility in the Pacific Northwest. CVEM has an intuitive user interface, simple component data requirements, flexibility in driving cycle selection, and accuracy comparable to the National Renewable Energy Laboratory ADVISOR model. Unlike the ADVISOR model, CVEM allows the user to execute a driving course that includes both horizontal and vertical movement recorded by an on-board GPS tracking system.

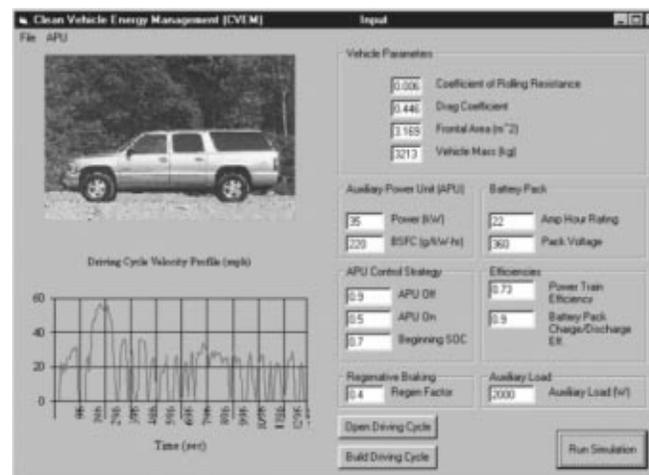
SmarterHEV, other design software (*see p.46*), is being integrated into CVEM. The package will be used to improve performance of the FutureTruck vehicle on a variety of local driving courses (*see p.30*). The software will be made available.

The UI Clean Snowmobile team plans to use the test stand to predict performance of its 2002 snowmobile (*see p.32*). The test stand is also used as a teaching tool in mechanical engineering classes.

Publication

David B. Reiche, "Simulating Standard and Local Driving Performance of a Series Hybrid Electric Vehicle." (MS Thesis, University of Idaho, September 2000).

CVEM
screenshot



NIATT's most significant outcome will be the development and transfer of technology products that are useful to others and that meet national, regional and state priorities. Likewise, the resulting knowledge base will be transferred to operating transportation agencies, research laboratories, and private commercial ventures.

- We cosponsor the annual Idaho Engineering Design Expo. At that expo, we showcase the results of capstone design classes in which our graduates and undergraduates collaborate to solve real transportation engineering problems.
- We make our Web site attractive and informative.
- We conduct short courses and classes for practicing engineers.
- We encourage our principal investigators and their students to publish and present papers at conferences, seminars, and workshops.
- We distribute final reports through the National Technical Information Services, the Transportation Research Board and other professional journals.
- We work to resolve potential issues of intellectual property and licensing rights within the university and with state and federal agencies.
- We aggressively pursue methods of promoting our products, getting them into the hands of the public and private sectors, where they can be produced and marketed.
- We support the work of our Idaho Technology Transfer (T2) Center.



NIATT Projects Displayed at Idaho Engineering Design Expo 2001

Sponsored in part by NIATT's UTC funds, the 2001 Engineering Design Expo featured displays and demonstrations of engineering transportation projects that attracted nearly 2,000 visitors to the University of Idaho campus. More than 200 booths, posters and demonstrations provided a showcase for senior engineering design projects and external sponsors. Visitors talked with students about new web tools, steel bridge construction, highway design, and other inventions and technical solutions that meet medical, physical, environmental and economic challenges. NIATT's FutureTruck (*pictured above*), clean snowmobile, hybrid electric race car and the Controller Interface Device were among the displays. Grade school and high school students were bused from around the area to attend the Expo and a variety of other activities that surrounded this yearly showcase event.

NIATT's Idaho Technology Transfer Center Hosts National LTAP Conference

More than 230 participants, representing 56 Local Technical Assistance Program (LTAP) centers and 12 foreign countries, attended the 2000 National LTAP Conference in Boise, Idaho, July 30 through August 2, 2000. The national conference, held in Idaho for the first time, was sponsored by NIATT's Idaho Technology Transfer (T2) Center. The program theme, "Bridging the Millennium with New Ideas," explored the unprecedented rate of advances in technology and how those advances are affecting the working world. UI President Bob Hoover gave the opening remarks.

The T2 Center is funded by Federal Highway Administration under their LTAP program. The organization provides a direct, hands-on approach to move innovative transportation technologies out of the lab, off the shelf, and into the hands of the people who maintain local, rural and tribal streets and roads.

At an April 2001 meeting of the Idaho Transportation Board, NIATT Director Michael Kyte and Eugene Calvert, T2 Director, were able to report a successful year of delivery of technical services and training to Idaho's cities, counties, and highway districts, and an increased level of collaboration with ITD on joint training projects. They also were able to report a very high level of customer satisfaction, based on a recently completed annual survey.



*NIATT booth at
the Engineering
Design Expo*

Organization of Northwest Transportation Training and Education Alliance Continues

A memorandum of understanding establishing a Northwest education and training partnership between transportation organizations and educational institutions draws closer to approval. DOT engineering and staff development offices, FHWA representatives, LTAP centers, and university- and college-level transportation engineering programs from five states (Alaska, Idaho, Montana, Oregon, and Washington) met during the March 2001 Road Builders' Clinic in Coeur d'Alene, Idaho, to continue their work to coordinate training and education programs and to broaden education and life-long learning opportunities for transportation practitioners in the Northwest. Jim McManus of the University of Washington agreed to chair the organization.

Michael Kyte, NIATT Director and organizer of the first meeting, conducted a video/telephone conference between members in April 2001. Alliance members reviewed a draft memorandum of understanding and discussed opportunities for working together.

UTC Directors Meet

NIATT Director Michael Kyte and Western Transportation Institute Director Steve Albert organized meetings of the University Transportation Center directors in January and June 2001. The meetings are intended to provide a forum to share information about what we do in our individual centers and how we might work more effectively together.

Information Shared with Idaho Transportation Department

Members of the Research Advisory Committee of the Idaho Transportation Department hear annually from the principal investigators and their students about the progress of the work under its cooperative research program with NIATT. In FY2001, NIATT researchers conducted a total of 26 projects sponsored by ITD.

Each year, the Idaho Transportation Department convenes a meeting of its traffic engineers, technicians, and electricians to discuss current practices, to share ideas, and to identify solutions to problems. This year, Michael Kyte and Ahmed Abdel-Rahim presented projects on which NIATT is working. As a result of the meeting, ITD has asked NIATT to present a version of its Traffic Signal Summer Camp to ITD engineers and technicians, providing needed training in traffic signal controllers and systems (*see p.24*).

Controller Interface Device to be Marketed by McCain Traffic

NIATT has been working with McCain Traffic Supply of Vista, California, to market NIATT's Controller Interface Device (*see p.38*). McCain sees the CID as an important tool for practicing traffic engineers, filling a needed gap in today's technology. The licensing of the CID to McCain fits in with NIATT's objective of transferring technology to the marketplace.



CID display board

“The CID can be modified/ adapted to my work and allow me to concentrate my resources on my research problem—the early detection of railroad train arrivals at an at-grade crossing and the use of this information to improve the safety and congestion at that crossing. I hope that NIATT continues to develop and improve this CID unit so it can be available widely to the research community. It allows the development of computer simulations that are extremely difficult and/or expensive without the use of hardware-in-the-loop methods.”

*Craig Roberts, Director,
Arizona Laboratory for Applied
Transportation Research*



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