The Western Transportation Institute (WTI) announces the

UNDERGRADUATE RESEARCH EXPERIENCE PROGRAM IN TRANSPORTATION

To be competitive in any field, students must be able to show that they are capable of independent and creative thinking. The Western Transportation Institute (WTI) at Montana State University offers a unique Undergraduate Research Experience (URE) for students from a variety of disciplines at MSU to develop these important skills. Successful URE applicants will work together with a professional researcher at WTI to execute a research work plan on a transportation topic, to produce a final report, and to present their results to staff and peers at the end of the program.

The Undergraduate Research Program provides a one-on-one mentoring relationship with a professional researcher at WTI, paid hands-on research experience, assistance in developing invaluable skills in data collection, analysis, and interpretation and in communicating research results to a broader audience. Students will also receive paid travel opportunities for successful paper submissions to professional conferences.

Successful applicants will earn $13/hour during both the Fall and Spring semesters while gaining hands-on research experience and working flexible hours. Program participants will work one-on-one with a professional research mentor at WTI on a WTI research project and will enroll for 490-R "Undergraduate Research/Creativity Activity" course credits (or a comparable alternative) during the Spring semester to earn academic credit for their research activities. The Undergraduate Research Program provides an excellent opportunity for undergraduates to fulfill the university core research requirement, earn academic credit, gain valuable academic skills, and build a professional resume. A 15-20 hour/week commitment is required.

To apply:
Please submit:

- A completed application form (attached)
- Resume (that includes all contact information as well as academic and employment history);
- A current web transcript;
- A one-page statement outlining reasons for wanting to participate in the program; future academic & career goals; and project of interest.

Application deadline: *September 15*

Submit applications to: Susan Gallagher, Western Transportation Institute, Montana State University, PO Box 174250. Email: sgallagher@coe.montana.edu; Phone: 994-6559.
Applications available at: http://www.wti.montana.edu/Education/Funding.aspx

Western Transportation Institute
Undergraduate Research Program
2009-2010 APPLICATION FORM

Applicant Name _____

Banner ID# _____

Address _____

City _____ State _____ Zip Code _____

Email Address: _____

Home Phone: _____

Academic Major: _____ GPA: _____

Academic Advisor: _____

Standing in Fall 2009: _____ Freshman ____ Sophomore ____ Junior ____ Senior

Expected Graduation Date: _____

Career interest: _____

How did you hear about the program? _____

Please rank project(s) of interest (see attached list for project descriptions and required qualifications):

___ 1. Before and After Safety Evaluation of Centerline Rumble Strips in the Gallatin Canyon

___ 2. Evaluation of Montana's Graduated Driver's Licensing Program

___ 3. Evaluation of Differential Speed Limits on Montana's Rural Highways

___ 4. Development of a Standard Test Procedure for Aperture Stability of Geosynthetics

___ 5. Transport and Electrochemical Properties of Environmentally Friendly Concrete

___ 6. Developing a Crash Prediction Model for Deer–Vehicle Collisions (DVCs)

___ 7. A Comprehensive Assessment of "Bike-on-Bus" Programs for Rural and Small Urban Transit Systems

___ 8. Nanoscale Approaches to Significantly Inhibit Corrosion of Highway Structures

___ 9. A Preliminary Investigation of Nanotechnology Solutions to Environmentally Friendly Asphalt

___ 10. Self-healing property of the cement-based building materials induced by Sol-Gel immobilized bacteria

___ 11. Driven to Distraction - Mitigating Distractions through Eye Tracking Technology

___ 12. Replacing thermal sprayed zinc anodes on cathodically protected steel reinforced concrete bridges

___13. Feasibility of Reclaimed Asphalt Pavement as Aggregate in Portland Cement Concrete Pavements

___ 14. Performance of Reinforced Concrete made with Recycled Materials

Applications must include a completed statement of interest, a current academic transcript, and a resume (please attach all documents to your application).

Completed applications are due *September 15, 2009* to:
Susan Gallagher, Education Program Coordinator, MSU Western Transportation Institute (CFT5 Building, 2327 University Way, Room 312), PO Box 174250, Bozeman, MT 59717-4250.
Email: sgallagher@coe.montana.edu Phone: 994-6559

Additional application materials can be downloaded at: http://www.wti.montana.edu/Education/Funding.aspx

Western Transportation Institute
2009-2010 Undergraduate Research Experience (URE)
Project Selections

1. Project Title: Before and After Safety Evaluation of Centerline Rumble Strips in the Gallatin Canyon

Research Mentors*: David Veneziano and Jared Ye*

Desired qualifications: Interest in general transportation and highway safety; Basic statistical and/or mathematical coursework; Experience with basic statistical software and/or Excel.

Project Description:
In the summer of 2006, the Montana Department of Transportation installed centerline rumble strips in the Gallatin Canyon to address safety problems, particularly crashes involving vehicles crossing the roadway centerline. This project will examine the safety performance (i.e. changes in crashes) along the route before and after the installation of rumble strips. This examination will aid in understanding how effective they were in addressing crash problems.

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2. Project Title: Evaluation of Montana's Graduated Driver's Licensing Program

Research Mentors*: David Veneziano*

Desired qualifications: Interest in general transportation and highway safety; Basic statistical and/or mathematical coursework; Experience with basic statistical software and/or Excel.

Project Description:
Going into effect on July 1st, 2006, Montana's Graduated Driver Licensing (GDL) laws "create a program that will allow persons under 18 years of age to progressively develop and improve their driving skills in the safest possible environment and that will improve highway safety by reducing the disproportionately high incidence of motor vehicle accidents involving minors (1)." A primary motivation of the program was to safely develop and improve their driving skills and reduce the number of crashes involving minors through a three step program. These steps are 1) Permit Period, 2) First-Year Restricted License, and 3) Full Privilege Driver License. In Montana, the ages at which each of these steps are reached vary depending on the application process of the driver.

The goal of this research is to evaluate the effectiveness of Montana's Graduated Driver's Licensing (GDL) program before and after implementation based on historical crash data. Effectiveness will be determined through an understanding of whether crashes were reduced in the years following program inception. While the results of this research will have no bearing on the continuation of the GDL program itself (as it provides benefits aside from potential crash reductions), they will serve to quantify the impacts that the program may or may not be having on overall teenage driver crashes.

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3. Project Title: Evaluation of Differential Speed Limits on Montana's Rural Highways

Research Mentors*: Jared Ye (WTI) and Duane Williams (MDT)*

Desired qualifications: Interest in traffic flow and safety; Experience with Microsoft Word and Excel (or Access)

Project Description:
Speed is a measurement of the traffic performance of the highway system, and is also a key variable of traffic safety. This project will investigate truck and car speeds on Montana's rural highways to examine if current differential speed limits, especially truck speed limits, are effective and appropriate.

Speed limits in the United States differ according to the type of road, the time of day, and land use. On Montana's rural highways, truck speed limits are generally 10 mph lower than the speed limits of cars for safety consideration. However, little is known so far about the effects of differential speed limits on vehicle speeds. As mentioned above, the objective of the project is to explore the effectiveness of differential speed limiters in Montana. Research results will help MDT and interested agencies identify the effect of truck and car speed limits and investigate associated safety strategies.

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4. Project Title: Development of a Standard Test Procedure for Aperture Stability of Geosynthetics

Research Mentor*: Eli Cuelho*

Desired qualifications: Mechanically savvy; ability to use word processing, spreadsheet and presentation software proficiently; demonstrated oral and written communication skills; basic knowledge of analytical research techniques.

Project Description:
Geosynthetics have been successfully used for filtration, separation, drainage, moisture barriers and reinforcement in flexible pavements. Several studies have been conducted to relate the performance of geosynthetic-reinforced pavements to specific material properties. One such property is the stability or in-plane shear strength of geogrid apertures. A new test method for determining the aperture stability modulus of geogrids is currently being developed within ASTM (American Society of Testing and Materials). This test standard has been under development for a long time and has several technical issues related to how the test is run, its appropriateness for a wide-variety of materials and the applicability of the results; therefore, it has not yet advanced to become a standard test procedure. Investigative work is needed to determine the state-of-the-practice of this procedure and to identify technical challenges. Various design modifications and laboratory experiments are needed to produce meaningful and useful results using a standard or modified test apparatus. The primary objective of this study is to document the current state-of-the-practice and issues with the test standard, and to design and build an apparatus to address these concerns.

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5. Project Title: Transport and electrochemical properties of environmentally friendly concrete

Research Mentor*: Yajun Liu*

Desired qualifications: Required: Background in civil engineering, chemical engineering, environmental science, or equivalent. Self-motivated, professional, and detail-oriented.
Preferred: Hands-on experience in electrochemical characterization techniques; Hands-on experience on concrete sample preparation, corrosion testing, or chloride concentration analysis.

Project Description:
As our country's growth and development spurs the expansion of the nation's highway system, each year hundreds of miles of public roads and highways are built, widened, realigned, patched, modified or reconstructed. As concrete is the most widely used manmade material on earth, the concrete industry has great potential for recycled materials. Recent years have seen increasing interest in Environmentally-Friendly Concretes (EFCs), which utilize alternative or recycled materials and thus benefit the environment. Among them, mineral admixtures such as fly ash, silica fume, and slag – have been used to replace cement in concrete while shown to enhance concrete durability and improve resistance to chloride diffusion. The objectives of this research are to characterize chloride diffusion coefficients of concrete samples with different mineral admixture designs, study the chloride threshold level for corrosion to initiate, and investigate their chloride binding capacities. The project will develop and establish standard accelerated test methods to determine the chloride diffusion coefficient and chloride depassivation thresholds of conventional and mineral admixture concrete specimens. Project results will be directly integrated into design practice by transportation agencies to increase the longevity and reduce the cost of highway structures.

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6. Project Title: Developing a crash prediction model for deer–vehicle collisions (DVCs)

Research Mentor*: Pat McGowen*

Desired qualifications: Completion of basic statistics course; Working knowledge of MS Excel;
Curiosity and ability to understand what may cause DVCs to occur. Experience with statistical software (e.g., SPSS, SAS) and/or geographic information systems (GIS) is desired.

Project Description:
Nationally there are 300,000 reported wildlife vehicle collisions, primarily with deer. Based on carcass and insurance data there are more likely one to two million including the unreported crashes. The number of DVCs continues to increase annually. Current crash prediction models may not be appropriate for DVCs. This research will consider the relationship of how deer population and traffic volume jointly impact deer–vehicle crashes. The research proposed would compile data on crashes (MDT), average daily traffic (MDT) and deer population (MFWP) for all Montana highways. Each mile of roadway will be assigned a deer population density based on its assigned hunting district. A deer–vehicle collision prediction model will be developed based on traffic and deer population. The model will also incorporate other factors that prove to be important such as speed limit and facility type (e.g., interstate or two-lane highway).

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7. Project Title: A Comprehensive Assessment of "Bike-on-Bus" Programs for Rural and Small Urban Transit Systems

Research Mentor*: Jaydeep Chaudhari*

Desired qualifications: Excellent written, verbal and telephone communications skills; Self-motivated; Good organizational and time management skills; Experience with Microsoft Office (Excel and Word); Proven data management and analysis skills. Students from Civil Engineering, Political Science, Architecture and Arts, Land Resources and Environmental Sciences, and Health and Human Sciences are especially invited to apply.

Project Description:
Bike-On-Bus programs establish a link connecting cyclists and public transportation to help cyclists extend their travel via buses and to increase transit ridership. These programs may involve the use of trailers towed behind buses, bicycle lockers, bicycle parking at bus stops, and bicycle racks mounted directly on the bus. The purpose of this project is to assess the bike-on-bus programs for rural and small urban transit systems in relation to advocacy, legislation, sources of federal funds, marketing, safety, maintenance and general operations. This project includes a literature review, survey design and analysis, cost-benefit analysis, and a bike-on-bus program inventory. Results from the project can be used to help rural and small urban transit agencies to improve their existing bike-on-bus programs or to assist other communities that have not yet developed the bike-on-bus programs.

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8. Project Title: Nanoscale Approaches to Significantly Inhibit Corrosion of Highway Structures

Research Mentor*: Xianming Shi*
Desired qualifications: A background in chemistry, chemical engineering, environmental science, or equivalent is required. Hands-on experience in electrochemical characterization techniques and hands-on experience on coating preparation, corrosion testing, or chemical laboratory analysis is preferred.

Project Description:
Deterioration and premature failure of concrete structures as a result of the chloride-induced corrosion of reinforcing steel bars is a very serious technical problem with significant economic and safety implications. To protect new highway structures from metallic corrosion, this research will explore the application of nanomaterials (with at least one dimension less than 100 nm) in the methods of mitigating corrosion risk at the steel/electrolyte interface. Research will be dedicated to the use of nanotechnology in intelligent corrosion protection systems (e.g., self-healing coatings). Another field would be the use of nanoparticles as innovative carrier for corrosion inhibitors in coatings, since nanoparticles feature high surface area and can be engineered for smart delivery of inhibitors.

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9. Project Title: A Preliminary Investigation of Nanotechnology Solutions to Environmentally Friendly Asphalt

Research Mentor*: Xianming Shi*

Desired qualifications: Required: Background in civil engineering, materials science, chemical engineering, chemistry, or equivalent; Self-motivated, professional, and detail-oriented.

Preferred: Hands-on experience or coursework related to asphalt pavement or construction materials; Knowledge or coursework related to polymers or nano-materials; Hands-on experience on asphalt sample preparation or materials property testing.

Project Description:
A variety of additives have been used to improve the performances of asphalt binder and pavement to resist severe field conditions (temperature cycling and heavy traffic loading), such as polymers, emulsions, crumb rubber, anti-stripping agents, and poly-phosphoric acid. But, most of the additives target only one property of asphalt, and are not designed to confer multiple functions to asphalt which needs an array of balanced properties. On the other hand, nanomaterials of various shape, size, and composition have been produced in the past decades. Existing research from other industries has shown that adding nanomaterials can enhance the mechanical and anti-oxidation properties of polymers, but there is little research on using nanomaterials in highway infrastructure such as asphalt binder. One hypothesis of this research is that multifunctional nanomaterials could enhance comprehensive performance of asphalt by controlling interaction at molecular or nanometer scales. This research project will enable the expanded use of recycled materials in highway infrastructure by adding multifunctional nanomaterials into asphalt binder and enhancing the optical, mechanical and/or chemical properties of asphalt mixture.

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10. Project Title: Self-healing property of the cement-based building materials induced by Sol-Gel immobilized bacteria

Research Mentor*: Zhengxian Yang*

Desired qualifications: Required: Be able to use word processing, spreadsheet and presentation software proficiently; Background in civil engineering, biochemistry and chemical engineering, mechanical engineering technology or equivalent; Coursework or knowledge in Portland Cement Concretes and/or related area; Self-motivated and creative.
Preferred: Demonstrated oral and written communication skills; Hands-on experience in concrete sample preparation and data analysis; Experience with laboratory testing and bacteria cell cultivation.

Project Description:
As a water-permeable, heterogeneous composite, concrete is the most widely used building material in the world. However, one culprit that compromises the integrity and durability of concrete structure is its cracking. Recently, the applicability of specifically mineral-producing bacteria for filling of pores and cracks in concrete is becoming increasingly popular. Possible solutions to the problem of loss of viability and related functionality of incorporated bacterial spores could include encapsulation or immobilization of spores in a protective matrix prior to addition to the concrete mixture. A possibility could be immobilizing bacterial spores in a protective silica sol-gels matrix prior to addition to the concrete mixture.

The objectives of this URE project are to identify suitable bacteria which not only have to resist mechanical stresses due to mixing but also be able to remain alive in high alkaline environment of concrete pore solution for a prolonged period and to establish whether the silica sol-gel immobilized bacteria incorporated in the concrete could act as self-healing agent to facilitate the process of autonomous repair of freshly formed cracks over a relatively long time.

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11. Project Title: Driven to Distraction - Mitigating Distractions through Eye Tracking Technology

Research Mentor*: Laura Stanley*

Desired qualifications: Background in Industrial Engineering or Civil Engineering.

Project Description:
The goal of this project is to quantify the behavioral effects of an education module specific to teaching novice teen drivers about distracted driving practices. This education module is grounded in research on the fundamentals of eye scanning behaviors known to be problematic for novice drivers, that is; failure to search, pay attention/distraction, and manage speed. Using a simulator-based training tool consisting of a *Realtime Technologies, Inc*. motion-based and desktop simulator, both equipped with eye-tracking hardware and software developed by *faceLAB*, the content of this project will focus specifically on the teen's understanding of distracted driving practices and thereby modifying these unsafe behaviors. This project will address teen safety driving by seeking ways to mitigated distracted driving crashes and reducing the economic impact of motor vehicle-related deaths, injuries and property damage.

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12. Project Title: Replacing thermal sprayed zinc anodes on cathodically protected steel reinforced concrete bridges

Research Mentors*: Doug Cross and Xianming Shi*

Desired qualifications: Required Skills: Be able to use word processing, spreadsheet and presentation software proficiently; Must be enrolled in or have passed CE 315 (Structures II).
Preferred Skills: Demonstrated oral and written communication skills; Experience with laboratory testing; Experience operating an EIS instrument.

Project Description:
Corrosion of reinforced concrete structures is a major and increasing problem worldwide.
The Oregon Department of Transportation (ODOT) has historic reinforced concrete bridges at the coast that employ impressed current cathodic protection (CP) to greatly reduce the corrosion of the embedded steel reinforcement. The CP systems rely on passing an electric current into the concrete through zinc metal anodes that have been sprayed onto the surface of the concrete. Some of these zinc anodes are nearing the end of their design lives. Anode sections that have debonded no longer protect the underlying steel reinforcement. When the natural rate of corrosion resumes, the unprotected sections are on the path to concrete spalling and steel section loss - the conditions that required ODOT to undertake expensive repairs and protection schemes. Currently, there is no procedure established by ODOT to remove old anodes, prepare the concrete surface, and install new anodes.

This URE project will be a critical component of an Oregon-DOT funded research project aimed to protect their cultural landmark bridges along the coast. Lab work will involve spraying molten zinc on to concrete samples so that the bond strength between the zinc and the concrete can be measured. Electrical resistance tests will be conducted on the samples to determine the overall resistance of the system. The AC tests will use electrochemical impedance spectroscopy to determine the equivalent resistance of the system while a standard multi-meter will be used to measure the resistance using DC.

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13. Project Title: Feasibility of Reclaimed Asphalt Pavement as Aggregate in Portland Cement Concrete Pavements

Research Mentors*: Mike Berry*

Desired qualifications: Required: Coursework on or knowledge of concrete; Hands-on experience with concrete and sample preparation; Self-motivated and creative
Preferred: Background and/or interest in structural/materials engineering; Background in civil engineering.

Project Description:
Each year, the highway construction industry in the United States produces over 100 million tons of reclaimed asphalt pavement (RAP) through standard rehabilitation and construction of our nation's roads. Although this reusable material has been put to use in some applications (usually in the form of asphalt paving), a significant quantity of this material remains unused and is either stockpiled or land filled. Therefore, alternative uses for this material are needed. One possible use for this material is the replacement of conventional aggregates in Portland cement concrete pavement (PCCP).

This project focuses on reducing the environmental impact of reinforced concrete construction by replacing conventional concrete aggregate (gravel and sand) with reclaimed asphalt pavement (RAP). The proposed student will work closely with the research team and assist in developing suitable mix designs with varying amounts of RAP replacement. The student will also assist in constructing specimens and testing various mechanical and durability properties. More specifically, the student will be given ownership of testing the chloride permeability of this alternate material. Additionally, the student will assist in the development and testing of other "green" materials for use in structural and nonstructural applications.

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14. Project Title: Performance of Reinforced Concrete made with Recycled Materials

Research Mentors*: Mike Berry*

Desired qualifications: Required: Coursework on or knowledge of concrete; Hands-on experience with concrete and sample preparation; Self-motivated and creative
Preferred: Background and/or interest in structural/materials engineering; Background in civil engineering.

Project Description:
This project focuses on reducing the environmental impact of reinforced concrete construction by replacing key concrete components (Portland cement and conventional aggregate) with common waste products. In this case, fly ash will be used as the exclusive binder in the concrete, and glass will be used as the aggregate. While considerable data has been collected on the basic material properties of the performance of this new concrete, only limited data has been obtained on its behavior in reinforced concrete structural elements, particularly columns. The student will assist in the design, construction, and testing of approximately 16 reinforced concrete columns made with 100 percent fly ash and pulverized glass aggregate. Mechanical properties of this material will also be tested and documented, as these properties are needed in predictive equations for column capacity.