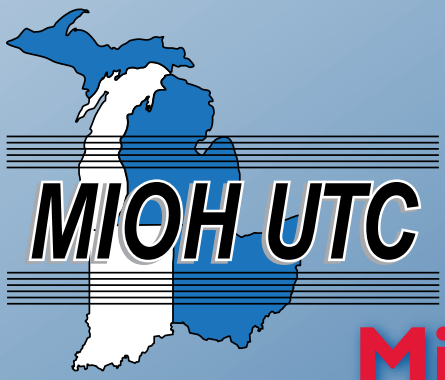

Michigan Ohio University Transportation Center

at the University of Detroit Mercy

University of Detroit Mercy

BGSU Bowling Green State University

Grand Valley State University

The University of Toledo 1872

Wayne State University

Annual Report 2009-2010, Year Four

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Director's Message

As in past years, in 2009-10 (our fourth year of operation) the MIOH UTC and its teams of researchers and educators at the five MIOH partner universities have displayed remarkable efficiencies and effectiveness to accomplish great results with a relatively modest investment. The DOT funding of $463,400, augmented by extensive matching, supported five K-12 and university educational projects and seven research projects. The focus and results of these projects are described in this annual report.

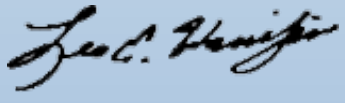
During the past year these projects involved 19 faculty members and 21 college students, and led to the generation of 29 papers and presentations, including seven journal publications. In addition, educational modules developed for working professionals, pre-college students and college students in the areas of Intelli-Drive, Alternative Fuels and Hydraulic Hybrids respectively were made available for free on line. These have great potential for reaching many more students and professionals than those directly involved in the MIOH teams.

These projects addressed the following areas:

- Use of biodiesel glycerol waste to produce more biodiesel
- Improved oxidative stability of biodiesel fuels
- Four K12 activities (courses, competitions and summer camps) focused on alternative fuels and intelligent vehicles and transportation systems. (Through support from MIOH and other sources, several thousand students learned about these critical emerging areas of transportation.)
- Efficiency improvements to Paratransit in the Toledo region
- Reducing congestion and improving supply chain efficiencies through exploitation of real-time data and modeling
- Transportation informatics and advanced image processing for pavement distress evaluation
- Analysis of safety impacts of the SCATS traffic control system
- Incorporating environmental sustainability into transit oriented development in Detroit

The results of these projects have had, and will continue to have, great impact on the efficiency and effectiveness of our transportation systems in our region and our nation, and to improve their effects on our environment and our economy.

This last year is a continuation of the historically high levels of leveraging and productivity of the MIOH UTC. In its first four years MIOH has undertaken 25 projects and augmented the $1.76 million of DOT funding with over $2.68 million in matching from private, state and university sources . . . multiplying the DOT investment by over 2.5 to create a far greater impact on national and regional issues and the wellbeing of our citizens. Please take the time to read about the specific projects, people and impacts that resulted from these investments during the past year.



Dr. Leo E. Hanifin
Director, MIOH University Transportation Center
and
Dean, College of Engineering and Science, University of Detroit Mercy

Theme, Mission & Focal Areas

MIOH UTC's Theme

Alternate energy and system mobility to stimulate economic development

MIOH'S Mission

MIOH will work to significantly improve transportation efficiency, safety, and security in Michigan and Ohio, as well as, across the nation by increasing the effective capacity of existing transportation infrastructure, reducing transportation energy dependence through alternative fuels, and enhancing supply chain performance.

This will be accomplished through:

1. the development and organization of new knowledge, technology and management systems;

2. the effective transfer of new and existing knowledge to commercial enterprises and educational communities; and

3. the development of a cadre of transportation professionals that is larger, more diverse, and better prepared to address the challenges and opportunities of 21st century transportation systems.

MIOH Focal Areas

Transportation System Efficiency and Utilization

MIOH will develop methods that meet future transportation system capacity requirements at minimum costs. To maximize the effectiveness/utilization of the current transportation infrastructure, and thereby minimize future expansion and related costs to taxpayers, MIOH will perform research, education and technology transfer to:

1. increase the utilization of existing assets through the application of technology and innovative management practices;
2. identify innovative design and operational/administrative solutions to bottle necks and safety/security in transportation systems; and
3. improve the management and planning of maintenance and repair.

Supply Chains

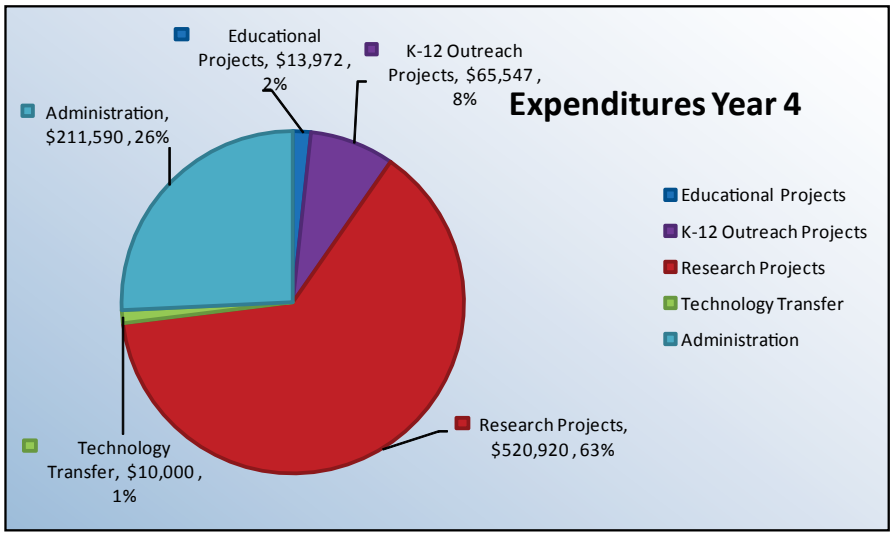
MIOH will focus on the transportation, logistics and distribution aspects of the supply chain and the interactions between supply chain participants through improved inter-modal connectivity and system-wide efficiency. These efforts will enhance our region's competitive position in the global economy and expand job opportunities. Efforts will:

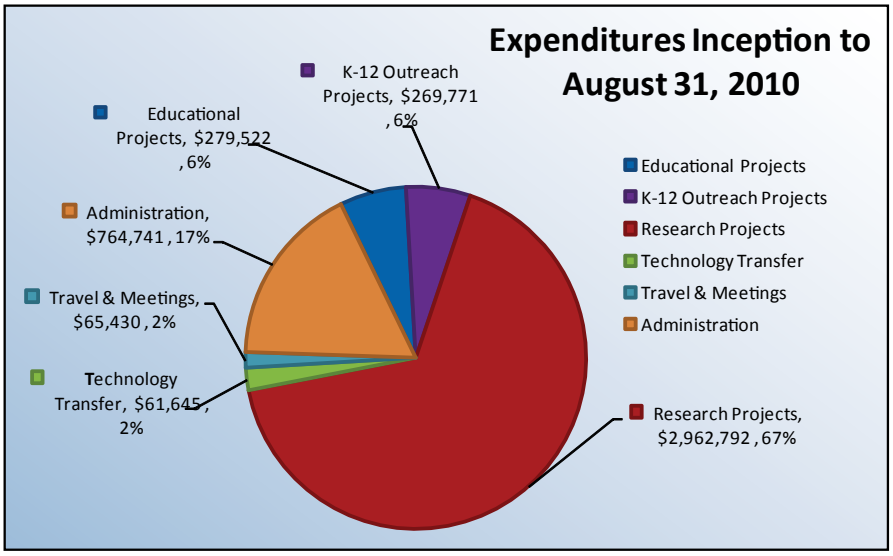
1. improve supply chain performance through the application of technology and innovative management practices;
2. identify innovative design and operational/administrative solutions to transportation system bottlenecks as they impact supply chains; and
3. improve the security and reliability of the supply chain.

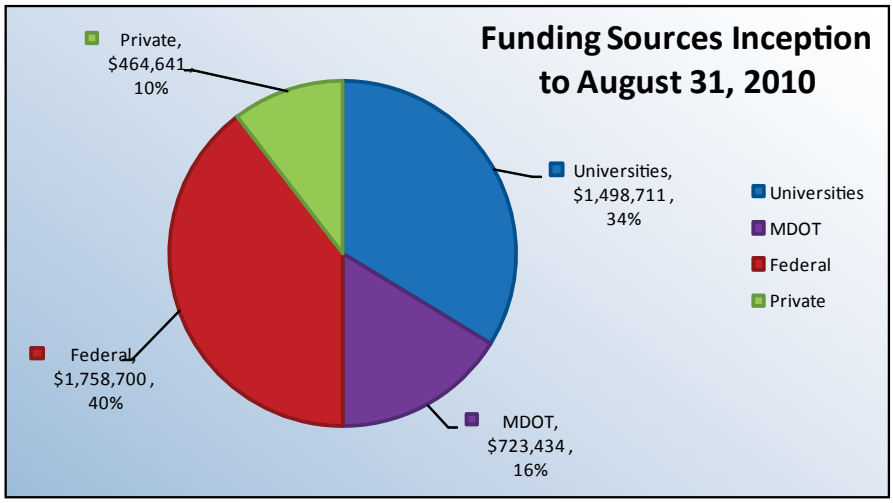
Alternative Fuels

MIOH will develop affordable alternate sources of energy for vehicles and methods to distribute fuels throughout the transportation network, yielding improvements in both security and the efficiency of transportation.

Funding Summaries







DOT Priorities

Mobility Strategic Objective:

"Advance accessible, efficient, intermodal transportation for the movement of people and goods."

Toward this end, DOT RD&T (e.g. Intelligent Transportation Systems) addresses the following priorities:

1. Exploiting web-enabled and other secure information technologies to share information on best practices in all modes
2. Examining ways to encourage cargo transport by water to improve the capacity of the intermodal transportation system
3. **In consultation with public and private sector partners, conducting research and expediting the deployment of technologies that improve system efficiency** and infrastructure durability
4. **Providing technical assistance and training to improve intermodal transportation planning and effective system management and operation**

Global Connectivity Strategic Objective:

"Facilitate a more efficient domestic and global transportation system that enables economic growth and development."

The increasingly global economy hinges on smooth supply chains and just-in-time manufacturing. Transportation is critical to both. An intermodal approach is central to DOT's role in promoting global connectivity. The following are the Department's RD&T (e.g. National Freight Action Agenda) priorities:

1. Encouraging and facilitating intermodal transportation planning worldwide
2. **Supporting and conducting research on issues concerning the intersection of passenger and freight transportation**

3. **Accelerating the use of ITS and other technologies that reduce delays at key intermodal transfer points, in significant freight corridors, and at international border crossings**

Environmental Stewardship Strategic Objective:

"Promote transportation solutions that enhance communities and protect the natural and built environment."

Transportation exerts pressure on environmental resources worldwide. The DOT Strategic Plan calls for a balance between environmental challenges and the need for a safe and efficient transportation network. Among the RD&T (e.g. Crossmodal Initiatives) priorities for achieving this vision are:

1. Supporting the President's Hydrogen Fuel Initiative through research on fuel distribution and delivery infrastructure, transportation of associated hazardous materials, and vehicle safety
2. **Supporting interdisciplinary research on connections among transportation, energy, and the environment**
3. Adopting transportation policies and promoting technologies that reduce or eliminate environmental degradation
4. Collaborating with Federal agencies, academic institutions, and the private sector to support and conduct **research on technologies that improve energy efficiency, foster the use of alternative fuels, and reduce vehicle emissions**
5. **Working with transportation partners to mitigate the adverse environmental effects of existing transportation systems**

Education and Workforce Development Strategic Objective:

RITA will work with partners in academia and industry to build the professional capacity of the transportation workforce. RITA's activities will complement the efforts of DOT's operating administrations by reaching out to the broader transportation and education communities. In addition, the Administration's proposal for reauthorization of surface transportation programs – the Safe, Accountable, Flexible, and Efficient Transportation Equity Act – includes a provision for a new Transportation Scholarship Opportunities Program that RITA will administer.

DOT Strategic Objectives								
Funded Projects	Mobility		Global Connectivity		Environmental Stewardship			Education & Workforce Development
	Improve System Efficiency	Technical Assistance & Training	Intersection of Passenger & Freight Transportation	Accelerating Technologies Reducing Delays	Interdisciplinary Research Transportation Energy & Environment	Improve Energy Alternate Fuels	Mitigate Adverse Environmental Impacts	
AF1, series 1-3					x	x	x	x
AF3, series 1-2					x	x	x	
AF4, series 1-5					x	x	x	
AF12,series1-2					x	x	x	
AF21, project 1					x		x	
AF31, project 1					x		x	x
SC1, series 1-2	x	x	x					x
SC2, series 1-5	x		x	x				
TS1, series 1-3	x		x	x				
TS2, project 1	x							
TS4, series 1-2	x		x	x				
TS13, project 1	x							
TS14, project 1	x							
TS15 series1-2	x			x				
TS18 series1-3	x							
TS19, project 1	x							
TS21,series1-2	x		x	x				
TS22,series1-2	x		x	x				
TS23,series1-2	x		x					
TS33, project 1	x							
K12-1,series1-4					x			x
K12-2,series1-4					x			x
K12-3,series1-4					x			x
K12-14,proj.1-3								x
K12-35,proj. 1					x			x

Program Overview

Overview of Education, Research, and Technology Transfer Programs

MIOH Education Program

University Education

Biodiesel Glycerol Waste Byproduct as Potential Feedstock for Production of Biofuel (AF31,Yr4)

Student laboratory manuals and lab courses are deficient in exercises dealing with biofuels and industrial microbiology. Topics for laboratory exercises dealing with biofuel for use in course laboratories may be realized.

In making biodiesel from plant and animal oils, glycerol is a byproduct. The biodiesel is burned in engines but the supply of glycerol, which is not a biofuel, exceeds the demand. It may be possible for some microbes that utilize biodiesel glycerol byproduct to make biofuel or other products.

Glycerol byproduct will be tested for sterility, and components other than glycerol that are toxic or can serve as nutrients for microbes. Microbes of interest to biofuel research whose characteristics indicate they may be likely to utilize glycerol byproduct will be assessed for this ability. *Escherichia coli* and *Klebsiella* species are now used in bioethanol synthesis as a consequence of genetic engineering. *Clostridium acetobutylicum* has been used by industry to make butanol from costly agricultural products. Bacterial species that possess extracellular polysaccharide may provide glucose for use by ethanol producing *Saccharomyces cerevisiae* after digestion with dextranase. Microbes such as *Streptomyces* species that have high levels of triacylglycerols should be assessed as a prospective source of biomass for biodiesel. It will be determined which microbes would be worth further investigation in making biofuel.

K-12 Outreach

The 2009 FIRST LEGO League (FLL) Challenge, *Smart Move* (K12-35,Yr4)

The 2009 FIRST LEGO League (FLL) challenge, *Smart Move*, was released on September 3, 2009.

FLL teams were tasked with learning about transportation – accessing people, places, goods and service in the safest, most efficient way possible. There were two parts to the *Smart Move* challenge – the Robot Game and the Project. This year's robot game took place on a field that represents a vehicle test track. Each team designed, built and programmed a sensor-equipped vehicle (their robot). This vehicle needed to gain access to places and things, while avoiding or surviving impacts. The playing field, which was 4' x 8', had numerous LEGO challenge elements and obstacles that the team's robot needed to traverse and interact with. Some challenge elements needed to be manipulated on the field, some needed to be delivered to specific locations, while other objects needed to be retrieved from their locations on the field and brought back to base.

The project for *Smart Move* asked teams to look at how transportation affects their everyday lives. Students came to understand that nearly everything we use is impacted by transportation. Teams first needed to describe their community, and then to create a list of how everything moves in, around, to and through their community. From this list, teams must learn more about these forms of transportation and identify problems with them. After selecting one particular problem, they created an innovative solution to this problem – then share what they learned with others.

A grant from the Michigan Ohio University Transportation Center provided the 91 *Smart Move* field setups necessary to run all fifteen Michigan FLL tournaments impacting over 3,100 students and adults.

The field setups represent about 20% of the annual budget for FLL in Michigan. Additional funding was used to purchase trophies for the two Championship Tournaments.

Alternative Fuels DAPCEP Class for High School Students (K12-2, project 4,Yr4)

For a fourth year, Mechanical Engineering faculty offered a five-week Saturday class through Detroit Area Pre-College Engineering Program (DAPCEP). The course, *Powering the Car of Tomorrow*, was developed by members of Chemistry, Biology and Mechanical Engineering. Activities covered Internal Combustion Engines, Making Biodiesel, Testing Biodiesel, Measuring Energy Content, Building a Fuel Cell Car, and Comparing Fuel Alternatives. This course also allowed faculty members to incorporate educational content developed for the Ford PAS modules into the DAPCEP program. Nineteen students participated in this course.

Transportation Summer Camp for High School Students (K12-3, project 4,Yr4)

TRANSIT, a one week summer camp, was conducted for the third year by Civil and Environmental Engineering faculty members from UDM.

It included presentations and hands-on activities by professionals from the following organizations:

- Southeastern Michigan Council of Governments, Traffic Division
- The Road Commission of Oakland County
- The Detroit Collaborative Design Center (UDM, School of Architecture)
- Michigan Department of Transportation
- Ford Motor Company
- Spalding DeDecker

Activities focused on intelligent transportation systems, paving systems, urban planning/transportation, Vehicle Infrastructure Integration, traffic signals/controls, and regional transit systems. Eleven students participated in the camp.

STEPS Camp (Science Technology and Engineering Preview Summer Camp for Girls) (K12-14, project 3,Yr4)

The STEPS Camp at UDM is a five-day residential program for high school girls designed to:

- Introduce young women to manufacturing, engineering, science, math, and robotics
- Increase their interest in a career in one of these areas
- Provide them with a positive university experience
- Provide exposure to college professors, college students, and professional engineers
- Improve their perception of engineering
- Inspire young women to consider a career in manufacturing, engineering or science

Activities included academic, social and personal reflection. The main project, included a Robotics Challenge based on the LEGO Mindstorm NXT system, which was revised in 2008 to include a transportation theme thanks to financial support from the UTC. The campers also participated in academic labs such as Batteries, Programming, Sensors, Circuits, Welding, Fuel Cells, Motors, and Engineering Math. STEPS 2010 was the camp's ninth year. It was the third camp to have a transportation theme integrated into its activities. The camp was conducted with a total of 24 girls participating.

(Excerpt from Campers' Newsletter)
"Some of the lessons we learned at camp include:

Don't give up on your dreams just because they are hard to accomplish.

Get exposed to lots of different types of work and activities.

Don't let anyone tell you that 'you can't do it.'

Be flexible and open-minded.

Stay true to yourself and keep your integrity.

Take the hard classes in high school... especially math.

Don't shut any doors. Engineering opens all kinds of opportunities for you."

MIOH Research Program

During its fourth year, the MIOH UTC defined and launched one new research project and funded six projects to build on previous research. All focus on important national priorities including independence from foreign oil, efficient freight delivery, and congestion mitigation.

The new project relates to paratransit transportation systems. The sequential projects, building on previously funded research, span all three focal areas: one each in alternative fuels and supply chain, and four related to transportation systems.

Project reports can be accessed through the website at http://mioh-utc.udmercy.edu/research/index.htm

Developing a Model-Based Decision Support System for Call-a-Ride Paratransit Service Problems (TS33,Yr4)

One faculty member from Bowling Green State University proposes to extend research relative to paratransit public transportation in the Toledo, Ohio region. To comply with the Americans with Disabilities Act (ADA) of 1990, the Toledo Area Regional Paratransit Service (TARPS), which is a subdivision of Toledo Area Regional Transit Authority (TARTA), has begun to reassess the way that it serves riders with special needs such as senior citizens with limited mobility and physically or mentally-handicapped individuals requiring door-to-door services with a fare scheme comparable to regular transit. However, a MIOH UTC funded previous project (TS13) by this Principal Investigator reveals that there still exist a significant amount of service gaps between the riders' service expectations and the actual rendering of paratransit services by TARPS. Some of these gaps include: (1) a lack of timely pick-ups and drop-offs of the riders; (2) frequent communication breakdowns between the riders and the TARPS drivers; (3) limited TARPS services for a certain region of the Toledo metropolitan area. Despite the TARPS' recent efforts to reduce these service gaps, its efforts are often restrained by an ongoing budget shortfall and limited technological assistance. To make matters more challenging, paratransit is more expensive to operate on a per-passenger basis due to its customized service requirement for user-specified origin/destination and time. To help TARPS officials better cope with ever-demanding paratransit service requirements, this project proposes a model-based decision support system (DDS) that would aid TARPS officials in automating the time-dependent TARPS vehicle routing and scheduling decisions in such a way that riders can be picked up and dropped off on-time and TARPS can be utilized in a fuel-efficient manner.

Improved Oxidative Stability of Biodiesel Fuels (AF4, project 5,Yr4)

As a four year research effort, a team of two faculty members and their graduate students from Wayne State University, in cooperation with the National Biofuels Energy Laboratory at NextEnergy in Detroit, are investigating the effect of antioxidants on the stability of different types of biodiesel; additionally, they are studying the long-term stability of biodiesel with synthetic/natural antioxidants.

Enabling Congestion Avoidance and Reduction in the Michigan-Ohio Transportation Network to Improve Supply Chain Efficiency (SC2, project 5,Yr4)

Faculty members and students from Wayne State University (lead) and the University of Detroit Mercy are developing efficient dynamic freight routing algorithms under both recurring congestion and non-recurring incidents by using real-time ITS traffic information. These routing models include anticipatory modeling of recurring congestion and modeling of reactive and anticipatory traffic flow behavior in response to non-recurrent congestion.

Transportation Informatics: Advanced Image Processing Techniques for Automated Pavement Distress Evaluation (TS18, project 3, Yr4)

A research team at The University of Toledo partnered by the University of Detroit Mercy furthers the effort that investigates the designing an automatic and non-destructive evaluation pavement inspection system using advanced image processing techniques. This new technique provides a low-cost, near real-time distress analysis option through a series of image processing techniques. The experimental results, obtained by testing real pavement images over local asphalt roads, present the enhanced effectiveness of the algorithm for automating the process of identifying road distresses from images.

This project seeks to provide a more generalized solution in a less restricted environment. Color and texture information will be used to extract the pavement regions. Neural networks are designed to process the pavement images and then used as a decision tool to provide a classification for various types of cracks.

Management and Analysis of Michigan Intelligent Transportation Systems Center Data with Application to the Detroit I-75 Corridor (TS21, project 2, Yr4)

Grand Valley State University and Wayne State University faculty and student teams pursue a project addressing the extension of analysis of the data collected by the Michigan Intelligent Systems (MITS) Center. Planned is the completion of design and implementation of a database management system for this voluminous data, about 50 gigabytes per year, within a MySQL database.

Based on the insights gained from the statistical modeling efforts, identify traffic flow improvement scenarios and assess them using Detroit area I-75 traffic corridor simulation model and analysis capabilities previously developed. Work with MITSC to identify possible opportunities for effectively using our results to impact the ITS work of the center. Build concept demonstrations to show that these opportunities can be effectively addressed. Implement an open access technology transfer web site, making all of our routing models, statistical models, software tools and MITSC data available for general use.

Crash Benefits of SCATS Control System (TS22, project 2, Yr4)

Continuing a previous project, faculty and students at the University of Detroit Mercy are undertaking research to determine the effectiveness of the Sydney Coordinated Adaptive Traffic System (SCATS) in reducing traffic hazard by examining crash rate as Measure of Effectiveness (MOE). A cost-benefit analysis of the SCATS system will be performed by considering congestion and crash benefits, installation/maintenance costs, and life span.

There is a need to determine the added related economic/health care cost benefits of the SCATS system. In this context, determination of the economic implications of crash benefit of the SCATS can play a significant role. If congestion and crash related benefits can be combined, then it may be feasible that the combined benefits will outweigh the cost of construction and maintenance.

Incorporating Environmental Sustainability into Transit Oriented Development in the Detroit Metropolitan Area (TS23, project 2, Yr4)

A team lead by WSU researchers with partners at UDM are conducting a study to develop programs for environmentally sustainable Transit Oriented Development (TOD) at two potential station sites along the Woodward Avenue planned LRT route in the Detroit metropolitan region. A previous study developed different TOD packages for these sites and identified planning, economic and institutional mechanisms for their effective implementation.

This study will also identify planning, economic, and institutional mechanisms for their effective implementation. The focus of the project is the integration of TOD with the planning and design of selected stations in the Detroit area in order to maximize environmental and economic outcomes.

TEAM MIOH Engages the Transportation Community

Peter Appel, Administrator of the US DOT, Research and Innovative Technology Administration, visited with the MIOH UTC in the fall of 2009. Faculty and students took this opportunity to share the research and activities undertaken by colleagues and collaborators in pursuing the mission of this university transportation center.

Six students from the partner universities met with Peter Appel, Administrator, Research and Innovative Technology Administration, US DOT, during his visit to the MIOH UTC.

MIOH UTC hosted faculty and student researchers at the Detroit Economic Club luncheon featuring U.S. Secretary of Transportation Raymond LaHood.

MIOH Technology Transfer Program

The MIOH UTC has developed a three-tier strategy for technology transfer that involves direct transfer, UTC-wide activities, and partnering with established organizations.

Direct Transfer

The MIOH UTC is engaged in technology transfer on a direct basis. That is, all projects involve direct participation of corporations and/or government agencies that can directly benefit from and employ the results of the project. Some of the participants are the Michigan Department of Transportation, Ford Motor Company, NextEnergy, UPS, Michigan Intelligent Transportation System (MITS) Center, Detroit Area Pre-College Engineering Program, the Road Commission for Oakland County, the Toledo Metropolitan Area Council of Governments, Ryder, Deloitte Consulting and the Southeast Michigan Council of Governments. Through direct participation in projects, these organizations not only influence the efforts but also prepare themselves to quickly transfer results into improved transportation systems and transportation education.

UTC Wide Activities / Partner Technology Transfer

A team of faculty from WSU and UDM, have created a short course explaining "Intelli-Drive" to inform potential stakeholders including public agencies, elected officials, private corporations and the traveling public. This power point course with slides and notes is available on the MIOH UTC website at: http://mioh-utc.udmercy.edu/education/intelli_drive/index.htm

"Fueling the Car of Tomorrow" is a series of hands-on activities intended to teach high school students about the future of the automobile through the eyes of scientists and engineers. Developed by UDM faculty, these modules can be integrated into high school curricula. In all, sixteen activities involve a wide variety of experiences for students: making biodiesel, comparing parameters of biodiesel and ethanol, operating a simulation model to examine fuel economy, and learning basic chemistry and/or biology related to combustion, greenhouse gas production, production of biofuels and hydrogen, and alternatives for vehicular propulsion.

These educational modules have been provided to the Ford Partnership for Advanced Studies (PAS) Program and been posted on the UDM and Ford PAS websites for free download and use by any high school nationally. http://eng-sci.udmercy.edu/pre-college/alt_fuel_curriculum/

Developed under the grant "Multipurpose Educational Modules to Teach Hydraulic Hybrid Vehicle Technologies," these materials include two simulations and associated student handouts. The Hydraulic Hybrid Vehicle Simulation consists of a MATLAB/Simulink model for the fuel economy performance of a hydraulic hybrid vehicle. The Hydraulic Test Stand Simulation is a LabVIEW program simulating a hydraulic pump/motor test apparatus. Both simulations are available for free use by university instructors at: http://mioh-utc.udmercy.edu/education/af-1/material/index.htm

Journal Publications

- Schumack, M., Baker, S., Benvenuto, M., Graves, J., Haman, A., and Maggio, D., 2010, Fueling the car of tomorrow: An alternative fuels curriculum for high school science classes, *The Science Teacher*, v.77, p.52-57.
- de Guzman R, Tang HY, Salley S, and Ng KYS, 2009, Synergistic Effects of Antioxidants on the Oxidative Stability of Soybean Oil- and Poultry Fat-Based Biodiesel, *Journal of the American Oil Chemists Society*, V.86,p.459-467.
- Tang HY, De Guzman RC, Ng KYS, and Salley SO, 2010, Effect of Antioxidants on the Storage Stability of Soybean-Oil-Based Biodiesel, *Energy & Fuels*, v.24, p.2028-2033.
- Shandilya,K. K., and Kumar, A., 2010, Qualitative Evaluation of Particulate Matter inside Public Transit Buses Operated by Biodiesel, *The Open Environmental Engineering Journal*, v.3, p.13-20.
- Shandilya, K. K., Kumar, A., 2010, Morphology of Single Inhalable Particle inside Public Transit Biodiesel Fueled Bus, *Journal of Environmental Sciences*, v.22(2), p.263–270.
- Ying and E. Salari, 2010, Beamlet Transform Based Technique for Pavement Image Processing and Classification, *Computer-Aided Civil and Infrastructure Engineering*, v. 25, p.572-580.
- Benvenuto,M., and Garshott,D., 2010, Producing Bio-Fuel In the Classroom: A Simple Experiment to Make Ethanol, *Michigan Science Teachers Association*, v.Feb., p.7-8.

Student Presentations and Poster Sessions

Efforts of Michigan student researchers were recognized at the ITS-Michigan annual meeting. Five MIOH UTC student researchers from partner universities were selected to present at the May 2010 annual summer meeting of the Intelligent Transportation Society of Michigan.

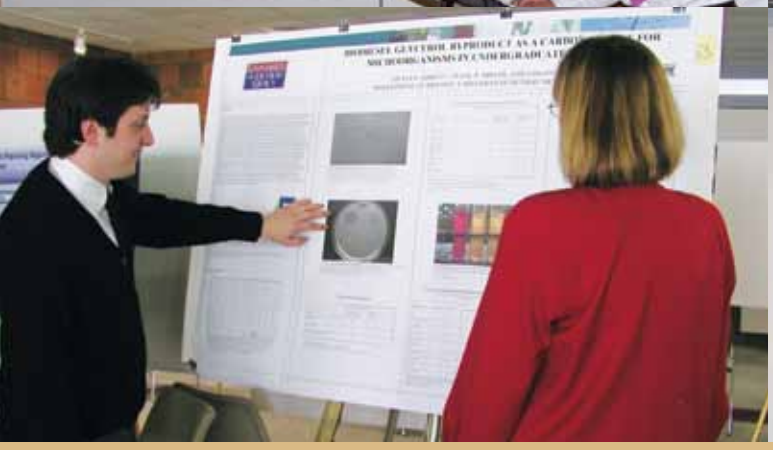
Posing with Dr. Robert Bertini, Deputy Administrator, Research and Innovative Technologies Administration, US DOT are: (from left to right) Dr. Jun-Seok Oh, Assoc Professor Western Michigan University; Dr. Bertini; Sujay Bodke, UDM graduate student; Zhengming Li, Michigan Tech University graduate student; Dr. Snehamay Khasnabis, WSU and ITS-Michigan Board Member; Subrat Swain, WSU graduate student; Congyi Liu, Michigan Tech University graduate student.

UDM graduate student Eric Tenezas (right) presents concepts of "Modeling Metropolitan Detroit Transit" at the Intelligent Transportation Society of Michigan Annual Meeting on May 20, 2010. The results of this work will support initiatives to create modern light rail transit systems in the Detroit metro region. This work was coanducted jointly by Dr. Snehamay Khasnabis, WSU and Dr. Utpal Dutta, UDM.

Dr. Robert Bertini, Deputy Administrator, RITA, US DOT, listens to Ryan Massalink, GVSU, during a poster session at the ITS MI annual meeting.

Ali Guner, WSU graduate student, presents "Dynamic Routing Using Real-Time ITS Information" a research project supported by the MIOH UTC. This work was conducted under the direction of Dr. Ratna Babu Chinnam and Dr. Alper Murat, WSU.

Sujay Bodke (right) presented a poster summarizing findings of the project "Crash Benefits of SCATS Control System." This research will help designers of smart highways to make them safer for all of us. Sujay is a recent UDM mechanical engineering masters graduate. The research was led by Dr. Utpal Dutta, UDM.



Vince Viljaj, UDM biology student, assisting Dr. James Graves on "Biodiesel Glycerol Waste Byproduct as Potential Feedstock for Production of Biofuel," presents research in progress at the University of Detroit Mercy's annual Celebration for Scholarly Achievement.

ITS Michigan "Gold Student Paper Award" winner Subrat Kumar Swain, WSU, receives his certificate from Jim Barbaresso, ITS-MI President. Subrat's paper resulted from a MIOH UTC project directed by Dr. Snehamay Khasnabis (right). Photo credit: MDOT

Conference Presentations

- Guner,A.R., Chinnam,R.B., and Murat,A., "Dynamic routing in congested networks using real-time ITS information," EURO 2010, Lisbon, Portugal, July 11-14, 2010 (Invited)
- Guner,A.R., Chinnam,R.B., and Murat,A., "Dynamic Routing in Stochastic Time-Dependent Networks for Traveling Salesman Problems with Time Windows." 2010 ALIO-INFORMS Joint International Meeting. Buenos Aires, Argentina, 2010 (Invited)
- Guner,A.R., "Dynamic Routing in Stochastic Time-Dependent Networks for Milk-Run Tours with Time Windows." Intelligent Transportation Society of Michigan Annual Meeting. Dearborn, MI, May, 2010 (ITS Michigan Best Paper Bronze Award)
- Guner,A.R., Chinnam,R.B., and Murat,A., "Dynamic Routing Using Real-time ITS Information." INFORMS Annual Meeting. San Diego, CA, October, 2009 (Invited Talk)
- Min, Hokey and Melachrinoudis, Emanuel, "An Intelligent Decision Support System for Paratransit Service Vehicle Routing and Scheduling." Presented at the 24th European Conference on Operational Research (EURO), Lisbon, Portugal, July 14, 2010.
- Kumar, A., Kadiyala, A., Kumar, V., Nerella,V., Shandilya,K.K., Velagapudi,S., and Somuri,D., "Characterization of Emissions and Indoor Air Quality of Public Transport Buses Using Biodiesel and Ultra-Low Sulfur Diesel," Proceedings of the International Conference on Emerging Technologies in Environmental Science and Engineering, October 26-28, 2009, Aligarh Muslim University, Aligarh, India (Keynote Presentation).
- Nafso,T., Ulferts,G., Chinnam,R.B., and Murat, A., "Real Time Traffic Information for Supply Chain Management through ITS," APICS International Conference: Academic Program, Toronto, Canada, October 3, 2009.
- Swain,S.K., Presented at the Intelligent Transportation Society Michigan Annual Meeting, May, 2010 (ITS Michigan Best Paper Gold Award)
- de Guzman,RJC, Tang,H., Salley,SO, and Ng,KYS., "Biodiesel Oxidative Stability Study: Factors and Improvement," presented at the AIChE's 2009 Annual Meeting, Nashville, TN, November 8-13,2009.
- Tenazas,E., "Modeling Metropolitan Transit," Presented at the Intelligent Transportation Society Michigan Annual Meeting, May, 2010.
- Graves, J., Miller,I., and Vuljaj,V., "Biodiesel Glycerol Byproduct as a Carbon Source for Microorganisms in Undergraduate Research," Spring Meeting of Michigan Branch of American Society for Microbiology, 2010.
- Shandilya, Kaushik K., "New Investigations into the Morphology of the particulate matter inside urban public transit bus in Toledo, Ohio," Presentation in Thirtieth Annual Sigma Xi Student Research Symposium and Third Annual Scholars' Celebration Student Research Symposium, Toledo, Ohio, October 24, 2009.

2009 MIOH UTC Student of the Year

Elibe Ama Elibe
Wayne State University

Elibe Ama Elibe was selected as the 2009 Outstanding Student of the Year in recognition of his contributions on Michigan Ohio University Transportation Center (MIOH UTC) projects, his academic performance, and community service.

Elibe completed a master's degree in civil and environmental engineering at Wayne State University (WSU) majoring in transportation engineering in summer 2010. Additionally, Elibe was selected by the Board of Regents of the Eno Transportation Foundation to participate in the 18th annual Eno Leadership Development Conference in Washington, DC in May 2010.

As a graduate research assistant at WSU, Elibe's recent work has been focused on a MIOH UTC funded study involving transit-oriented development along a proposed light-rail transit system on Woodward Avenue in the Metro-Detroit area. Elibe has made valuable contributions to the research and has demonstrated his ability to offer creative approaches to the central problem. This study is directed by Dr. Snehamay Khasnabis, WSU, and Dr. Utpal Dutta, University of Detroit Mercy.

Earlier in 2009, Elibe worked as a research assistant on the MIOH UTC project, "Modeling Metro Detroit Transit," providing excellent support in data collection, data analysis, and preparation of reports. In the summer of 2009, Elibe assisted in mentoring an undergraduate student of civil engineering as part of the Louis Stokes Alliances for Minority Participation (LSAMP) program at WSU. In this role, Elibe demonstrated his ability to guide a young student through the process of engineering research.

Eliba Ama Elibe receives a US DOT Award. Bestowing the award are Robert H. Plymale, President of the Council of University Transportation Centers and Peter Appel, Administrator of Research and Innovative Technology Administration, US DOT.

Above: 2009 MIOH UTC Outstanding Student of the Year, Elibe Ama Elibe, receives the MIOH UTC award at a meeting of the Institute of Transportation Engineers, Michigan Section. Left to right: Snehamay Khasnabis, WSU; Elibe A. Elibe; Kirk Steudle, Director, Michigan Department of Transportation; Colleen Hill, ITE President; and Utpal Dutta, UDM.

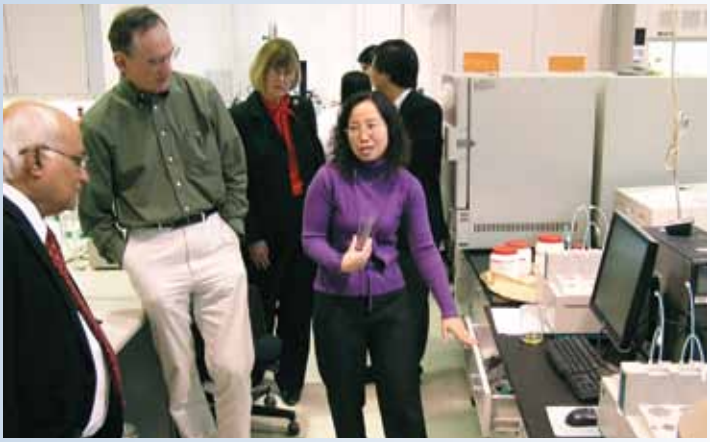
At left: Elibe A. Elibe receives an Eno Foundation Certificate during the 2010 Leadership Conference.

Recently Completed Research

The following are some examples of specific accomplishments that support the national strategy for surface transportation research and/or respond to DOT priorities. Full reports are available via the MIOH UTC webpage: http://mioh-utc.udmercy.edu/research/index.htm

- **Improved Oxidative Stability of Biodiesel Fuels**
  A team of researchers at Wayne State University has investigated the oxidative stability of different types of biodiesels and their blends under long-term indoor and outdoor storage, and the impact of antioxidants on biodiesels from various feed-stocks.

  Conclusions regarding the effectiveness of various natural and synthetic antioxidants (α-tocopherol (α-T), butylated hydroxyanisole (BHA), butyl-4-methylphenol (BHT), t-butylhydroquinone (TBHQ), 2, 5- Di-tert-butyl-hydroquinone (DTBHQ), ionol BF200 (IB), propylgallate (PG), and pyrogallol (PY)) to improve the oxidative stability of soybean oil (SBO-), cottonseed oil (CSO-), poultry fat (PF-), and yellow grease (YG-) based biodiesel at the varying concentrations between 250 and 1000 ppm. Results indicate that different types of biodiesel have different natural levels of oxidative stability, even when derived from the same basic feedstock, due to variations in both natural antioxidant level and FAME composition. Moreover, PG, PY, TBHQ, BHA, BHT, DTBHQ, and IB can enhance the oxidative stability for these different types of biodiesel. Antioxidant activity increased with increasing concentration. The induction period of SBO-, CSO-, YG-, and distilled SBO-based biodiesel could be improved significantly with PY, PG and TBHQ, while PY, BHA, and BHT show the best results for PF-based biodiesel. This indicates that the effect of each antioxidant on biodiesel differs depending on different feedstock. Moreover, the effect of antioxidants on B20 and B100 was similar, suggesting that improving the oxidative stability of biodiesel can effectively increase that of biodiesel blends. Some binary mixtures of antioxidants are more effective in improving oxidative stability of biodiesel than individual ones, suggesting a synergistic interaction which may be important in the development of suitable blends. The best synergy was produced by the 2:1 TBHQ: BHA blend while the best improvement in IP was achieved by using the 2:1 TBHQ: PY blend. Considering %SYN and SF, these two formulations are good choices for long term storage. The effectiveness



of individual antioxidants in SBO-based biodiesel oxidative and storage stability over a 30-month period of indoor storage and binary antioxidants in distilled SBO-based biodiesel under indoor and outdoor conditions over a 6-month period were studied. Results indicate that the oxidative and storage stability of both untreated SBO-based and untreated DSBO-based biodiesel decreases with time. The addition of the antioxidant TBHQ can improve and maintain oxidative and storage stability of the biodiesel over a 30-month period. The binary combination TBHQ: BHA also showed better performance than either individual antioxidant or can improve oxidative and storage stability of DSBO-based biodiesel for up to 6 months.

- **Improving the Energy Density of Hydraulic Hybrid Vehicles (HHVs) and Evaluating Plug-In HHVs**
  In this project, researchers from the University of Toledo (UT) and University of Detroit Mercy (UDM) have evaluated a new concept for improving energy density and extending operation distance for HHV's by incorporating a compressed air reservoir. The UT developed a Simulink model and it was validated by UDM researchers. Researchers also analyzed the "plug in" feature of the design; i.e., the capability to recharge the air tank with an electric compressor. The analysis shows that a fully recharged tank provides minimal assist under the current configuration. The researchers subsequently altered the design to eliminate the "pressure exchangers." This new configuration powered solely by a hydraulic motor was found to significantly improve the range of the vehicle (considering the air/hydraulic system as the only propulsion system).

The researchers concluded that in spite of the improved performance achieved through design changes and application to a lighter vehicle, it still appears that the original UT strategy – extending the energy density of a hydraulic system by adding a switching air tank design – is impractical. There is too much wasted energy in the air vented from the accumulators each time a switch occurs. If a way could be found to recover this lost energy – perhaps by venting to a reservoir rather than to the atmosphere – the air-augmented hydraulic system could possibly be made more feasible.

- **Enabling Congestion Avoidance and Reduction in the Michigan-Ohio Transportation Network to Improve Supply Chain Efficiency**

Over the past four years, a team of MIOH researchers, from Wayne State University and the University of Detroit Mercy, have developed practical dynamic routing models that can effectively exploit real-time traffic information from Intelligent Transportation Systems (ITS) to mitigate both recurrent as well as non-recurrent congestion stemming from incidents (e.g., accidents) in transportation networks.

The researchers conclude that, with the aid of this information and technologies, the models can help drivers avoid or mitigate trip delays by dynamically routing the vehicle from an origin to a destination in road networks. While non-recurrent congestion is known to be responsible for a major part of network congestion, extant literature mostly ignores this in proposing dynamic routing algorithms. The researchers model the problem as a non-stationary stochastic shortest path problem and propose effective data driven methods for accurate modeling and estimation of recurrent congestion states and their state transitions. Researchers developed solution methods for generating routing "policies" to be used by drivers to select the best node to go next based on a "state" (vehicle location, time of day, and network congestion state). While optimality is only guaranteed if the researchers employ the full state of the transportation network to derive the policy, they recommend a limited look-ahead approach to prevent exponential growth of the state space. The proposed model also estimates incident-induced arc travel time delay using a stochastic queuing model and uses that information for dynamic re-routing (rather than anticipate these low probability incidents).

ITS data from the Southeast Michigan road network, collected in collaboration with MITS Center and Traffic.com, is used to illustrate the performance of the proposed models. The experiments clearly illustrate the superior performance of the dynamic routing policies generated for both recurrent and non-recurrent congestion scenarios. Experiments show that as the uncertainty (standard deviation) in the travel time information increases, the dynamic routing policy becomes increasingly superior to static path planning methods. The savings however depend on the network states as well as the time of day. The savings are higher during peak times and lower when traffic tends to be static (especially at night). Experiments also show that explicit treatment of non-recurrent congestion stemming from incidents can yield significant savings.

These results were presented at the INFORMS Annual Conference as well as other conferences and publications.

- **Advanced Image Processing Techniques for Automated Pavement Distress Evaluation**

A research team at the University of Toledo partnered by the University of Detroit Mercy has developed algorithms to detect and classify surface cracks from pavement images. After the pavement images are captured by a digital camera, regions corresponding to cracks are detected over the acquired images by local segmentation and then represented by a matrix of square tiles. The crack tile distribution is used in a neural network to identify various types of cracks. In addition, a Beamlet transform based technique to extract the linear crack features from pavement images has been introduced. Initially, an enhancement method is applied to reduce the effects of any non-uniform background and undesired objects to facilitate the application of the Beamlet transform. The experimental results, obtained by testing real pavement images over local asphalt roads, present the effectiveness of both methods for automating the process of identifying road distresses from images.

Conclusions reached through this research resulted in identifying a low-cost, user-friendly and fast pavement distress detection and classification method using advanced image processing techniques. It has been shown that the proposed pavement analysis system allows complete automation with a near real-time evaluation of pavement distresses. The accuracy of this system in identifying pavement distress meets the standards set out by the road authority for pavement management. The experimental results indicate that the proposed system produced highly reliable and accurate results from the 200 tested samples.

The application developed in this research mainly focused on distress detection and classification. Future developments will target the detection of cracks in a less restricted environment and the analysis of crack properties, such as width, length and their severity.

- **Management and Analysis of Michigan Intelligent Transportation Systems Center Data with Application to the Detroit I-75 Corridor**

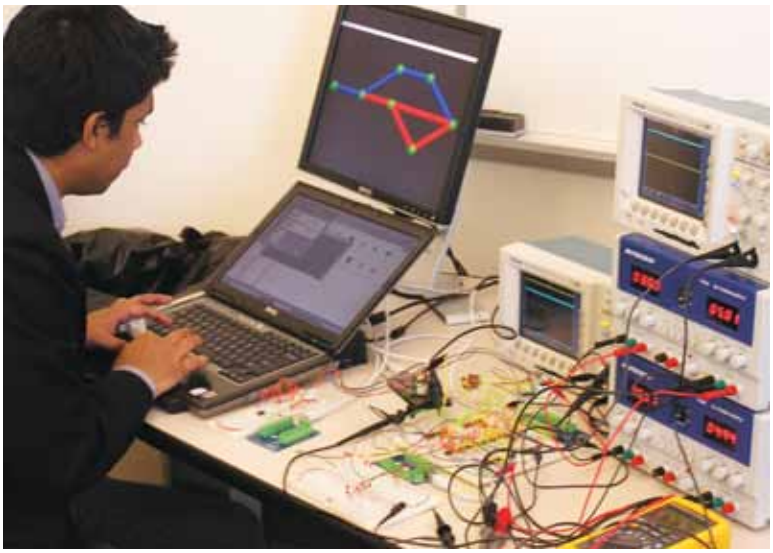
Researchers at GVSU and WSU report on the first project of a two project sequence. The overriding objective of this project is to describe, explain, and predict the flow of traffic in a corridor with respect to time and space and to apply these results in the routing of traffic. *The results of this project can be employed by ITS systems that seek to reduce congestion by better routing large volumes of traffic at a small time interval as opposed to PTA's that route one vehicle at a time.*

The following summarizes conclusions of the first project.

Statistical Analysis: a Multi-Level Model (MLM) can be use to predict traffic speed up to 30 minutes in the future. Only two speed values are required to make such predictions, making computations fast and data storage requirements minimal. The potential benefits of avoiding turbulent conditions such as those caused by non-metered entry during rush hour can be demonstrated with the same data.

Re-Routing Models: Dynamic re-routing models can be used with an Intelligent Transportation System to route traffic around incidents in near-real time, including changing alternative routes in response to traffic flow. A hardware-based model solver (see picture) may be needed to perform needed computations in near-real time.

Micro-Simulation for Incident Management Assessment Strategies: Micro simulation analysis shows that managed routing of traffic improves traffic volume and travel time in dealing with a traffic incident helping to validate the potential application of re-routing models and the application of statistical analysis results.



- **Transit Oriented Development at Selected LRT Stations in the Detroit Metropolitan Area**
  A team of researchers from the Wayne State University and the University of Detroit Mercy are conducting a study to develop programs for Transit Oriented Development (TOD) at two potential station sites along the Woodward Avenue planned LRT route in the Detroit metropolitan region. (Note: The initial plan for Phase I of the Woodward Ave. light rail project was created though a MIOH UTC project. It received a $25 million TIGER grant from FTA that will complement the private, state and local commitments, enabling construction to begin.)

  This study developed a set of mechanisms (both general and station-specific) that can be deployed through proper intergovernmental cooperation to implement the proposed development. First, a set of general mechanisms is presented that may be applied to transportation projects in general and that may require interface with land use planning and economic development. This discussion is followed with station-specific mechanisms that attempt to relate the proposed development with strategies that may be deployed to expedite their effective implementation.

  The specific conclusions of this study are as follows:

  The network level analysis culminated in the selection of two stations for TOD analysis: the Masonic Temple site along Woodward Avenue in the city of Detroit, and the Amtrak rail station in the cities of Troy and Birmingham. Pedestrian friendliness (either current or potential) was one of the major factors considered, along with the availability of vacant land, and the proximity to major transportation corridor(s) in selecting the station site.

  Detailed project level analyses were conducted on the two selected transit stations that are marked by both significant similarities and contrasts. The developments proposed at the two stations encompass a variety of land use including multi-family residential, retail, service-oriented, and other use within the area of influence of the station.

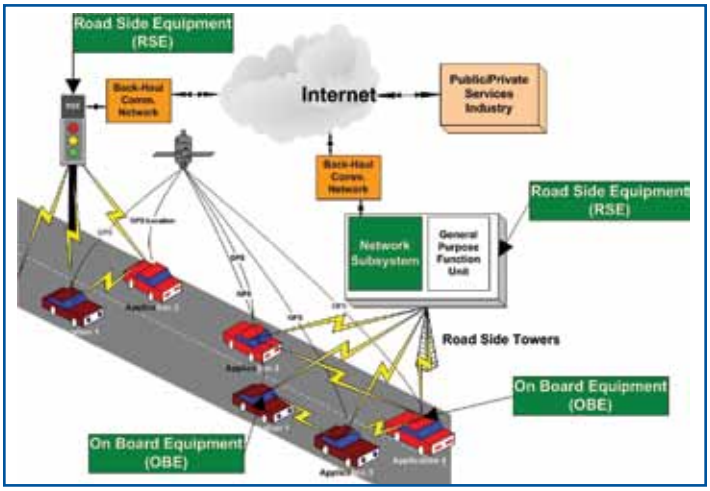
- **New Approach to Enhance and Evaluate the Performance of VII and ITS Communication**
  Partnering with the Center for Advanced Research (CAR), a team of faculty and students at the UDM undertook development of a test bed that allows the testing of different inter-vehicle communication protocols. The test bed provided a tool to evaluate message delay and channel throughput. Additionally, it facilitated investigation of real-world, inter-vehicle communication scenarios with actual vehicles.

  The following conclusions have been reached by researchers as they defined the requirements of the development of a test bed that has been used to evaluate and validate different wireless protocols. WLAN communication protocols have been evaluated for vehicular applications. Multiple performance measures, such as communication range, time-to-login, throughput and jitter time, have been used to determine the effectiveness of wireless protocols in the ITS environment. Experimental results showed that the practical communication range may vary from the theoretical value according to the type of WiFi transceiver used. Another measure, time-to-login, showed the importance of having a static assignment of a unique address for network nodes, where the dynamic addressing resulted in significant delays.

  Newly developed methodologies were proposed to reduce the cost of test bed implementation. The first method aims to use a single node to generate a network load that is similar to the load of multiple nodes. As a result, it was proven that this method is not valid due to the inconsideration of the random access of the large number of nodes. The second method divides the network with costly wireless transceivers into two or more subnets with low-cost transceivers, where all subnets are bridged together using the costly link. Throughput, jitter time and delay time were used as measures to validate the proposed methodology. The last method was to evaluate the impact of the distance between vehicles on the communication throughput. Several experiments were designed and implemented

at a racing track to measure the throughput while the relative distance between the transmitter and receiver varied. Results showed the degradation of channel throughput as the relative distance increased.

The researchers implemented an end-to-end Orthogonal Frequency Division Multiplex communication system using MATLAB/SIMULINK with the required configuration. The consistency between simulation results and analytical solutions has validated the proposed system. Research focused on the analysis of the impact of Doppler shift, as a function of relative speed, on the signal quality. PSK schemes presented greater resistance for Doppler shift impact in comparison with QAM schemes; however, with a lower data rate. Moreover, an explicit, precise mathematical model was derived for each mode to provide a close-form relation between Doppler shift and BER. An adaptive methodology was developed to improve system robustness to Doppler shift impact. Simulation results showed the enhanced performance of the proposed methodology and indicated the possible range of operation in term of frequency shift as well as relative speed.



- **Crash Benefits of SCATS Control System**

A team of researchers at the University of Detroit Mercy undertook a study to determine the effectiveness of the Sydney Coordinated Adaptive Traffic System (SCATS) in reducing traffic hazard by examining crash rate as Measure of Effectiveness (MOE). The comparison of a test corridor using SCATS was compared with a control corridor using pre-timed signals for various measures of effectiveness.

The conclusions of this study can be summarized as follows:

1.) Where the SCATS signal system is installed, a shift in severity from types A (incapacitating injury, permanent injury) and B (non-incapacitating injury) to C (possible injury, slight bruises and cuts).

2.) Even though, the installation of the SCATS system cost more, by transforming from more severe crashes to less severe crashes, savings would result to the travelling public.

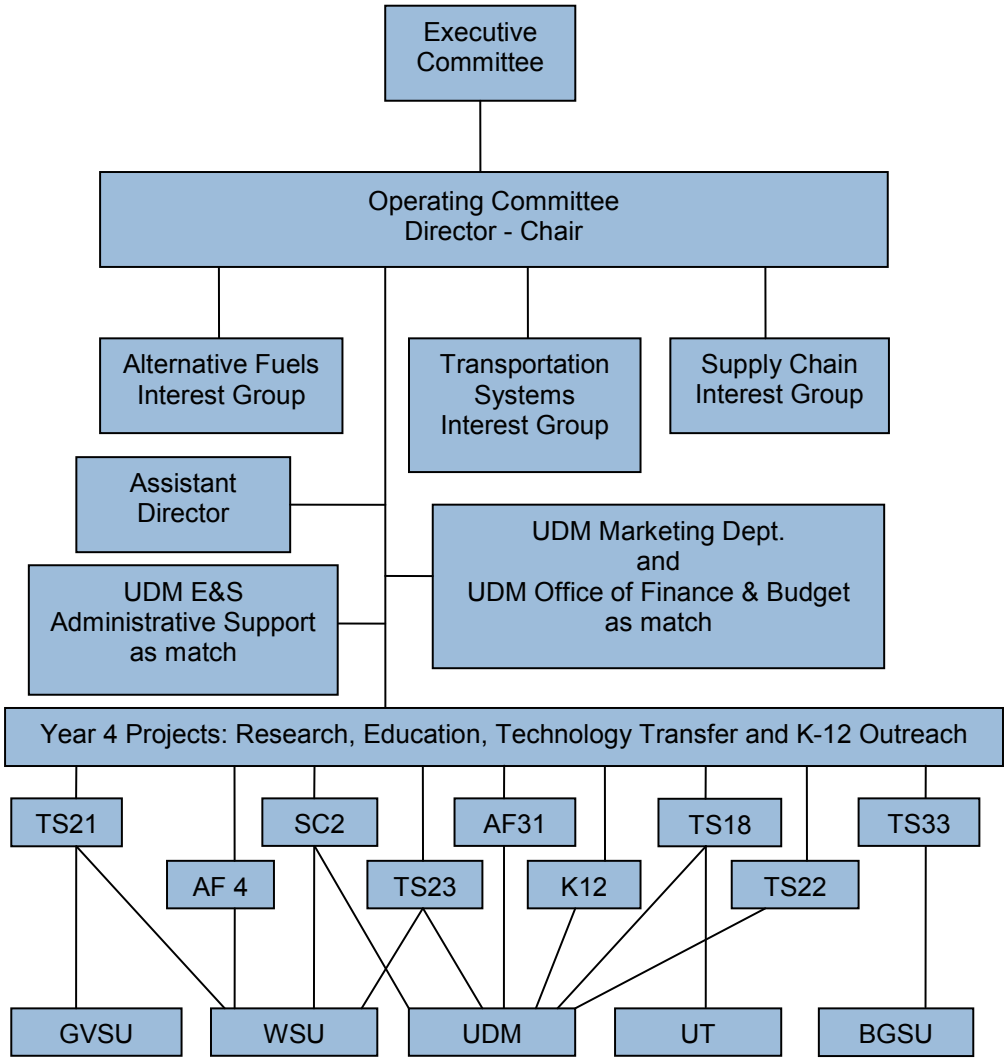
3.) In most cases, the statistical analysis did not prove the superiority of the SCATS system at the 95 percent confidence level, when before and after data were compared. Similar results were also observed in the comparison between SCATS and Pre-timed signal crash experience.

As many MIOH UTC projects are in the final stages of completing the research begun in previous years, even more significant accomplishments are expected in the near future. The following page provides excerpts from DOT strategic documents that are directly related to MIOH UTC focal areas and projects. This is followed by a table that maps the sponsored projects against these top priorities of the DOT.

Management Structure

The MIOH UTC's management approach is one that is open and inclusive of all partners, both at the five MIOH universities and its partner corporations and government agencies. The MIOH organization, summarized in the graphic below, reflects that approach. It does not have an "advisory committee" that is separate from the decision-making groups of the UTC. Rather, all university, corporate, and government representatives serve on interest groups and/or the MIOH Operating Committee to stimulate, identify, and review project proposals in addition to developing and approving the MIOH annual program plan and budget.

Organizational Chart



Partner Universities

University of Detroit Mercy
Detroit, Michigan
(Lead Institution)
www.udmercy.edu

Bowling Green State University
Bowling Green, Ohio
www.bgsu.edu

Grand Valley State University
Grand Rapids, Michigan
www.gvsu.edu

The University of Toledo
Toledo, Ohio
www.utoledo.edu

Wayne State University
Detroit, Michigan
www.wayne.edu

Principal Center Staff

Dr. Leo E. Hanifin is Director of the MIOH UTC and Dean of the College of Engineering and Science at UDM. In addition to considerable industrial experience, Dr. Hanifin has extensive experience leading research centers, research and educational coalitions and engineering education.
Contact: hanifinl@udmercy.edu, Ph: 313-993-1216, Fax: 313-993-1187.

Patricia Martinico joined the UTC in the fall of 2006 as Assistant Director. Ms. Martinico's background includes administrative experience as Assistant Dean of Architecture at UDM, as well as corporate event planning for a Michigan destination management company. In addition, she holds graduate degrees in business and economics.
Contact: martinpa@udmercy.edu, Ph: 313-993-1510, Fax: 313-993-1187.

Executive Committee, Year 4 as of August 31, 2010

University	Member
BGSU	**Michael Ogawa,** Vice President for Research and Economic Development
GVSU	**Paul Plotkowski,** Dean of Engineering and Computing
UDM	**Pamela Zarkowski,** Academic Vice President
UT	**Frank Calzonetti,** Vice President for Research Development
WSU	**Mumtaz Usmen,** Dean of Engineering
MIOH UTC	**Leo Hanifin,** UTC Director and Dean of Engineering and Science, UDM (ex officio)

Operating Committee, Year 4 as of August 31, 2010

Leo Hanifin	UTC Director
Hokey Min	Faculty Representative BGSU
Charles Standridge	Faculty Representative GVSU
Utpal Dutta	Faculty Representative UDM
Richard Martinko	Faculty Representative UT
Peter Savolainen	Faculty Representative WSU
James Merritt	US DOT – R & D Program Mgr, Pipeline Safety
Kirk Steudle, alt. Niles Annelin	MDOT – Director
Jim Saber, alt. Roland Kibler	NextEnergy – Director, Program Development
Carmine Palombo	SEMCOG – Director, Transportation
Warren Henry	TMACOG – Vice President for Transportation

Interest Groups, Year 4 as of August 31, 2010

(7-12 members each) *Operating Committee Members may also participate in interest group(s).*

Alternative Energy

Roland Kibler	Manager, Technology Development, NextEnergy
Mark Schumack	Faculty, Mechanical Engineering, UDM
Snehamay Khasnabis	Faculty, Civil Engineering, WSU
Barry Piersol	Assistant to the Dean, College of Technology, BGSU
John Wilson	Energy Tech Consultant, TMG / Energy
Scott Staley	Director, Hybrid and Fuel Cell, Ford Motor Company
Eric Sattler	Assured Fuels Initiative U.S. Army TARDEC, National Automotive Center
Steve Salley	Faculty, Chemical Engineering, WSU

Transportation Systems

Carmine Palombo	Director of Transportation, SEMCOG
Ralph Robinson	Co-Lead UMTRI's Transportation Systems Group
Charlie Standridge	Professor, College of Engineering and Computing, GVSU
Utpal Dutta	Professor, Dept. of Civil Engineering, UDM
Mumtaz Usmen	Dean, College of Engineering, WSU
Barry Piersol	Asst. to the Dean, College of Technology, BGSU
Pete Lindquist	Chair, Dept. of Geography & Planning, UT
Lee Nederveld	Operations Engineer, MDOT
Lou Lambert	Consultant
Steve Underwood	Center for Automotive Research
Richard Beaubien	Associate, Hubbell, Roth & Clark, Inc.
Colleen Hill	Transportation Engineer, Hubbell, Roth & Clark, Inc.

Supply Chain

Chip Napier	Metro Detroit District Engineering Manager, UPS
Thomas Madden	Supply Chain Management, General Motors
John Drury	Leader – Supply Chain Network Optimization Team, IBM
John Taylor	Faculty, Business, WSU
Hokey Min	Faculty, BGSU
Shahram Taj	Faculty, Business, UDM
Ratna Chinnam	Faculty, WSU
Paul Hong	Faculty, UT
Tim Buckel	Metro Detroit Engineering Manager, UPS
Lee Nederveld	Operations Engineer, MDOT
Gene Robinson	Director of Automotive Glass Technology, Libby-Owens-Ford
S. Manivannan	Sourcing & Lean Manager - GE Transportation
Terry Onica	Director, Automotive Marketing, QAD
John Daly	Manager – Director, Genesee County Road Commission

Michigan Ohio University Transportation Center

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