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2014 - 2015

Annual Report

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Letter from the Director

With your great support and care, PacTrans continuously made solid progress over the past year toward its goal of being Region 10's research engine, applied technology showcase, workforce development base, educational leader, information center, and collaboration platform. We had a very busy past year because of the parallel operations of both the Region 10 University Transportation Centers funded by SAFETY-LU and MAP-21. Through carefully planning and implementing activities to address the needs of both centers, PacTrans is gradually transitioning from a general center addressing regional needs in all five strategic directions of the US Department of Transportation to a safety-focused Region 10 transportation center. Highlights of our major activities in the 2014-2015 fiscal year are as follows:



To build strong partnerships with transportation safety agencies and companies in Region 10, PacTrans took several key actions. The first one was to organize the Region 10 Transportation Safety Workshop in collaboration with chapters of Institute of Transportation Engineers in Washington, Oregon, Idaho, and Alaska. Over 70 transportation safety professionals from all four states in Region 10 participated in this one-day workshop. PacTrans also hosted several bilateral exchange events with transportation safety agencies, such as Washington Traffic Safety Commission, to enhance mutual understanding and seek collaboration opportunities.

PacTrans enhanced its regional leadership by organizing several important events including the Region 10 Transportation Conference, Region 10 Student Conference, Region 10 Reception at the TRB annual conference, and Region 10 Transportation Seminars and Webinars. All these events were very well attended. For example, more than 170 people participated in the Region 10 Transportation Conference. Our regional transportation seminars cover a variety of important topics, including workforce development leadership cultivation, innovation training, etc. Hundreds of people attended these seminar events collectively.

All of the 31 research projects funded in the 2013-2014 fiscal year were completed. Also, 19 new safety research projects have been selected to receive funding for 2014-2016. After completion of the first two years of research projects, PacTrans allocated funds to support technology transfer activities. Five projects have been selected from the Call for Success Stories and will receive funds to facilitate the tech transfer process.

Furthermore, consistent efforts and funding were made to support students. In addition to the continued support to PacTrans fellow students and student outreach activities, funds were allocated for student intern and travel support. For example, more than 40 students received travel support from PacTrans to attend the 2015 Transportation Research Board (TRB) Annual Meeting and PacTrans researchers delivered approximately 100 technical presentations at the conference.

A lot more exciting activities can be found in this PacTrans Annual Report. We hope this report is informative and useful to both internal and external readers and serve as the bridge to bring in more collaboration with local partners. We welcome any suggestions or feedback you may have on our work and highly appreciate your continued support!

Sincerely yours,

A handwritten signature in black ink that reads "Yin Hai Wang". The signature is written in a cursive, flowing style.

Yinhai Wang, PhD, Professor
DIRECTOR OF PACTRANS

PacTrans Center

The Pacific Northwest Transportation Consortium (PacTrans) is the University Transportation Center (UTC) for Region 10. Established in January 2012, PacTrans continues to function as the UTC for Federal Region 10 with funding from the US Department of Transportation (USDOT) and local transportation agencies and industry. PacTrans is a coalition of transportation professionals and educators from Oregon State University (OSU), the University of Alaska, Fairbanks (UAF), University of Idaho (UI), Washington State University (WSU), and the University of Washington (UW).

PacTrans' theme centers on "Developing Data Driven Solutions and Decision-Making for Safe Transport." It serves as a focal point within Region 10 to develop initiatives and facilitate collaborative activities with regional partners to maximize the effectiveness of their collective services and programs toward the US Department of Transportation (USDOT) strategic goal of safety.

Safety can be defined as a place that is free from danger, risk, or injury; safety is central to our transportation system. Map-21 (section 501) defines "safety" to include highway and traffic safety systems, research, and development related to the vehicle, highway, driver, passenger, bicyclist, and pedestrian characteristics, accident investigations, communications, emergency medical care, and transportation of the injured. With our combined expertise, research facilities, and experience in human factors, vehicle design, traffic operations, cybersecurity, land use, economics, innovative construction methods, and infrastructure monitoring and rehabilitation, PacTrans is well suited to address all such issues of regional importance using data-driven approaches.

MANAGEMENT STRUCTURE

The University of Washington serves as the lead institution in the PacTrans consortium. The PacTrans Center is located at More 112 on the UW campus. Dr. Yin Hai Wang, Professor of transportation engineering in the Civil and Environmental Engineering Department, serves as Director of PacTrans. The management structure of PacTrans includes the director and staff, Board of Directors, and an External Advisory Board.

The PacTrans Board of Directors includes the PacTrans center director and associate directors from all five consortium

universities. The Board of Directors meets in person on a quarterly basis to discuss matters pertaining to PacTrans research, education, outreach and technology transfer.

The PacTrans External Advisory Board (EAB), which is composed of nine members, includes directors from the research office of the state DOTs in Region 10 and representatives from other transportation agencies, private industries, and communities. The role of the External Advisory Board (EAB) is to provide input on PacTrans' strategic planning and outreach activities.

PACTRANS OPERATION TEAM FOR 2014-2015

Yin Hai Wang, Director; Professor, UW Civil and Environmental Engineering Department, (206) 616-2696, yinhai@uw.edu

Linda Boyle, Associate Director of Research; Associate Professor and Chair, UW Industrial and Systems Engineering Department, and Professor, UW Civil and Environmental Engineering Department



Maria Bayya, Assistant Director, (206) 685-6648, bayyam@uw.edu



Elysse Reyna, Communications Manager, (206) 685-3894, elysse@uw.edu



Melanie Paredes, Program Coordinator, (206) 221-9290, melqcp@uw.edu



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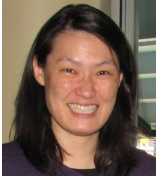


Kristian Henrickson, PacTrans Graduate Assistant, henr2237@uw.edu

BOARD OF DIRECTORS FOR 2014-2015 FISCAL YEAR



Yinhai Wang, Director at University of Washington



Linda Boyle, Associate Director of Research at University of Washington



Chris A. Bell, Associate Director at Oregon State University



Ken Casavant, Associate Director at Washington State University



Billy Connor, Associate Director at the University of Alaska, Fairbanks



Mark Hallenbeck, Associate Director of Outreach, University of Washington



Anne Vernez-Moudon, Associate Director of Education, University of Washington



Ahmed Abdel-Rahim, Associate Director at the University of Idaho

EXTERNAL ADVISORY BOARD FOR 2014-2015 FISCAL YEAR



Carolyn Morehouse, Chief of Research, Development and Technology Transfer, Alaska Department of Transportation and Public Facilities



Michael Bufalino, Research Manager, Oregon Department of Transportation (ODOT)



Scott Drumm, Manager of Research & Strategic Analysis Dept., Port of Portland, Portland, Oregon



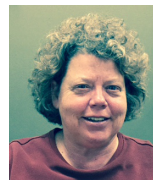
Charlie Howard, Director of Integrated Planning, Puget Sound Regional Council (PSRC)



Wayne Kittelson, Principal, Kittelson & Associates, Inc.



Edward Mantey, Vice President of Toyota Vehicle Planning, Corporate Strategy, Technical Administration



Rhonda Brooks, Acting Director of Research and Library Services, Washington State Department of Transportation



Ned Parrish, Research Program Manager, Idaho Transportation Department (ITD)



Jerry Whitehead, President, Western Trailers

Highlights from 2014-15

PACTRANS REGIONAL TRANSPORTATION CONFERENCE

During a day packed with the latest research and innovation in transportation safety, over 170 attendees gathered at the University of Washington on October 17th for the 2014 PacTrans Regional Transportation Conference. Participants came from across the Northwest to attend “The IOUs of Safety - Infrastructure, Operations, and Users,” representing transportation agencies, universities, and private organizations from Alaska, Oregon, Idaho, and Washington. The conference allowed transportation leaders to review and update critical transportation issues for Region 10 and afforded PacTrans researchers a forum to share research ideas on data-driven solutions to transportation problems. PacTrans also showcased its research products for potential applications and technology transfer. John Campbell, Research Leader at Battelle’s Center for Human Performance and Safety, was the keynote speaker.



PACTRANS HOSTS TRANSPORTATION SAFETY WORKSHOP

The PacTrans Region 10 Transportation Safety Workshop, held at the Talaris Conference Center on May 5, 2015 drew representatives from universities, public agencies, and private companies across the Pacific Northwest to discuss important regional transportation safety issues. Jointly organized by PacTrans, ITE Washington, ITE Oregon, ITE Idaho, and ITE Alaska, more than 70 attendees joined the workshop to contribute to PacTrans’ research agenda, share ongoing efforts in addressing critical safety problems, and solidify partnerships in transportation safety research and practice. Keynote speakers included Kenneth Feldman, Deputy Regional Administrator, Federal Transit Administration (FTA), and Chris Madill, Deputy Director, Washington Traffic Safety Commission (WTSC), respectively.



Dongho Chang, City Traffic Engineer, City of Seattle, moderates the Transportation Agency Panel



Carlos Ortiz, ITE Western District President

REGION 10 STUDENT CONFERENCE

On Saturday, October 18th, transportation students assembled at the University of Washington for the Region 10 Student Conference. Jointly sponsored by PacTrans and the UW student chapter of the Institute of Transportation Engineers, students from Region 10 (Alaska, Idaho, Oregon, and Washington) learned about new transportation research occurring in the Pacific Northwest and how to prepare for success in the professional world of transportation engineering. Wayne Kittelson, the Founding Principal of Kittelson & Associates and member of the PacTrans External Advisory Board, delivered the keynote speech on career opportunities in engineering.



(L-R) Jennifer Warner, Ruimin Ke, and Xiangyang Guan pose with their winnings from the student poster competition.

PACTRANS SEMINAR SERIES

PacTrans continued its regional seminar series to help generate discussions of ongoing and future research and foster an exchange of information between transportation professionals and researchers. Each PacTrans regional seminar talk is broadcasted over the internet as a webinar to offer cost-effective participation from remote sites in the region.



PacTrans hosted **Dr. Michael Cassidy** of UC Berkeley, professor and director of the Region 9 University Transportation Center funded by US Department of Transportation, on November 5, 2014 for his lecture entitled "Lessons Learned from Spatiotemporal Studies of Freeway Carpool Lanes." Virtually all cities of the world are plagued by crossmodal conflicts on roadways. Our best hope to make cities more sustainable, explained Dr. Cassidy, will be to tackle the low-hanging fruit of segregating distinct travel modes on roadways into their own reserved lanes.



Dr. Man-Chung Tang, Chairman of T.Y. Lin International and member of the U.S. Academy of Engineering, discussed innovation on March 4, 2015 and as the designer of over one hundred bridges, was uniquely qualified to do so. He is known not only for his contributions to the overall bridge design industry, but for the quality and innovation of his individual designs. In his encouraging talk, Dr. Tang broke down the components of innovation into an easy to use formula: 5I + 3W + 3C.



Dr. Imad Al-Qadi, an internationally renowned professor in pavement materials and engineering, visited the University of Washington on April 28, 2015 to speak at the Spring Seminar. Dr. Al-Qadi, Founder Professor at the University of Illinois at Urbana-Champaign, delivered his talk entitled "Transportation Infrastructure Assessment Techniques Using Ground Penetrating Radar."

PACTRANS AND LOCAL PARTNERS COLLABORATE ON SAFETY AND TECHNOLOGY ►

PacTrans works closely with transportation agencies in research, education and workforce development, and technology transfer. PacTrans sought agency representatives' input from long-time collaborators such as Washington State Department of Transportation (WSDOT), as well as from new partners, including the Washington Traffic Safety Commission (WTSC) and the Washington State Transit Insurance Pool (WSTIP).



Members of PacTrans universities (shown from left): Maria Bayya (UW), Ahmed Abdel-Rahim (UI), David Hurwitz (OSU), Jennifer Warner (OSU), Billy Connor (UAF), and Yin Hai Wang (UW).

CUTC AWARDS AND PACTRANS RECEPTION AT THE 94TH TRB ANNUAL MEETING

At the 2015 TRB Annual Meeting, PacTrans participated in UTC related activities, hosted a Region 10 reception, and presented more than 100 academic papers and talks.

The Region 10 reception, hosted in partnership with OSU, WSU, the Center for Environmentally Sustainable Transportation in Cold Climates and the National Institute for Advanced Transportation Technology, brought together professionals, public officials, and students from all over the world. Oregon State University student Jennifer Warner received the Michael Kyte Region 10 Outstanding Student Award.

PacTrans was also represented at the Council of University Transportation Centers (CUTC) banquet, where University of Washington student Kristian Henrickson received the PacTrans Student of the Year award.



Kristian Henrickson (center) receives the Student of the Year award with Shashi Nambisan, CUTC President (left), and Greg Winfree, assistant secretary, OST-R (right).



PacTrans Welcomes New Faculty



Dr. Ingrid Arocho joined Oregon State University in January 2015 as an assistant professor in the School of Civil and Construction Engineering. She holds a MCE and a PhD in civil engineering from North Carolina State University. Dr. Arocho's research interests include construction

equipment fleet management, pollution production during construction activities, and construction methods improvement to reduce environmental impact. Her previous research has included the estimation and forecasting of pollution emissions from construction equipment fleets.



Dr. Paolo Calvi joined the University of Washington department of Civil and Environmental Engineering as assistant professor in structural engineering September 2015. He received his PhD from the University of Toronto and MS from the University of Pavia. Dr. Calvi's research

interests include experimental and numerical response of reinforced concrete and prestressed concrete structures, evaluation of demand on structures, displacement-based assessment of reinforced concrete buildings and bridges, and development of displacement based design methodologies for structures incorporating added damping, rocking systems and base isolation devices.



Dr. Daniel Borello joined Oregon State University as an assistant professor in the School of Civil and Construction Engineering in 2014. He earned a MS in civil engineering and PhD in civil engineering from the University of Illinois at Urbana-Champaign. Dr. Borello combines experimental testing

and numerical simulations to study the behavior of large structures, particularly steel buildings. His research interests include sustainable infrastructure and mitigating the impact of earthquakes through innovative, replaceable structural systems including steel plate shear walls, self-centering systems, and supplemental energy dissipation devices. By facilitating economical yet resilient materials and systems, Dr. Borello aims to enhance the life cycle and safety of large structures while improving access to such structures in developing countries. His passion for teaching steel design and structural engineering placed him in the top 10 percent of instructors while at the University of Illinois at Urbana-Champaign.



Dr. Erdem Coleri joined Oregon State University in September 2014 as an assistant professor in the School of Civil and Construction Engineering. Prior to OSU, he held the position of postdoctoral scholar and project scientist at the University of California Pavement Research Center. Dr. Coleri received his PhD from the

University of California at Davis with specialization in pavement materials and structures. His research interests include the areas of sustainable pavement materials and structures, energy efficient pavement design strategies, and infrastructure health monitoring using wireless sensor networks.



Dr. Ahmed Ibrahim joined the University of Idaho Civil Engineering Department as an Assistant Professor. Dr. Ibrahim's most recent academic appointments were at St. Louis University and King Fahd University of Petroleum and Minerals in Saudi Arabia. He received his Ph.D. degree in Civil/Structural Engineering from

the University of Missouri-Columbia in 2010.

His research interests include non-linear behavior and modeling of reinforced and prestressed concrete elements, damage modeling of reinforced concrete elements under blast loading, experimental testing of reinforced concrete members under multi-hazard loading, and confinement of reinforced concrete bridge columns. His research has been funded from the US Department of Transportation and presented in several articles published in journals and conference proceedings. Dr. Ibrahim is registered as a professional engineer in the state of Michigan and his experience includes more than ten years in the industry and academia in the US and overseas. He performed structural damage evaluations of many schools in Peru, South America for UNESCO. He is a voting member in many professional committees like ACI 555 "Concrete with Recycled Materials" and he is also a member of the "Impact, shock, and Blast" committee in the ASCE.



Dr. Emad Kassem joined the University Of Idaho Department of Civil Engineering as an Assistant Professor. He received his M.S. and Ph.D. from Texas A&M University. Prior to joining the University of Idaho, Dr. Kassem was an Associate Research Scientist at the Texas A&M Transportation Institute and Adjunct

Assistant Professor at Prairie View A&M University. His research focuses on characterization of infrastructure materials, tire-pavement interaction, microstructure analysis of asphalt mixes and granular materials, non-destructive evaluation of pavements, multifunctional materials, and analytical and computational modeling of infrastructure materials. The sponsors of his research projects include the Federal Highway Administration, Texas Department of Transportation, Idaho Transportation Department, Southwest Region University Transportation Center, and Qatar National Research Fund. Dr. Kassem has more than 60 technical publications, conference papers, and reports in the field of materials and pavements engineering. He serves as a reviewer of several technical journals and he actively participates in the activities of several committees of the Transportation Research Board. He received the Texas A&M Transportation Institute/Trinity New Researcher Award in 2011 for his research contributions.



Dr. Judy Liu joined Oregon State University as a professor in the School of Civil and Construction Engineering in September 2015. Dr. Liu holds a MS and a PhD in civil engineering from the University of California at Berkeley. In her research, Dr. Liu explores resilient steel structures, with focus on seismic

and disproportionate collapse resistance. She has interests in behavior and design of structural steel connections and innovative systems for lateral resistance. She was awarded an AISC Milek Fellowship for research on steel slit panels for lateral resistance. Dr. Liu is a member of a number of committees, including the ASCE/SEI Disproportionate Collapse Mitigation Standard Committee, NCSEA Basic Education Committee, and AISC Partners in Education Committee. She also serves as Research Editor for the AISC Engineering Journal. She has been honored with an AISC Special Achievement Award for her contributions to the Partners in Education Committee and other efforts to improve structural steel education.



Dr. Chris Parrish joined Oregon State University in 2014 as an associate professor in the School of Civil and Construction Engineering. Dr. Parrish holds a PhD in civil and environmental engineering with an emphasis in geospatial information engineering from the University of Wisconsin-Madison and a MS in civil and

coastal engineering with an emphasis in geomatics from the University of Florida. His research focuses on full-waveform LiDAR, topographic-bathymetric LiDAR, hyperspectral imagery, uncertainty modeling, and UAVs for coastal applications. Additionally, Dr. Parrish is the Director of the American Society for Photogrammetry and Remote Sensing (ASPRS) LiDAR Division and associate editor of the journal *Marine Geodesy*. Prior to joining OSU, he served as lead physical scientist in the Remote Sensing Division of NOAA's National Geodetic Survey and affiliate professor in the Center for Coastal and Ocean Mapping - Joint Hydrographic Center at University of New Hampshire.



Dr. Jason Weiss joined Oregon State University in July 2015 as a professor and the head of the School of Civil and Construction Engineering. He also holds the Miles Lowell and Margaret Watt Edwards Distinguished Chair in Engineering and is the Director of the Kiewit Center for Infrastructure and Transportation

Research. Before joining OSU, he was a faculty member at Purdue University for 15 years where he held the position of the Jack and Kay Hockema Professor of Civil Engineering and Director of the Pankow Materials Laboratory. He earned a BAE from the Pennsylvania State University and a MS and PhD from Northwestern University. He is actively involved in research on cement and concrete materials specifically focused on early age property development, cracking, transport in concrete, and concrete durability. Specifically, he is known for research his group has performed in the areas of shrinkage and cracking reduction, the use of the ring and dual ring test, use of electrical resistivity and the formation factor, use of internally cured concrete, and concrete pavement durability.

UTC Spotlight

PACTRANS RESEARCH LEADS TO RECYCLED CONCRETE LEGISLATION

Research from Washington State University has led the Washington State Legislature to recently pass Bill 1695 that calls for the use of recycled concrete in future building projects. Based on the PacTrans research project, “Evaluation of Recycled Concrete as Aggregate in New Concrete Pavements,” for the Washington Department of Transportation (WSDOT), Haifang Wen, WSU associate professor of civil and environmental engineering, found that recycled concrete performs just as well as newly manufactured concrete.

Many concrete roadways managed by the Washington State Department of Transportation (WSDOT) have surpassed their original design life and expected traffic loading, but due to costs associated with replacement, much of this needed replacement has been backlogged. Both the Federal Highway Administration and the WSDOT are interested in alternatives that promote cheaper and more sustainable pavement construction practices. Recycled concrete aggregates (RCA) can reduce costs, environmental impacts, and project delivery time when used in concrete pavements.

Wen and his colleagues performed multiple tests to characterize RCA properties and determine if RCA had any effects on the properties of fresh concrete and hardened concrete. RCA had no significant effects on the compressive strength, modulus of rupture, coefficient of thermal expansion, drying shrinkage, or freeze-thaw durability of hardened concrete for up to a 45% replacement of coarse RCA for natural coarse aggregate.

The concrete industry, which was very interested in Wen’s research, took this research to the legislature this past year. By January 2016, the bill mandates a minimum use of 25% recycled concrete and a higher percentage in the future, with usage steadily increasing in the subsequent years.

The research project was selected by AASHTO as a 2014 Sweet Sixteen High Value Research Project with WSDOT Secretary Lynn Peterson receiving the award on behalf of WSDOT and the research team. The AASHTO Sweet Sixteen High Value Research Projects were selected out of 180 research projects nominated by state highway agencies.

Mandatory concrete recycling paves the way for new possibilities for PacTrans, as Wen and colleagues will have more opportunities to work with the Washington State Department of Transportation and other government agencies to continue improving sustainability in transportation and infrastructure.



Research Success Stories

DATA COLLECTION AND SPATIAL INTERPOLATION OF BICYCLE AND PEDESTRIAN DATA

Public transit and non-motorized travel modes represent convenient, affordable, and sustainable alternatives to personal motor vehicles for many travelers. However, understanding travel patterns and mode choice behavior is crucial to making well-informed planning and operations decisions that will optimize the allocation of limited resources and increase participation in these modes. Toward this end, this project is focused on leveraging current data collection efforts to obtain more complete travel demand information, and introducing new methods that have the potential to reduce cost and improve the quality and coverage of transportation data. First, this study first conducted a poll via online questionnaire to gain a better understanding of how communities are conducting manual bicycle and pedestrian counts, and how the data is used in decision making. A field study was also conducted to evaluate the manual counting errors that arise under different scenarios. Next, a novel methodology for spatial extrapolation of manual and automated mechanical bicycle count data was developed and applied to real-world data from the city of Bellingham, WA. With this approach, it is possible to estimate network-wide bicycle volumes from a relatively small number of discrete count locations. Using this method of network-wide demand estimation, a GIS software tool was

developed to assess cyclist accident risk exposure and evaluate various improvement scenarios. Next, this study introduced a set of data acquisition and analysis techniques that apply Bluetooth and Wi-Fi MAC address sensing technologies to estimate origin/destination (OD) and demand information for non-motorized travelers and transit riders.

While stationary wireless sensing has been employed by a number of DOTs, this study takes a novel approach in which mobile sensors are distributed throughout the transportation network. Specifically, a smartphone application was developed to collect Bluetooth and Wi-Fi MAC addresses and GPS location data, and deployed using volunteers in Moscow, Idaho over a 10 day period. Sensors were also installed on four University of Washington (UW) Transportation buses in Seattle, WA over a four week period. Methodologies for data processing, OD estimation, and mode inference are introduced to exclude invalid detections and produce useable information for planning and decision making. The result of this work demonstrates the feasibility of a low-cost and effective data acquisition tool, and received excellent feedback from partners at UW Transportation.

Contact: Michael Lowry, mlowry@uidaho.edu

DRIVE NET OFFERS DATA OPPORTUNITIES FOR ORGANIZATIONS



On February 10, officials from Washington State Department of Transportation (WSDOT) met with PacTrans to discuss DRIVE Net, the Digital Roadway Interactive Visualization and Evaluation Network. WSDOT expressed interest in establishing DRIVE Net as the organization's data management and analysis tool, and discussed system maintenance options with the STAR Lab research team. WSDOT's Statewide Travel and Collision Data Office (STCDO) learned about data stored in DRIVE Net, and is willing to contribute more data to the system. DRIVE Net is an online platform for transportation data sharing, modeling, visualization, and decision support. Both WSDOT and PacTrans funding were received in developing the system.

Contact: Yin Hai Wang, yinhai@uw.edu

HOW GREEN IS YOUR GREEN INFRASTRUCTURE?

A field-scale testing facility to investigate efficiency of road-side stormwater technologies

Many small and large urban communities in the U.S. have undertaken efforts towards transforming their existing street systems into “sustainable streets” or “green streets” that incorporate multiple ecological, community, and mobility functions. Implementation of natural drainage systems (such as planting strips, rain gardens, bio-swales, and filter strips built into the sidewalks) have become popular road-side green infrastructure solutions aimed at improving environmental sustainability of streets, because of their ability to treat roadway runoff, filter out roadway pollutants, and prevent sewer overflows after heavy storm events. However, there is lack of data and understanding on the effectiveness of these practices in capturing and treating roadway runoff, especially during the establishment period and during the different seasons. The main goal of this project was to collaborate with the Benton County, City of Corvallis, Oregon Water Resources Department, and Oregon-BEST, and multiple other partners to construct, instrument, monitor, model, and evaluate the effectiveness of bio-retention practices during their establishment phase.

As a result of this collaborative project, the OSU-Benton County Green Stormwater Infrastructure Research Facility - an Oregon Best Lab was installed in the summer of 2014. This is an instrumented, semi-controlled, and three celled testing facility for green infrastructure that captures runoff from the Benton County Public Works transportation yard. Each cell enables field-scale

testing of a road-side stormwater (natural or artificial) technology, and provides opportunities for near real-time monitoring and comparison with other technologies. In our initial experiments, we monitored and evaluated hydrologic performance of one of the cells, consisting of native broad-leaf plants and grasses, in mitigating flows during multiple storms. Findings illuminate quantitative differences among the peak flow reductions and peak delays in the bio-retention cell for storms occurring during the establishment period. Additional research is being conducted to further evaluate and model the extent of the establishment period on both flow and water quality.

Another equally useful impact of this project is the construction of a new state-of-the-art testing facility that can be used for assessing the effectiveness of new and existing green infrastructure practices in the future. Research and projects at this facility are expected to benefit not only the researchers and the industry, but also enable development of engineering guidelines for the large number of design and maintenance parameters that currently make green infrastructure design a difficult process. Finally, presentations (e.g., at Water Environment School at Clackamas County, OR) and tours (e.g. to state agencies) have also been delivered as part of outreach efforts to improve awareness and knowledge of these practices and the facility.

Contact: Dr. Meghna Babbar-Sebens, meghna@oregonstate.edu



Research Highlights

PASSING ZONE BEHAVIOR AND SIGHT DISTANCE ON RURAL HIGHWAYS-EVALUATION OF CRASH RISK AND SAFETY UNDER DIFFERENT GEOMETRIC CONDITIONS

The rate of vehicular fatalities on rural roads is commonly twice that of their urban counterparts. One of the primary contributors to these fatalities is the passing maneuver, regarded as one of the most complex maneuvers facing motorists on rural two-lane roads and highways, particularly in the presence of dynamic horizontal and vertical curve combinations. Conversely, simply taking away passing opportunities presents the potential for reduction in capacity or level-of-service. The research being jointly conducted by the University of Alaska Fairbanks and University of Idaho aims to address the safety concerns related to passing behavior in passing zones on two-lane rural roads without diminishing roadway efficiency.

Research methods will include both field and driving simulator studies. First, a mobile video data collection system will be used by the University of Alaska Fairbanks to collect real-world passing maneuvers at known problem locations in Alaska (as seen in Figure 1). Vehicle trajectory data will be extracted from the video and analyzed to determine the second-by-second speeds and locations of vehicles during passing maneuvers. This data will be used to study the effective use of passing areas, differential rates of speeds, maneuvers or trajectory changes made by oncoming vehicles, and spatial variations in passing maneuver critical points. Second, a multi-phase driving simulator study will be conducted at the University of Idaho's Human-In-The-Loop Simulation Lab (Figure 2) to capture driver passing decisions under varying geometric and environmental conditions. The collected simulator data will be supplemented with the collection of driver demographic data and participant opinions and perspectives.

Two-lane rural highways represent a major percentage of the transportation network infrastructure in the Pacific Northwest



region. The anticipated outcomes of this project will have direct and specific benefits for guidelines and design criteria (e.g., signage and striping needs) related to passing zones on rural curvilinear roadways.

Contact: Nathan Belz, npbelz@alaska.edu

ASSESSING THE CAPACITY OF THE PACIFIC NORTHWEST AS AN INTERMODAL FREIGHT TRANSPORTATION HUB

The economic health of the Pacific Northwest greatly depends on domestic and international trade markets and the efficient performance of freight transportation systems and their interconnections across the region. This project synthesized information from multiple sources about the capacity of the Pacific Northwest region to handle intermodal freight transportation demand. The findings from this research are intended to be used as a framework to develop a research program focusing on the planning decision making needs of stakeholders in the region.

Major sources of information about intermodal capacity were published reports from different stakeholders, online resources, and information obtained through conversations with a small set of stakeholders. Information about the current and future intermodal freight transportation demand in the region was obtained from the Freight Analysis Framework (FAF3) database of the Federal Highway Administration (FHWA) and complemented by information available in published reports. The analysis of the current and future gap between capacity and demand for intermodal freight transportation was completed using a Strength,

Weaknesses, Opportunities, and Threats (SWOT) approach to develop a more complete understanding of the factors affecting the development and expansion of intermodal freight transportation in the region.

Although the accuracy of the quantitative data cannot be considered very high, general trends were analyzed. Most of the intermodal freight flow in the region is containerized cargo that visits the main marine ports in Seattle, Tacoma, and at a smaller scale Portland. Other port terminals that are able to handle intermodal freight flow exist in the region but represent a small portion of the total flow. Two Class I railroads have dedicated intermodal terminals in the region providing service for truck-road intermodal transportation, and rail connectivity to marine ports. An analysis of the difference between intermodal

capacity and demand at an aggregate level indicates that the current infrastructure is able to handle the existing demand for containerized international freight flow in the region. However, different scenarios of demand growth show that if capacity expansion does not occur, the existing capacity will not be sufficient to satisfy the demand by 2040.

Main factors affecting the perception of stakeholders about the level of service and future expansion of intermodal freight transportation in the region include highway congestion in the major metropolitan areas, lack of other generators and receivers of intermodal freight flow, and coordination between different stakeholders.

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CHANGING RETAIL BUSINESS MODELS AND THE IMPACT ON EMISSIONS FROM TRANSPORT

Worldwide, awareness has been raised about the dangers of growing greenhouse gas emissions. In the United States, transportation is a key contributor to greenhouse gas emissions. American and European researchers have identified a potential to reduce greenhouse gas emissions by replacing passenger vehicle travel with delivery service. These reductions are possible because, while delivery vehicles have higher rates of greenhouse gas emissions than private light-duty vehicles, the routing of delivery vehicles to customers is far more efficient than those customers traveling independently. In addition to lowering travel-associated greenhouse gas emissions, because of their more efficient routing and tendency to occur during off-peak hours, delivery services have the potential to reduce congestion. Thus, replacing passenger vehicle travel with delivery service provides opportunity to address global concerns - greenhouse gas emissions and congestion.

While addressing the impact of transportation on greenhouse gas emissions is critical, transportation also produces significant levels of criteria pollutants, which impact the health of those in the immediate area. These impacts are of particular concern in urban areas, which due to their constrained land availability increase proximity of residents to the roadway network. In the United States, heavy vehicles (those typically used for deliveries) produce a disproportionate amount of NO_x and particulate matter - heavy vehicles represent roughly 9% of vehicle miles travelled but produce nearly 50% of the NO_x and PM₁₀ from transportation.

This work modeled the amount of VMT, CO₂, NO_x, and PM₁₀ generated by personal travel and delivery vehicles in a number

of different development patterns and in a number of different scenarios, including various warehouse locations. In all scenarios, VMT is reduced through the use of delivery service, and in all scenarios, NO_x and PM₁₀ are lowest when passenger vehicles are used for the last mile of travel. The goods movement scheme that results in the lowest generation of CO₂, however, varies by municipality.

Regression models for each goods movement scheme and models that compare sets of goods movement schemes were developed. The most influential variables in all models were measures of roadway density and proximity of a service area to the regional warehouse.

This work supports earlier findings that VMT can be reduced by delivery schemes. Earlier efforts found VMT reduction between passenger travel and delivery vehicles to range from 50 to 95 percent. This work, which included both urban and more rural areas and more realistic comparisons between delivery service areas and retail customer sheds, found a wider range in the VMT reduction. In Seattle, reductions in VMT as small as 20% were observed when passenger vehicle travel was replaced by warehouse-based delivery service. However, in the more rural areas, where passenger vehicle trips are longer and the delivery service areas more closely resemble the retail store customer sheds, the reductions in VMT were between 70 and 85 percent. Likewise, the work here saw reductions in CO₂ only in the more rural areas, and observations of 20 to 45 percent were at the low end of the 20-90 percent reduction range observed in the earlier studies.

Contact: Anne Goodchild, annegood@uw.edu

Research Projects

The universities in the PacTrans consortium heavily invest in safety and environmental sustainability research to address transportation issues in the region and nationally. Our consortium has several sought-after data sources accumulated over many years of research that accounts for the users, vehicles, system network, roadway, and environment. Across the five universities, PacTrans has many researchers who are experts in all five of the Strategic Goals highlighted by the US DOT (safety, sustainability, state of good repair, livable communities, and economic competitiveness) whose expertise complements the PacTrans objectives of safety and sustainability.

The current PacTrans project portfolio is composed of projects of small, medium, and large scopes. The small projects are designed to help foster pilot research on new but promising concepts and ideas. The medium and large sized projects are designed to address research issues of regional importance and require two or more institutes to work together.

Research proposals are subject to a peer review process that is overseen by the PacTrans Board of Directors. The proposals are evaluated to determine technical merit, alignment with regional and national priorities, capabilities and resources of the research team, and project scope.

Upon completion of the research a draft technical report is submitted to PacTrans and is subject to a peer review prior to publication of the final report.

During its first year of operation (2012-2013), PacTrans funded a total of 22 research projects. All were new research.

During its second year of operation, PacTrans funded a total of 31 research projects, of which 4 were continuing research projects started in the first year.

During its third year, PacTrans funded a total of 16 research projects. All were new research.

PacTrans receives its funding from the USDOT via OST-R to operate as the University Transportation Center (UTC) for Federal Region 10. Since UTC funds must be matched by non-federal sources on a 1:1 basis, all PacTrans research projects are required to provide match funds at least equal to the federal dollars allocated by PacTrans.

2013-2014 RESEARCH PROJECTS

Project Title	PI	Institution	Type
Performance-Measure Based Asset Management Tool for Rural Freight Mobility in the Pacific Northwest - year 2 (2013-14)	Jeremy Lyle Sage Ahmed Abdel-Rahim Kenneth Casavant	WSU Lead UI WSU	MULTI
Behavior of Drilled Shafts with High-Strength Reinforcement and Casing - year 2 (2013-14)	Armin W. Stuedlein Pedro Arduino	OSU Lead UW	MULTI
A Platform for Proactive Risk-based Slope Asset Management Phase II - year 2 (2013-14)	Keith Cunningham Michael Olsen Joseph Wartman	UAF Lead OSU UW	MULTI
High Performance Bridge Systems for Lifeline Corridors in the Pacific Northwest - year 2 (2013-14)	Marc Eberhard Andre Barbosa Dawn Lehman Charles Roeder John Stanton David Trejo	UW Lead OSU UW UW UW OSU	MULTI
Data Collection and Spatial Interpolation of Bicycle and Pedestrian Data - year 2 (2013-14)	Michael Lowry Yinhai Wang Mike Dixon Ahmed Abdel-Rahim Mark Hallenbeck	UI Lead UW UI UI UW	MULTI
Refinement and Dissemination of a Digital Platform for Sharing Transportation Education Materials - year 2 (2013-14)	Kevin Chang Ahmed Abdel-Rahim Shane Brown David Hurwitz William Cofer Robert Perkins Linda Boyle	UI Lead UI OSU OSU WSU UAF UW	MULTI- Education
Educating Younger Drivers in the Pacific Northwest Regarding the Dangers of Distracted Driving Phase II - year 2 (2013-14)	David S. Hurwitz Linda Boyle Ahmed Abdel-Rahim Ghulam Bam William Cofer	OSU Lead UW UI UA WSU	MULTI- Outreach
Assessing the Capacity of the Pacific Northwest as an Intermodal Freight Transportation Hub - year 2 (2013-14)	Hector Vergara	OSU	SMALL
SSI Bridge 2: Evaluation of Soil Structure Interaction Effects on PNW Bridges - year 2 (2013-2014)	Ben Mason	OSU	SMALL
Alternative Information Signs: An Evaluation of Driver Comprehension and Visual Attention - year 2 (2013-14)	David S. Hurwitz	OSU	SMALL
Geospatial Analysis of Bicycle Network "Level of Stress", Bicycle Crashes and the Geo-coded Pavement Conditions for Risk Factors Identification - year 2 (2013-14)	Haizhong Wang	OSU	SMALL
Investigating the Feasibility of Using QR (Quick Response) Codes for Construction Document Control in Highway Construction - year 2 (2013-14)	Hyun Woo Lee	OSU	SMALL

Project Title	PI	Institution	Type
Improved Corrosion Inspection Procedures for Reinforced Concrete Bridges: Electrical Resistivity of Concrete – year 2 (2013-14)	O. Burkan Isgor	OSU	SMALL
Improving Sustainability of Urban Streets via Rain Gardens – How Effective Are These Practices in the Pacific Northwest? – year 2 (2013-14)	Meghna Babbar-Sebens	OSU	SMALL
Evaluate H2RI Wicking Fabric for Pavement Applications – year 2 (2013-14)	Michael Olsen William "Billy" Connor	OSU UAF	SMALL
Improving Performance, Knowledge, and Methods to Provide Quality Service and Products – year 2 (2013-14)	William "Billy" Connor	UAF	SMALL
Performance of Depressed Medians on Divided Highways in Alaska – year 2 (2013-14)	Guhlam Bham	UAF	SMALL
Evaluate of Precut Thermal Cracks for an Asphalt Concrete Pavement in Interior Alaska – year 2 (2013-14)	Jenny Liu	UAF	SMALL
Encouraging Young Civil Engineers: Support for the UAF College of Engineering and Mines Steel Bridge Team Competition Steel Bridge – year 2 (2013-14)	Leroy Hulsey	UAF	SMALL
Roundabout Design Training for Alaska’s Engineers – year 2 (2013-14)	Nathan Belz	UAF	SMALL
A Framework for Improved Safety and Accessibility through Pedestrian Guidance and Navigation – year 2 (2013-14)	Denise Bauer	UI	SMALL
Modeling Passing Behavior on Two-Lane Rural Highways: Evaluating Crash Risk under Different Geometric Condition – year 2 (2013-14)	Michael Dixon UI Brian Dyre UI	UI	SMALL
Enhancing the Resilience of Idaho’s Transportation Network to Natural Hazards and Climate Change – year 2 (2013-14)	Tim Frazier	UI	SMALL
Testing of Cavity Attenuation Phase Shift Technology For Siting Near-Road NO2 Monitors – year 2 (2013-14)	Timothy Larson	UW	SMALL
Field Validation of Recycled Concrete Fines Usage – year 2 (2013-14)	Donald Janssen	UW	SMALL
Identifying and Analyzing the Relative Advantages and Disadvantages of Public-Private Partnerships and Traditional Delivery for Roadway Projects – year 2 (2013-14)	Jan Whittington	UW	SMALL
Changing Retail Business Models and the Impact on CO2 Emissions from Transport: E-commerce Deliveries in Urban and Rural Areas – year 2 (2013-14)	Anne Goodchild	UW	SMALL
Smartphone-Based System for Automated Detection of Walking – year 2 (2013-14)	Philip Hurvitz	UW	SMALL
NDE System for Determining Wood Guardrail Post Integrity- year 2 (2013-14)	Donald A. Bender	WSU	SMALL
Assessment of Lube Oil Management and Self-Cleaning Oil Filter Feasibility in WSF (WA State Ferries) Vessels – year 2 (2013-14)	Liv Haselbach	WSU	SMALL
Optimizing Asphalt Pavement Performance For Climate Zones Within Washington State- year 2 (2013-14)	Haifang Wen	WSU	SMALL

2014-15 RESEARCH PROJECTS



- **Project:** Safety Data Management and Analysis: Addressing the Continuing Education Needs for the Pacific Northwest
- **PI:** Kevin Chang (UI), kchang@uidaho.edu
- **Co-Investigators:** Cynthia Chen (UW), Robert Perkins (UAF), Ali Hajbabaie (WSU), Shane Brown (OSU)

Safety data collection, management, integration, improvement, and analysis activities are integral to developing a robust data program that leads to more Informed Decision making, better targeted safety investments, and overall improved safety outcomes. Safety data includes crash, roadway, traffic, licensing, and vehicle data. With the increased complexity of the safety data management and analysis activities, and with the limited resources most transportation agencies have, there is a critical need to provide the transportation workforce in the Pacific Northwest with the resources needed to effectively manage and analyze safety data.

The objectives of this multi-institution project are to: 1) develop a comprehensive understanding of needs and priorities with regard to safety data management and analysis, 2) develop a set of core skills and knowledge required for safety data management and analysis, 3) provide a comprehensive set of safety data workforce development resources that can easily be accessed for use and distribution, and 4) identify and utilize proven delivery pipelines to supplement program outreach efforts and activities in the safety data area.



- **Project:** Mitigation of Lane Departure Crashes in the Pacific Northwest through Coordinated Outreach
- **PI:** David Hurwitz (OSU), david.hurwitz@oregonstate.edu
- **Co-PI:** Linda Boyle (UW), Leila Hajibabai (WSU), Billy Connor (UAF), Ahmed Abdel-Rahim (UI)

Approximately 60 percent of fatalities on our nation's roadways are the result of lane departure crashes. In some cases, the vehicle crossed the centerline and was involved in a head-on crash or opposite direction sideswipe. In others, the vehicle left the roadway to roll over or impact one or more natural or man-made objects, such as trees, utility poles, bridge walls, embankments, or guardrails. A variety of transportation engineering solutions have been proposed to mitigate the occurrence of lane departure crashes including but not limited to: the safety edge, nighttime visibility, rumble strips, retroreflectivity, and pavement lane markings. While these strategies have shown varying degrees of promise in particular contexts, they do not immediately address all of the causal factors inherent in road users (motor vehicle and all-terrain vehicle operators) such as fatigue, operating under the influence, distraction driving, etc. There is a critical need to raise the awareness of the traveling public in the Pacific Northwest about the risks regarding lane departure crashes and how behaviors can mitigate their occurrence. The economic impact of these crashes needs attention so as to help prioritize alternative investments in such transportation engineering solutions. Essentially, users need to understand the benefits and costs of alternative programs.

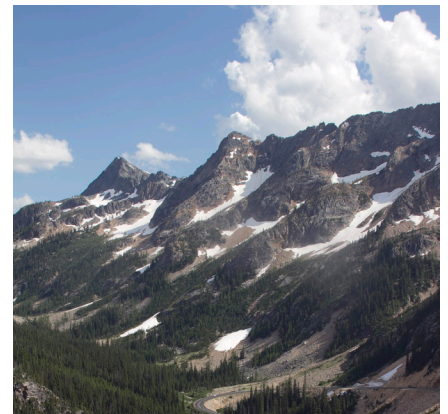
- **Project:** Regional Map Based Analytical Platform for State-Wide Highway Safety Performance Assessment
- **PI:** Ali Hajbabaie (WSU), ali.hajbabaie@wsu.edu
- **Co-Investigators:** Yin Hai Wang (UW)

Most traffic crash modeling and safety performance analysis cannot capture impacts of dynamic factors that are often critical for understanding the occurrence mechanism of crashes and are very labor intensive. To address these deficiencies, this proposed research takes advantage of the ongoing DRIVE Net research at the University of Washington to build large-scale safety analysis functions on the data-rich eScience transportation platform. The proposed research has the following objectives: Improve current crash modeling methods; Develop a Safety Performance Index (SPI); Monitor the safety performance of the state highway network on regional map using SPI; Develop a Potential Safety Improvement Index (PSII); Develop safety improvement analysis methods for accident hotspots based on the overlapped SPI and PSII.



- **Project:** Mixed Use Safety on Rural Facilities in the Pacific Northwest
- **PI:** Nathan Belz (UAF), npbelz@alaska.edu
- **Co-Investigators:** Billy Connor (UAF), Byron Bluehorse (UAF), Kevin Chang (UI), Ahmed Abdel-Rahim (UI), Mostafa Hegazi (UI)

In the United States, formalized facilities and roadway crossings for non-traditional and non-motorized modes do not exist which jeopardizes the safety of these users in many cases. These factors create a pervasive and systemic nationwide safety issue. This research will address the issues associated with providing safe accommodation, limiting the improper use of public rights-of-way, and maintaining mobility, and provide future guidelines for design, education, and enforcement for mixed-use rural facilities. The goal of this project is to: improve safety and minimize the dangers for all transportation mode types while traveling in mixed-use environments on rural facilities through the development and use of engineering and education safety measures.



- **Project:** Unmanned Aircraft System Assessments of Landslide Safety for Transportation Corridors
- **PI:** Keith Cunningham (UAF), kw Cunningham@alaska.edu
- **Co-Investigators:** Michael Olsen (OSU), Joseph Wartman (UW)

The proposed research addresses Pacific Northwest Transportation Consortium (PACTRANS) research priority of using new data-driven technologies to improve the safety of transportation systems in the Northwest United States. Landslides pose significant threats to the safety of motorists throughout the mountainous terrain of the Pacific Northwest. The research will advance landslide safety assessment for transportation corridors by capitalizing on recent advances in unmanned aircraft systems (UAS) and new low-cost Structure from Motion (SfM) photogrammetry techniques. The resulting improved hazard assessment techniques will facilitate cost-effective evaluation of landslide safety across the broadly distributed transportation networks of the Pacific Northwest.





- **Project:** Bicycle Safety Analysis: Crowdsourcing Bicycle Travel Data to Estimate Risk Exposure and Create Safety Performance Functions
- **PI:** Haizhong Wang (OSU), Haizhong.Wang@oregonstate.edu
- **Co-Investigators:** Yin Hai Wang (UW), Michael Lowry (UI)

Engineers and planners face challenges like insufficient data and lacking of proper tools when conducting safety analysis for bicyclists. This project will create tools, guidelines, and repeatable processes that engineers and planners can use to analyze crowdsourced bicycle data, calculate bicycle exposure to dangerous situations, and create and analyze safety performance functions for bicyclists.

State departments of transportation (DOTs) and local communities will be able to use the new tools from this project to make evidenced-based decisions when allocating limited transportation funds to prioritize bicycle safety improvement projects. The developed bicycle crowdsourcing data analysis tool, geographic information systems (GIS) tool for bicycle risk exposure analysis and bicycle safety performance function will help engineers or planners to make more informed decisions for safety analysis for a particular location.



- **Project:** Evaluation of the Social Cost of Modal Diversion: A Multi-Modal Safety Analysis
- **PI:** Jeremy Sage (WSU), jlsage@wsu.edu

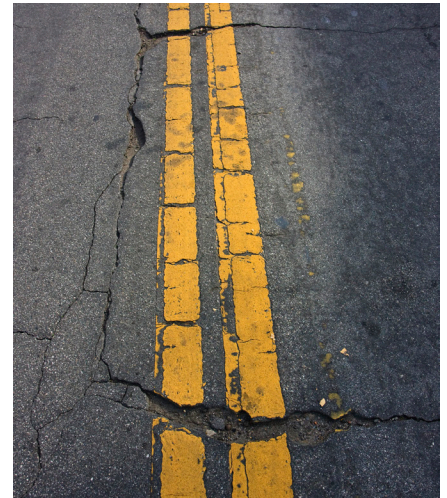
Infrastructure investment by public agencies routinely has a multi-faceted objective. Often, considerable components of these objectives may be viewed as attributable to the goal of increasing the social welfare of the residents of the region and users of the transportation system. Transportation factors related to social welfare or social costs may typically be viewed in terms of pollution, congestion, and safety. The realization of social cost savings or benefits (performance) is largely dependent upon the response functions (how the user responds to a change in the transportation system) of users. Response functions are largely an insight to the economic conditions experienced by the user. This project will develop a reliable and implementable performance evaluation of safety projects that is readily implementable by effected jurisdictions. To achieve this evaluation, the project will draw from literature and implement tactics from several research lines, primarily that of the transportation infrastructure investment, social cost, and modal choice literature.

Specifically, this research will enable concerns like those over oil transport on rail to possess a reliable tool by which proposed safety projects and actions may be evaluated for the larger impacts to freight transportation in the region. It is not the focus of this project to evaluate the efficacy of energy movement by rail, but to determine the impacts of increased oil/coal movement, and the safety actions concerned with this movement, on the overall transportation system and its users. Increased utilization of rail by oil and its transportation system wide effects on capacity possess three direct safety risks for the communities and economies of the Pacific Northwest. (1) Capacity Induced Diversion: Increased rail demand under capacity constraints diverts hauls back to the roadways, necessarily implying that there will be increased trucks on the roadway at a time when many states are seeking to divert more trucks to rail. (2) Derailment Abatement: Oil car derailment poses direct threats to the safety and security of all communities it passes through. Consideration of rail safety based legislation is underway throughout the region. These actions pose a significant likelihood of slowing down rail or altering movement, making it less attractive to shippers and shrinking available capacity. Thus, these safety actions have the potential to compound the effects of capacity constraints and further induce diversion to the roadways. (3) At-Grade: Oil export terminals in the Pacific Northwest are established within some of the most populated cities of the region. These increased exports pose significant safety concerns as the necessary number of at-grade crossing delays dramatically increases as train volume increases. Similarly, smaller towns are also faced with congestion and traffic impacts.

- **Project:** Determination of Creep Compliance and Indirect Tensile Strength for Mechanistic-Empirical Pavement Design Guide (MEPDG)
- **PI:** Haifang Wen (WSU), haifang_wen@wsu.edu

Pavement condition greatly affects the safety of driver. For instance, the rutting in wheelpath creates hydroplaning which can leads to loss of control of vehicles. The roughness, e.g. potholes, can pose safety hazards to the driver. Therefore, improving the pavement condition by designing cost-effective long-lasting pavement is of paramount importance. The adoptions of Mechanistic-Empirical Pavement Design Guide (MEPDG) align well with this goal, when compared to traditional empirical pavement design.

Dynamic modulus, indirect tensile (IDT) creep compliance and strength are the three primary mechanistic properties of asphalt mix for the asphalt pavement in the MEPDG. Thermal cracking is one of dominant distresses in Northern States in the U.S. Based the NCHRP 01-40, the thermal cracking prediction by the Pavement ME is very sensitive (highest category) to the IDT creep compliance and IDT strength. The MEPDG is a significant improvement over empirical design method and the models in MEPDG were developed based on national database of material properties and are not applicable to local materials. Therefore, there needs a local calibration of models and establishment of catalog of typical material properties, including IDT creep compliance and strength at low temperature, for local material. Without catalog of material properties in a state, the calibration of models would not be valid. The objective of this proposed research is to develop catalogs of IDT creep compliance and IDT strength for thermal cracking for materials in Idaho.



- **Project:** Safe Main Street Highways (SMSSH)
- **PI:** Anne Vernez Moudon (UW), moudon@uw.edu

Increases in non-motorized travel also raise important safety issues, as pedestrians and bicyclists constitute the most vulnerable road users. Therefore, tools to identify locations with a high risk of collisions between motor-vehicles and pedestrians or bicyclists are essential to insure that gains in mobility, air quality, and health are not accompanied by higher rates of injuries and fatalities in vulnerable road users. The overall goal of this project is to assist in complying with Washington State Strategic Highway Safety Plan of zero fatality and serious injury by 2030, and in reducing the number of pedestrian and bicyclists involved in motor-vehicle collisions on state highways.



- **Project:** An Evaluation of Safety Impacts of Seattle’s Commercial Delivery Parking Pricing Project

- **PI:** Anne Goodchild (UW), annegood@uw.edu
- **Co-Investigators:** Edward McCormack (UW)

The City of Seattle Department of Transportation (SDOT) conducts the Commercial Vehicle Pricing Project in order to improve commercial vehicle load zone access and efficiency in downtown Seattle and more, yet the project does not provide an understanding of the extent to which commercial vehicles circle while looking for available load zones or use parking areas outside of designated load zones. The proposed study will identify the correlations between collision rates and commercial vehicle on-street parking activity. In doing so, it will inform SDOTs revised strategies for Commercial Vehicle Load Zone location, pricing, and design, supporting the design of a safe and commercially accessible urban core.





- **Project:** Relationships among Worker Gender, Communication Patterns, and Safety Performance in Work Zones – year 3 (2014-2015)

- **PI:** Jessica Kaminsky (UW), jkaminsk@uw.edu

Safety communication, including safety training, is an important and cost effective tool for achieving excellent safety performance during construction (Hallowell 2010). However, recent work has identified that worker demographics has an impact on how safety knowledge is shared. Thus, the proposed research intends to study how worker gender impacts patterns of work crew safety communication on roadway construction in the Pacific Northwest. This project hypothesizes that work crews with both male and female members (or, gender diverse work crews) show different communication patterns and worse safety performance than crews without gender diversity and investigate this hypothesis by various methods in the project.



- **Project:** Modeling Passing Behavior on Two-Lane Rural Highways: Evaluating Crash Risk under Different Geometric Conditions

- **PI:** Kevin Chang (UI), kchang@uidaho.edu

- **Co-Investigators:** Ahmed Abdel-Rahim (UI), Brian Dyre (UI)

The primary goal of this project is to provide a better understanding of a driver's passing behavior and model their decision-making on two-lane rural highways under different geometric configurations. This project will specifically examine passing behavior on horizontal curves on two-lane rural highways and explore how the different degrees of curvature influence driver behavior. The outcome of the project will provide state DOTs with guidelines that allow them to improve the safety and efficiency of traffic operations along this particular type of highway setting.



- **Project:** Evaluation of Ultra-wideband Radio for Improved Pedestrian Safety at Signalized

- **PI:** James Frenzel (UI)

- **Co-Investigators:** Denise Bauer (UI)

The goal of this project is to increase the safety of signalized intersections for pedestrians with special needs due to limited mobility or vision. This aligns directly with the strategic goal of "Safety" and addresses the topic of "Technological Impacts on Safety". The research outcomes and technology developed under this proposal can be applied to existing intersections throughout the United States without significant changes to the infrastructure other than additional electronics.



- **Project:** Cost-Effective Bridge Safety Inspections Using Unmanned Aerial Vehicles (UAVs)

- **PI:** Dan Gillins (OSU)

- **Co-Investigators:** Chris Parrish (OSU)

The objective of this research is to evaluate how well UAV technology can be used to perform visual bridge inspections. Since the FHWA requires biennial bridge inspections, evaluating this exciting and emerging technology will provide helpful information to every region in the United States. To accomplish this objective, necessary goals are to: 1) investigate existing UAV technology, including available platforms, sensors, flight controllers, and mission planning tools; 2) review FHWA requirements for performing bridge inspections per 23 CFR Part 650; 3), acquire UAV-based imagery and video for 1-3 representative bridges; 4) develop recommendations for how to properly plan flights for bridge inspections; 5) analyze resulting images and video to determine which FHWA bridge requirements are satisfied (and which ones are not satisfied); and 6), transfer to the DOTs recommendations on how to properly implement UAVs for performing bridge inspections.

- **Project:** Fault Tree Analysis for Accident Prevention in Transportation Infrastructure Projects
- **PI:** Hyun Woo Lee (OSU), hw.chris.lee@oregonstate.edu
- **Co-Investigators:** Ingrid Arocho (OSU)

The study will combine literature review and content analysis to develop a list of risk factors that lead to contribute to major accident types in transportation infrastructure projects. OSHA's Fatality and Catastrophe Investigation Summaries will be the main source of data for the content analysis. OSHA requires construction companies to report any type of work-related accidents resulting in the hospitalization of three or more workers. Thus, this summary database contains valuable information regarding safety-related performance, which can be used as a basis for identification of accident types and risk factors. The data collection in this study will target: (1) accident related to the Highway, Street, and Bridge Construction Sector (NAICS 237300); and (2) projects performed in the Northwest Region of the US (Region 10 according to the OSHA categorization).



- **Project:** 3D Virtual Sight Distance Analysis Using Mobile LIDAR Data
- **PI:** Michael Olsen (OSU), michael.olsen@oregonstate.edu
- **Co-Investigators:** David Hurwitz (OSU), Alireza Kashani (OSU)

This research explores the feasibility, benefits and challenges of a safety analysis for sight distances based on DOT Mobile Laser Scanning (MLS) data. This research will also develop a systematic MLS data analysis framework to evaluate sight distances in different practical scenarios. The use of high density MLS data for sight distance analysis provides a data driven solution to aid decision making for safe transportation, directly aligning with the PacTrans FY2014-2015 theme. Further, it fits directly within Topic Area #3 Technological Impacts on Safety.



- **Project:** Development of Low-Cost Wireless Sensors for Real-Time Lifeline Condition
- **PI:** Daniel Borello (OSU)

This research proposes to develop a low-cost wireless sensor to assess the condition of the lifeline bridges following a natural hazard. The primary goal of the sensor will be to minimize cost and increase the ease of installation. Off-the-shelf hardware will be adopted to meet the design criteria, emphasizing multiple year autonomous operation. The sensors will be configured to measure individual member demands, calculated locally at the node, eliminating the challenge of time-synchronization. Structural models will be developed to predict the loss of the structure based on these measurements. The sensors will be paired with a wide-area network, allowing real-time analysis of the entire transportation system following an event. Therefore, this project will deliver a low-cost sensor that can be widely deployed throughout the Pacific Northwest transportation network to provide first responders with an overview of the current state, and route appropriately.



Education and Workforce Development

Transportation education and workforce development are high priorities for the PacTrans institutions as key components of the mission and plans for the consortium. Our five universities educate the majority of transportation professionals working in Region 10 and have won awards for innovative and effective engineering education efforts. PacTrans' activities in education and workforce development emphasize cultivating future leaders and professionals through education on the systems approach to safe and sustainable transportation solutions.

PacTrans provides educational and workforce development activities in several different areas centered on four themes: enhancing student learning through an adoptable curriculum, increasing student experiences with real-world transportation issues, increasing the recruitment of students through expanded university outreach programs, and improving regional collaboration in education and workforce development.

Each year PacTrans provides scholarships, fellowships, assistantships, and internships to students at the PacTrans universities. As part of our mission to bring talented professionals into the transportation field, PacTrans provides funding to students seeking transportation-related degrees. Students and faculty in the PacTrans universities are directly involved in transportation research and education, and have developed strong relationships with state transportation departments and other regional organizations.

PacTrans' relationships and impact extends to the international transportation community, as well. Collaboration and education exchanges bring visitors from countries such as Denmark, China, Luxembourg, and Israel, and the Valle Scholarship and Scandinavian Exchange Program fosters cooperative international education among the University of Washington and Scandinavian institutions.

REGION 10 STUDENT CONFERENCE

Transportation students in Region 10 gather every year at the Region 10 Student Conference. PacTrans and the UW Student Chapter of the Institute of Transportation Engineers (ITE) jointly sponsored the Region 10 Student Conference on October 18, 2014 at the University of Washington. In existence for over a decade, this tradition serves as an excellent venue for students to share research and develop professional connections.



PACTRANS STUDENT LEADERSHIP TRAINING: MARSHA ANDERSON BOMAR

Marsha Anderson Bomar is a transportation entrepreneur, leader, and trailblazer for women in transportation engineering. To get to where she is today, Anderson Bomar recognizes the importance of developing strong communication skills for career and leadership success. For the PacTrans Student Leadership Training on April 20, Anderson Bomar critically examined the way language can work for and against us, the communication differences between men and women, and what students can do now to build skills to grow as strong leaders.

ANNUAL TRANSPORTATION RESEARCH BOARD (TRB) MEETING

The Annual TRB Meeting attracts approximately 12,000 transportation professionals from around the world. The meeting, held in January in Washington, D.C., represents one of the most important and widely attended venues for transportation researchers and practitioners to exchange research information and share technology transfer stories.

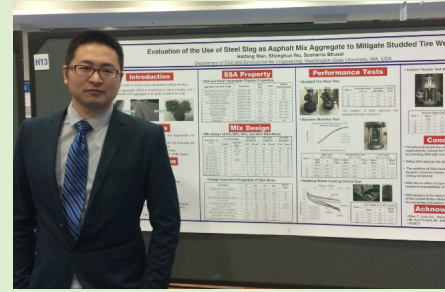
The meeting covers all transportation modes, with more than 3,000 program presentations and a variety of sessions addressing topics of interest to all attendees—policy makers, administrators, practitioners, researchers, and representatives of government, industry, and academic institutions.

Every year, PacTrans honors the center's Student of the Year by sponsoring full travel costs and awarding \$1,000. The Student of the Year is nominated by transportation faculty for excellence in academic achievement and overall contribution to the transportation community. The Student of the Year is officially recognized by CUTC at the awards banquet held in conjunction with the TRB meeting.

PacTrans reimburses a portion of conference travel expenses for students who are the primary presenter/author of a paper accepted for presentation at the meeting. At the 94th Annual Meeting (January 11 - 15, 2015), more than 100 academic research papers and talks were presented by PacTrans graduate students as primary authors.

WSU PHD STUDENT RECEIVES 2015 DAVID R. JONES SCHOLARSHIP (4/15)

Shenghua Wu, civil engineering Ph.D. candidate specializing in asphalt pavement and technology at Washington State University, won the 2015 David R. Jones scholarship from the Association of Modified Asphalt Producers (AMAP). The award recognizes dedication, scholarly work, and the desire to carry on a career in the asphalt industry. This award is presented yearly by AMAP in order to encourage talented young engineers and chemists to pursue the challenging and rewarding work building safe and efficient highways for the nation. Only two scholarships were awarded across the country.



UI STUDENTS RECOGNIZED AT 21ST ANNUAL CONFERENCE ON RURAL PUBLIC AND INTERCITY BUS TRANSPORTATION

Civil Engineering students Christopher Bacon, Riannon Heighes, and Brett Seely (pictured with Dr. Kevin Chang, UI CE Assistant Professor on right) won paper competitions administered by the National Conference on Rural Public and Intercity Bus Transportation. Each student received a cash prize and travel funds to attend the conference October 26-29, 2014 in Monterey, California. This year's conference theme was "Setting Our Course for the Future." Students were asked to envision four alternative perspectives for our transportation future: a vision of continued growth, one of disciplined or constrained growth, a future of decline and collapse, or one of transformation. Christopher participated in the graduate student research paper competition. His paper, entitled "Real-Time Information Projecting Towards the Future," received second place honors and focused his research on how GPS-tracking on city busses could make a positive impact in the future.



OSU MASTER'S STUDENT AWARDED PRESIDENT'S LEGACY SCHOLARSHIP

Jasmine Pahukula, 2nd year master's student at Oregon State University, was awarded "President's Legacy Scholarship" for graduates at the 2014 Advancing Women in Transportation (WTS) Winter Gala, in Portland, Oregon. This award provides a \$3,500 scholarship to a young woman pursuing a career in transportation. Eligible candidates are pursuing graduate degrees in transportation or a related field and demonstrate leadership skills and an active commitment to community service.

This year's competition focus was on women who demonstrate leadership in bringing ideas, innovation and new approaches to transportation challenges in the US and beyond. Jasmine's research in time of day analysis of crashes involving large trucks



in urban areas was a contributing factor to her selection. In addition, the WTS awards committee selected Jasmine to compete for the WTSF International Leadership Legacy Scholarship.

ROBERT STEVENS DELIVERS PACTRANS LEADERSHIP TRAINING SEMINAR

"How many of you remember what made you decide you wanted to become an engineer?"

Dr. Robert Stevens, President of the American Society of Civil Engineers (ASCE), posed this question to students and professionals alike in his talk, "Engineering the Future," on February 19. Using his own prolific career and involvement in ASCE as a springboard, Stevens discussed the outlook of civil engineering education and leadership development, and dispensed words of wisdom for young engineers still exploring their educational and professional path.

Regarding the qualities required to excel in engineering leadership today, Stevens offered specific advice. "Participate. You've got to speak up. If you want to succeed, and by succeed, I mean have a career that you enjoy, you need... to work with other people," said Stevens. "It comes from taking the risk and trying."

OUTREACH ACTIVITIES TO NEW ENTRANTS INTO TRANSPORTATION

All five consortium members sponsor educational and recruitment activities for high school students, under-represented minority and women students, military veterans, and K-12 student populations to encourage their interest in transportation science and technology.

PacTrans 2014-2015 Fellows

As part of PacTrans' mission to bring talented professionals into the transportation field, PacTrans provides funding to students seeking transportation-related graduate degrees each year.



Michael Corwin is originally from Raleigh, North Carolina. He attended North Carolina State University for his undergraduate study in civil engineering. His work experience began as an undergraduate research assistant at the Institute for Transportation Research and Education, where he assisted in a wide

variety of transportation-related research projects. Michael also performed research for Science Applications International Corporation, where he worked in the Saxton Transportation Operations Laboratory near Washington, DC. Before attending the University of Washington, he interned with Kittelson & Associates in Fort Lauderdale, FL for the summer. Currently, he is gaining experience in the public sector, with WSDOT in the Tolling Division.

Michael has a wide variety of interests in transportation, including operations, safety, and transit. He plans on focusing on ITS applications to solve various problems in these areas. Upon earning his Master's degree in Civil Engineering, Michael plans on working in the private sector with a transportation consulting firm.



Ryan Hughes graduated with a Bachelor's of Science in Civil Engineering with honors from Saint Louis University (SLU) in Saint Louis, MO in the spring of 2013. He recently finished a year service with the Jesuit Volunteer Corps where he volunteered as a full time staff member at Cristo Rey Brooklyn High School, a

small Catholic school in Brooklyn, NY that serves low income youth. Ryan is passionate about transportation planning, urban development, and the social justice issues related to both. He is currently working as a transportation planning and engineering intern with Fehr & Peers in downtown Seattle. He has experience working in corporate sustainability, hydraulics and hydrology, and transportation planning. Although originally from Louisville, KY, exploring new cities is one of Ryan's favorite activities, and Seattle has kept him busy doing just that.



Kelly Fearon is from Gaithersburg, Maryland and she received her undergraduate degree in civil engineering from the University of Delaware. She has worked for the Gaithersburg Public Works Department and Maryland State Highway in the Inspection Division. She also worked on designing stormwater management plans

last summer for Stantec. Currently, she is working as an intern for WSDOT Tolling Division. She is primarily interested in the planning aspects of transportation and hopes to find a job in this field after graduating. In her free time she likes to read and hike.

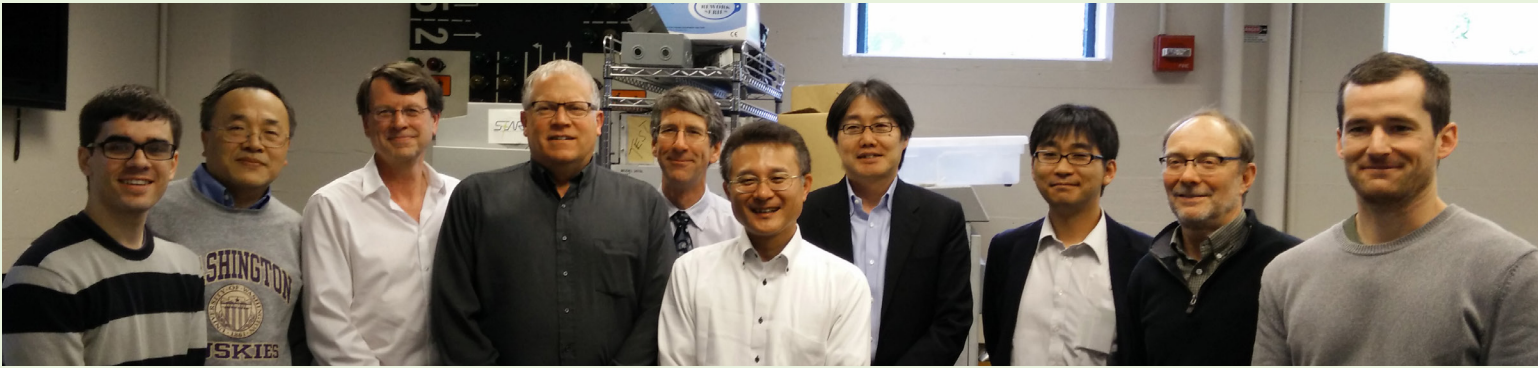


Jackson Lester is originally from Lexington Kentucky, and received a Bachelor of Science in Economics from Tulane University in 2012. He has been living in Park City, Utah for the past two years working as a ski instructor. In the summer of 2014, Jackson led a 71-day cycling and volunteer trip of 34 volunteers from

Portsmouth, NH to Vancouver, BC, with a non-profit group called Bike and Build to benefit affordable housing charities.

He is working on his Master's in Civil Engineering in Transportation at the University of Washington and is particularly interested in public transit. Currently Jackson is interning with Washington State Ferries to publish a worldwide ferry service comparison document of financial and operational measures for the 2015 Washington State Legislative Session. Jackson plans to graduate in August of 2015 and hopes to work as a consulting engineer specializing in urban transportation revitalization projects. In his free time he enjoys cycling, travel, and eating ice cream, sometimes all at the same time.

Outreach



PACTRANS HOSTS INTERNATIONAL EXCHANGE, CONNECTS JAPANESE AND US TRANSPORTATION PROFESSIONALS

On May 26, PacTrans welcomed transportation professionals from Japan as part of an international exchange to share best practices in data, organizational collaboration, and road management. Kenji Saita, Assistant Manager, West Nippon Express Company (NEXCO), and Seishu Kitamura, Senior Researcher and Kzuhiko Makimura, Deputy Director, both of the Institute of Behavioral Sciences, visited the PacTrans STAR Lab to learn about the center's work in intelligent transportation systems (ITS).

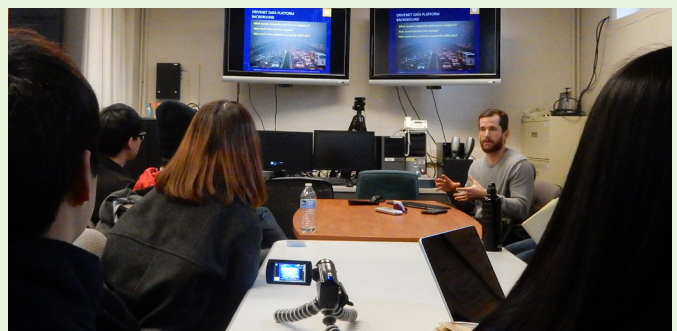
The group discussed the different types of traffic detectors employed by Washington State Department of Transportation (WSDOT) and those under development at the University of Washington, and ways to navigate the privacy concerns of data collection in Japan.

PacTrans, Washington State Transportation Center (TRAC), and WSDOT have a history of close collaboration. Doug Brodin, WSDOT Research Manager for ITS, Traffic and Congestion, and Freight, emphasized the importance of the long-term relationships with PacTrans and TRAC and considered it the key in the successful collaborative efforts between WSDOT and universities, which is visible in the many PacTrans intern students working in WSDOT.

Dr. Yin Hai Wang, PacTrans director, highlighted the center's interest in international collaborations and potential future partnership with NEXCO and IBS and the Japanese delegation responded very positively.

PACTRANS AND SUNGKYUNKWAN UNIVERSITY STUDENTS EXCHANGE RESEARCH ON TRANSPORTATION DATA SCIENCE

Dr. Sam Oh, professor of data science at Sungkyunkwan University in Seoul, brought undergraduate students participating in a data science camp to visit the PacTrans STAR Lab this February. In their visit, students saw data science in action, gaining exposure to complex data analysis and visualization in transportation research. The lab, which excels in traffic sensing and traffic data management, is known for the Digital Roadway Interactive Visualization and Evaluation Network (DRIVENet), an online transportation data platform.





STUDENTS, TEACHERS VISIT PACTRANS STAR LAB

This June, 19 incoming first year women pre-engineering University of Washington students and high school science teachers had the unique opportunity to visit the PacTrans STAR Lab. As part of the Women in Science and Engineering (WiSE) UP Summer Bridge program, participants learned about the lab's work in intelligent transportation systems, data science, detection and data collection technologies, and conventional transportation engineering issues.

Graduate student Kristian Henrickson presented an overview of STAR Lab, while John Ash explored DRIVENET, and Ruimin Ke demonstrated unmanned aerial vehicles.

The WiSE UP program allows young women to explore engineering majors, gain a better understanding of STEM professions, and prepare for academic success at the collegiate level.



PACTRANS STAR LAB PARTICIPATES IN UW ENGINEERING DISCOVERY DAYS

The University of Washington College of Engineering held its annual Engineering Discovery Days April 24 - 25, 2015. Engineering Discovery Days draws thousands of students from the region's elementary, middle and high schools. These visitors explore exhibits and demonstrations that showcase the work and research done by UW engineering students and faculty. The PacTrans STAR Lab demonstrated the exhibit "Beyond Red Light, Green Light," explaining how modern technology is improving transportation planning.



PACTRANS AND WSTIP FORM RESEARCH PARTNERSHIP

The Washington State Transit Insurance Pool (WSTIP) consists of 25 Washington public transit agencies that pool their resources in order to provide and purchase insurance coverage, manage claims and litigation, and receive risk management and training. Nearly \$7 million a year is paid for third party property damage and bodily injury claims against WSTIP members. In order to mitigate transit related collisions and enhance traffic safety, WSTIP and PacTrans are establishing a collaborative research partnership to test transit vehicle collision avoidance systems. As part of this effort, Mr. Jerry Spears, Deputy Director of WSTIP, invited PacTrans Director, Professor Yinhai Wang, to attend the WSTIP Board's Executive Meeting on March 26. Dr. Wang delivered a speech at the Work Session to introduce PacTrans and its past and active research on transportation safety. There is a clear need for WSTIP and PacTrans to partner for transit related safety research. Dr. Wang's introductory presentation helped the WSTIP board understand PacTrans and its research strengths, and laid a foundation for future collaborative activities.

Technology Transfer

PacTrans is committed to a program of technology transfer directed toward researchers, transportation professionals, public policy makers, and the general public. As such, technology transfer is integrated in all research projects from beginning to end. At the proposal stage of research, PIs submit an implementation plan describing their intentions for disseminating the results of their research. A representative from transportation agencies or private industry participates in the monitoring panel for each multi-institutional project to ensure the potential practical value and facilitate the possible technology transfer activities of the research products.

The PacTrans Region 10 Transportation Conference scheduled on October 16, 2015, offers a great platform for people from the practice side to talk to researchers for technology transfer opportunities. Additionally, through peer-reviewed journals, conference proceedings, other scientific arenas, and through social media, PacTrans researchers share the results of their

PacTrans-funded research projects and seek for partners for technology transfer. PacTrans newsletters and annual reports also serve as vehicles for outreach and technology transfer. People can access publications through the PacTrans website (www.pactrans.org) or via e-mail. To take advantage of receiving publications via e-mail, contact pactrans@uw.edu.

PACTRANS STAR LAB

A strong ITS research program and its corresponding supporting laboratory are indispensable resources for high-quality training of ITS professionals and for solving traffic problems in the Puget Sound region. Following Dr. Yinhai Wang's proposal in June 2003, the Department of Civil & Environmental Engineering in the University of Washington College of Engineering and PacTrans' predecessor, Transportation Northwest (TransNow), USDOT University Center for Federal Region 10, decided to establish a laboratory for Smart Transportation Applications and Research (STAR) to enhance the strength of ITS research and education at the University of Washington. Major objectives of the STAR Lab are: support advanced ITS research, cultivate ITS professionals, explore effective solutions to transportation problems, provide hands-on training instruments and software applications for students in ITS classes, and construct a bridge between the UW and agencies of transportation practice.

The STAR Lab is located at More Hall 101 on the UW Seattle campus. Over the past ten years, the STAR Lab has gained broad support from both transportation agencies and private industry, and developed numerous practical tools and technologies in traffic sensing, sensor data analysis, traffic simulation, and other areas. For example, the Washington State Department of Transportation (WSDOT) has decided to make the STAR Lab a remote training center and provides live traffic data and traffic operation software for research and training activities. Leading companies in the ITS field also provided great support to the STAR Lab. For further information about the STAR Lab, please contact Dr. Yinhai Wang:

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WEBSITE: www.pactrans.org
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TEENAGE DRIVERS AND DISTRACTED DRIVING

New Video

Inexperienced drivers are at particular risk for distraction from factors within and outside of the car. PacTrans conducted a large outreach project to increase teenage driver awareness of the dangers of distracted driving. In this new video from PacTrans, Dr. David Hurwitz and Dr. Linda Ng Boyle discuss driver distraction, their outreach work with young drivers, and making the road safer for everyone. Watch it at <http://bit.ly/PacTransDistracted>

In the Media

This study, recently published in the Journal of Transportation Safety and Security, has received attention from a wide range of media outlets. NPR spoke with Dr. David Hurwitz, assistant professor at Oregon State University, about the findings, which included that teens sometimes change clothes and do homework while driving. The good news is that fewer teens reported texting while driving than in previous studies. The Onion, a news satire organization, had a less-than-serious take on the study in the humorous American Voices column.



Funding and Expenditures

FINANCIAL PARTNERSHIPS

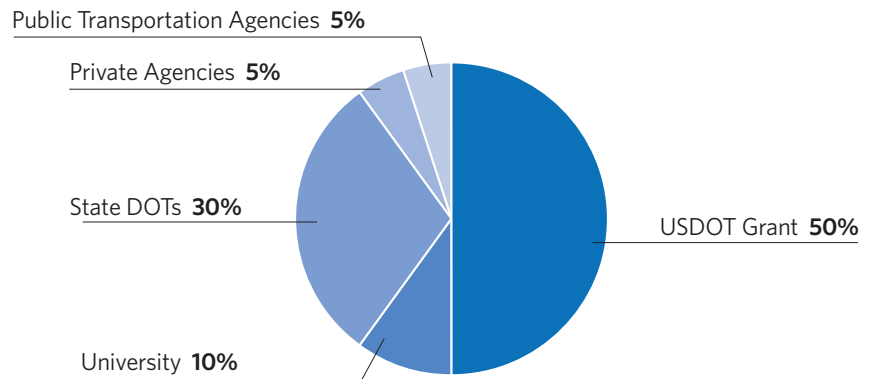
PacTrans continues to serve as the USDOT Region 10 University Transportation Center with \$6.9 million funding from the USDOT and an equal amount of match funds from local partners. The \$13.8 million funds have been applied or scheduled to apply to research, education, workforce development, outreach, and technology transfer efforts in Region 10. With two funding running parallel both addressing different needs, we expect to close out funding in 2016 for our first center and continue with second center funding on the specific theme of transportation safety. Specifically, PacTrans research focuses on developing data-driven safe and sustainable solutions for the diverse transportation needs of the Pacific Northwest. An extensive collaboration network has been established during the past years. Example partners who collaborated with PacTrans include the following companies, public agencies, and professional societies:

- Alaska Department of Transportation and Public Facilities
- CH2MHILL
- City of Bellevue
- City of Lynnwood
- City of Portland
- City of Seattle
- Idaho Transportation Department
- National Cooperative Highway Research Program
- Oregon Department of Transportation
- Oregon State University
- Parsons Brinckerhoff
- Toyota Motors
- Port of Seattle
- Port of Portland
- Puget Sound Regional Council (PSRC)
- Transpo Group
- University of Alaska, Fairbanks
- University of Idaho
- University of Washington
- Washington State Department of Transportation
- Washington State Transportation Improvement Board
- Washington State University
- Washington Traffic Safety Commission
- Western Systems
- Intel
- Microsoft

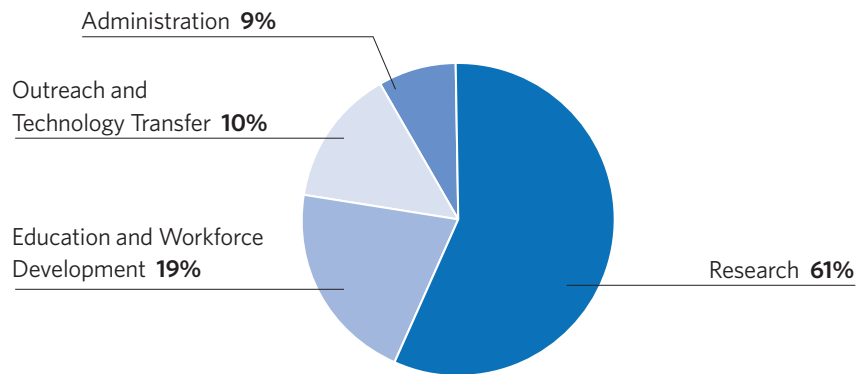
CENTER FUNDED THROUGH SAFETY-LU

Funding Sources

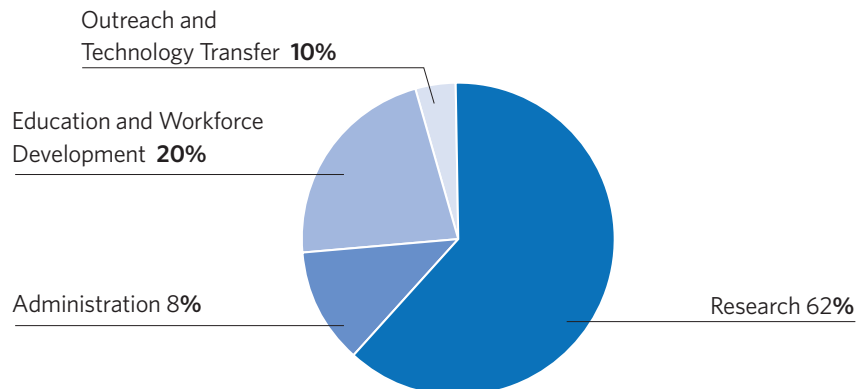
[\$6.9 million USDOT funds + \$6.9 million match funds]



2014-2015 Expenditures



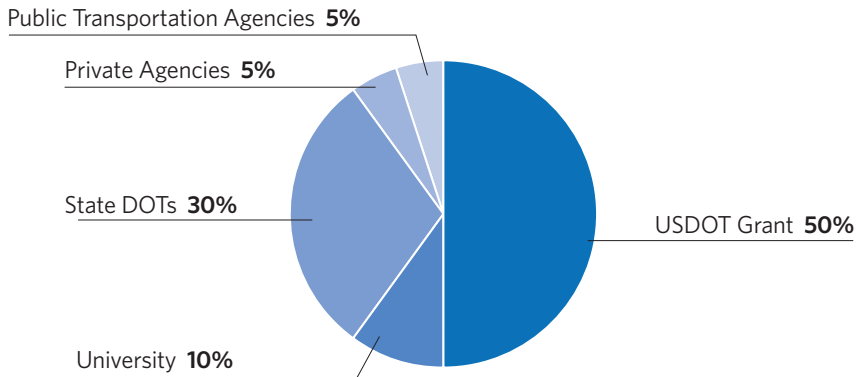
Cumulative Expenditures 2012-2015



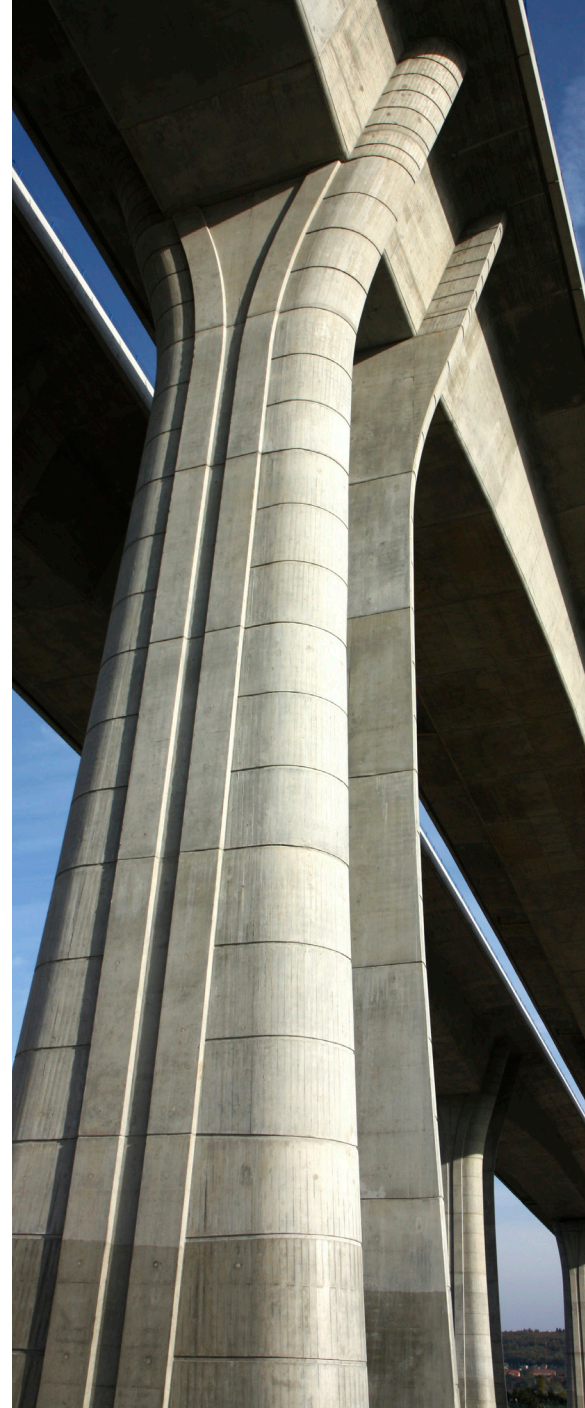
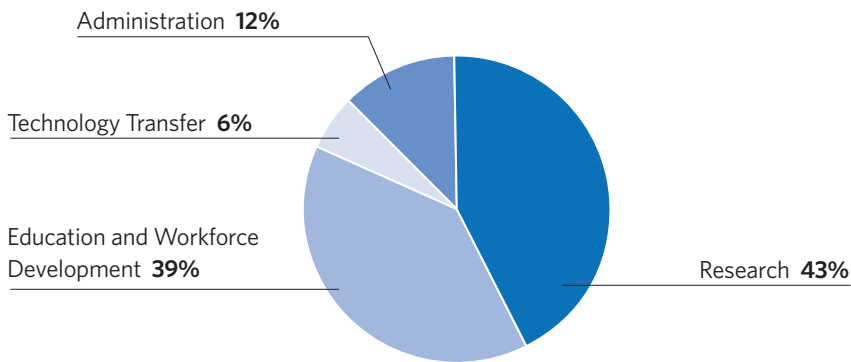
- Research
- Administration
- Education and Workforce Development
- Outreach and Technology Transfer

Funding Sources

[\$6.9 million USDOT funds + \$6.9 million match funds]



2014-2015 Expenditures



TECHNOLOGY TRANSFER CONTINUED

PACTRANS LEADS CALL FOR SUCCESS STORIES

The PacTrans Board of Directors led a call for success stories for PacTrans-funded activities in summer 2015 to disseminate the excellent work performed in research and education throughout the center. To this end, PacTrans made available a total of \$20,000 (with a budget limit of \$4,000 for each proposal) to support technology transfer and outreach efforts of successfully completed projects in Year 1 (2012-2013) and Year 2 (2013-2014). Promotion funding could be used for activities such as video production, media materials (such as animations), and conference participation.

NEWSLETTERS

The PacTrans Newsletter features highlights of research, student achievements, events, and news pertaining to the Pacific Northwest Transportation Consortium and its partners. The newsletter is published quarterly and is posted to the PacTrans website and distributed to the newsletter list.



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