Program Progress Performance Report for University Transportation Centers

Prepared for the USDOT Office of the Assistant Secretary for Research and Technology (OST-R)

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Project title: **Pacific Northwest Transportation Consortium (PacTrans): Developing Data Driven Solutions and Decision-Making for Safe Transport in the Pacific Northwest**

Program Director:
Yinhai Wang, PhD
Professor and Director
E-mail: yinhai@uw.edu
Tel: 206.616.2696

Submitting Official:
Maria Sonia L. Bayya
Assistant Director
E-mail: bayyam@uw.edu
Tel: 206.685.6648

Organization Name:
University of Washington
Pacific Northwest Transportation Consortium (PacTrans)
University of Washington
Civil and Environmental Engineering Department
More Hall 112
Seattle, WA 98195

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1. Accomplishments

- **What are the major goals of the program?**

Pacific Northwest Transportation Consortium (PacTrans) consists of institutions from all four states in our region with the University of Washington (UW) as the lead and Oregon State University (OSU), University of Alaska Fairbanks (UAF), University of Idaho (UI), and Washington State University (WSU) as partner institutions. PacTrans' theme centers on "Developing Data Driven Solutions and Decision-Making for Safe Transport". PacTrans will serve 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 U.S. Department of Transportation (USDOT) strategic goal of Safety. Major goals and objectives of PacTrans include: serving as Region 10's research engine, applied technology showcase, workforce development base, educational leader, information center, and collaboration platform.

- **What was accomplished under these goals?**

During the six month period from April 1 – September 30, 2015, several important activities are conducted following our implementation plan and the emerging needs to contribute our consortium's transportation expertise directly to the advancement of the nation and region's transportation workforce development, education, research, technology transfer, and outreach. Representative examples of these activities are:

- As Region 10's research engine, PacTrans selected two new multi-institutional general research projects (coded with MG), one multi-institutional educational research project (coded with ME), one multi-institutional outreach project (coded with MO), and twelve single-institutional research projects (coded with SR and university acronym) for fiscal year 2015-2016.

  The multi-institution research projects for Year 2015-2016 are:

  MG-2015-1: Enhancing Safe Traffic Operations Using Connected Vehicles Data and Technologies (Research team: UW and WSU)

  MG-2015-2: An Examination of the Impact of Increasing Commercial Parking Utilization on Cyclist Safety in Urban Environments (Research team: OSU and UW)

  ME-2015-1: Safety Data Management and Analysis: Addressing the Continuing Education Needs for the Pacific Northwest (Research team: UI, UW, UAF, WSU, OSU). This is the continuation of ME-2014-1

  MO-2015-1: Mitigation of Lane Departure Crashes in the Pacific Northwest through Coordinated Outreach (OSU, UW, WSU, UAF, UI). Also this is the continuation of MO-2014-1

  The small projects for Year 2015-2016 are:

SR-UW-2015-1: Developing a clustering-based empirical Bayes analysis method for hotspot identification

SR-UW-2015-2: Analysis of Roadway Safety under the Alternative Project Delivery Systems

SR-UW-2015-3: Identifying High-risk Built Environments for Severe Bicycling Injuries

SR-WSU-2015-1: Guidelines for Pervious Concrete Sidewalks, Parking Lots, and Shared-Use Paths to Improve Drivers, Bikers, and Pedestrian Safety

SR-WSU-2015-2: Benchmarking and Safety Assessment for Modified Lateral Spreading Design Procedure Using Three-Dimensional Nonlinear Finite Element Analysis

SR-OSU-2015-1: Torsional Safety of Highway Traffic Signal and Signage Support

SR-OSU-2015-2: Deployment and Validation of Low-Cost Wireless Sensors for Real-Time Lifeline Condition Assessment

SR-OSU-2015-3: Improved Safety and Efficiency of Protected/Permitted Right Turns for Bicycles in the Pacific Northwest

SR-OSU-2015-4: A Network-Level Decision Making Tool for Pavement Maintenance and User Safety

SR-OSU-2015-5: Understanding Interdependencies Between Systems Towards Resilient Critical Lifeline Infrastructure in the Pacific Northwest

SR-UI-2015-1: Aerodynamic Effects on Two-Lane Rural Highway Safety

SR-UI-2015-2: Spatial Analysis of Bicycle and Pedestrian Count Data

- Research projects selected for the Fiscal Year 2014-2015 funding cycle are progressing as scheduled. These projects are:

  MG-2014-1: Bicycle Safety Analysis: Crowdsourcing Bicycle Travel Data to Estimate Risk Exposure and Create Safety Performance Functions (Research team: OSU, UW, UI)

  MG-2014-2: Mixed Use Safety on Rural Facilities in the Pacific Northwest (Research team: UAF and UI)

  MG-2014-3: Unmanned Aircraft System Assessments of Landslide Safety for Transportation Corridors (Research team: UAF, OSU, and UW)

  MG-2014-4: Regional Map Based Analytical Platform for State-Wide Highway Safety Performance Assessment (Research team: WSU and UW)

  ME-2014-1: Safety Data Management and Analysis: Addressing the Continuing Education Needs for the Pacific Northwest (Research team: UI, OSU, UAF, OSU, and UW)

MO-2014-1: Mitigation of Lane Departure Crashes in the Pacific Northwest through Coordinated Outreach (Research team: OSU, UAF, UI, UW, and WSU)

SR-OSU-2014-1: Development of Low-Cost Wireless Sensors for Real-Time Lifeline Condition Assessment

SR-OSU-2014-2: Cost-Effective Bridge Safety Inspections Using Unmanned Aerial Vehicles (UAVs)

SR-OSU-2014-3: 3D Virtual Sight Distance Analysis Using Mobile LIDAR data

SR-OSU-2014-4: Fault Tree Analysis for Accident Prevention in Transportation Infrastructure Projects

SR-UI-2014-1: Evaluation of Ultra-wideband Radio for Improved Pedestrian Safety at Signalized Intersections

SR-UI-2014-2: Modeling Passing Behavior on Two-Lane Rural Highways: Evaluating Crash Risk under Different Geometric Conditions

SR-UW-2014-1: Relationships among Worker Gender, Communication Patterns, and Safety Performance in Work Zones

SR-UW-2014-2: An Evaluation of Safety Impacts of Seattle's Commercial Delivery Parking Pricing Project

SR-UW-2014-3: Safe Main Street Highways (SMSH)

SR-WSU-2014-1: Determination of Creep Compliance and Indirect Tensile Strength for Mechanistic-Empirical Pavement Design Guide (MEPDG)

SR-WSU-2014-2: Evaluation of the Social Cost of Modal Diversion: A Multi-Modal Safety Analysis

SR-UAF-2014-1: Passing Zone Behavior and Sight Distance on Rural Highways-Evaluation of Crash Risk and Safety under Different Geometric Conditions

SR-UAF-2014-2: Supporting Four Safety Projects in Alaska: Analyzing Driver Behavior, Accident Reduction Factors, Highway Patrol Investments, Develop Highway Safety Manual

- To outreach PacTrans research results to the right audience and in a proper format, PacTrans conducted a call for success stories (http://depts.washington.edu/pactrans/successstory2015/). Submitted stories were evaluated by the PacTrans Technology Transfer Taskforce and six success stories were selected to receive technology transfer funds to facilitate the technology transfer activities, including video production, workshop presentation, etc.
- PacTrans sponsored and demonstrated the STAR Lab at the 2015 ITS America' Seattle Symposium on Building a Smart, Diverse, and Shared Travel Network, held July 16 – 17 at the University of Washington. It brought transportation professionals from both public and private sectors together to discuss shared-use mobility and technology-driven solutions. The symposium featured a variety of panels and speakers, and keynote addresses were delivered by Regina Hopper, President and CEO, ITS America, Scott Kubly, Director, Seattle Department of Transportation, and the Hon. Secretary

Lynn Peterson, Washington State Department of Transportation. Dr. Yinhai Wang, PacTrans Director, provided closing remarks and described the center's work and research. The PacTrans STAR Lab offered a technical tour for more than 20 conference attendees. Specific research work demonstrated included unmanned aerial vehicle based traffic data collection, Media Access Control (MAC) address sensing for multi-modal data collection, Microsoft Kinect-based pedestrian detection, and the Digital Roadway Interactive Visualization and Evaluation Network (DRIVE Net).

- On May 5, 2015, the PacTrans Region 10 Transportation Safety Workshop drew representatives from universities, public agencies, and private companies across the Pacific Northwest to discuss important regional transportation safety issues. This workshop was jointly organized by PacTrans, ITE Washington, ITE Oregon, ITE Idaho, and ITE Alaska. Open only to invited participants, more than 70 attendees, both in-person and online, joined the workshop at the Talaris Conference Center to identify critical regional transportation safety issues for PacTrans to study. Regional transportation experts representing industry, agency, and university perspectives contributed to PacTrans' research agenda, shared ongoing efforts in addressing critical safety problems, and solidified partnerships in transportation safety research and practice.
- PacTrans joined University Transportation Center representatives from across the nation for the 2015 Council of University Transportation Centers Summer Meeting, June 1-4 in Brunswick, New Jersey. Held at Rutgers, the event brought transportation and university professionals and administrators together to share best practices and success stories to advance research, education, and development in the transportation field.
- 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. 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.
- Aug 28, 2015, sponsored by PacTrans, students from the University of Alaska Fairbanks College of Engineering and Mines won first place in all categories for their steel bridge entry in the American Society of Civil Engineers (ASCE) Pacific Northwest Conference. Every year, the ASCE issues a new set of rules designed to challenge young engineering students. Students apply must apply concepts learned in the classroom and develop a competitive and innovative scale-model steel bridge that is within the guidelines set. At the competition, the bridge is then scored on many different factors, such as weight and rigidity, construction speed and even the number of team members building the bridge. The UAF team led the way in all areas from overall performance to structural efficiency and even aesthetics. The conference was held at Idaho State University, where 13 different Universities from the region convened to compete in many challenges, including a concrete canoe competition. This was UAF's second year competing in the concrete canoe challenge and they earned 4th place.

- **What opportunities for training and professional development have the program provided?**

PacTrans continues to provide training and professional development opportunities through multiple channels:

- Research channel. All the selected research projects involve graduate and/or undergraduate students, which are typically associated with opportunities to work with state and local transportation agencies. By involving students, PacTrans provides students invaluable opportunities in developing skills they need to be successful in their future careers in academia, industry, and government. One example to mention here is the recently received TRB Transit IDEA project. Some UW graduate students will work with Washington State Transit Insurance Pool and several transit agencies to test the effectiveness of some collision avoidance systems to be installed on 36 transit vehicles.
- Educational channel. PacTrans consortium partners offer a variety of on-campus and online courses designed for professional development. The online programs, such as the online Master of Sustainable Transportation, are particularly good for working professionals because of the flexibility in schedule and location. PacTrans also sponsored working professionals to share their valuable expertise and practical knowledge to students by teaching important courses on campus, such as CEE 498 Traffic Simulation and CEE 589 Transit System Planning to enrich our transportation educational curriculum.
- Outreach channel. PacTrans offers training and educational opportunities to students through its outreach activities. For example, approximately ten incoming first year women pre-engineering University of Washington students and high school science teachers visited the PacTrans STAR Lab on June 19 to learn the lab's work in intelligent transportation systems, data science, detection and data collection technologies, and conventional transportation engineering issues. Also, PacTrans funded the UAF engineering student team to showcase their skills and technologies in different venues. They won first place in all categories for their steel bridge entry in the American Society of Civil Engineers (ASCE) Pacific Northwest Conference.
- PacTrans fellowship program. PacTrans continues to support student education and research activities. Five new PacTrans fellows, Thomas Steckel, Richard Lee, Riley Kimball, Carl Luke Peters, and Jeffrey Conor, have joined the UW Transportation Engineering program since the fall of 2015.
- Seminars and workshops. PacTrans invites outstanding transportation professionals to deliver talks to PacTrans students and working professionals in Region 10. These talks highlight a variety of topic areas, and clearly address the needs of leadership training, workforce development, career education, and research introduction. From the educational perspective, these events are helpful not only in building students' comprehensive understanding of transportation, but also increasing skills to address critical transportation issues in future practice and prepare students to be leaders in

their field of expertise. The following seminars/workshops were delivered during the reporting period:

- On April 20, 2015, Marsha Anderson Bomar delivered a PacTrans Student Leadership Training. Marsha Anderson Bomar is a nationally recognized transportation entrepreneur, leader, and trailblazer for women in transportation engineering with a list of awards and recognitions that rivals the length of a term paper. To get to where she is today, Anderson Bomar highlights the importance of developing strong communication skills for career and leadership success. For the PacTrans Student Leadership Training, 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.
- On April 28, 2015, 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 (GPR)." at the Spring PacTrans Regional Transportation Seminar. Dr. Imad Al-Qadi is an internationally renowned professor in pavement materials and engineering. Dr. Al-Qadi has been working on GPR research for more than two decades, among his other diverse research interests. He is the Director of the Advanced Transportation Research and Engineering Laboratory (ATREL) and the founding Director of the Illinois Center for Transportation (ICT). A registered professional engineer, Dr. Al-Qadi has authored/co-authored more than 550 publications and has served as the principal investigator of more than 100 projects sponsored by various federal, state, and international agencies and industry.
- On June 4, Emily Feenstra, Director for Infrastructure Initiatives of the American Society of Civil Engineers (ASCE), spoke at the PacTrans-sponsored Transportation Seminar. Her talk, "The Case for Engaging in Public Policy – Your Projects Depend on It," related the current status of infrastructure funding, how ASCE has engaged in the policy debate, and the importance of engineers' involvement in policy.
- Aug 14, 2015, PacTrans invited Dr. Simon Washington hold seminar with title of 'The Effect of Government Policy on the Promotion of Energy Efficient Vehicles'. Dr. Simon Washington holds the ASTRA Chair at the Queensland University of Technology in Brisbane, Australia. He contributes to the fields of behavioral econometrics in transport safety and risk analysis, urban planning, evaluation, and travel behavior. He is Associate Editor of two leading international transport journals (Journal of Sustainable Transport; and the J of Anal Meth in Acc Res), Editorial Board Member of four leading international journals (Acc Anal & Prev,Trans Res A and C, and the J Trans& Stat). In this presentation, Dr. Simon Washington examines and estimates the effects of different types of government incentives on both energy efficient vehicles (EEVs) demand (market and fleet penetration), and EEV price premiums across 15 metropolitan regions from 2008 to 2012.

- Suzzanne Childress, Principal Travel Modeler at Puget Sound Regional Council delivered a talking on transportation modeling at the UW Graduate Transportation Seminar on April 14, 2015.
- Craig Stone, Assistant Secretary of WSDOT, delivered a seminar talk on WSDOT tolling practice at the UW Graduate Transportation Seminar on May 5, 2015.
- Cos Roberts, owner and president of Urban Tech Systems, also came to the UW campus and delivered a talk on transit systems at the UW Graduate Transportation Seminar on May 19, 2015.
- Stephanie MacLachlan, Asset Management and Technical Services Program Manager at King County DOT shared her knowledge on asset management with PacTrans graduate students on May 26, 2015.

- PacTrans Internship Program. PacTrans internship program continues to offer students great training opportunities by partnering not only with local agencies but also private industries. We have an internship program with WSDOT, Seattle DOT, Bellevue Transportation Department, Transpo Group, FEHR & PEERS, Parsons Brinckerhoff, Puget Sound Regional Council, ODOT, etc. Additionally, PacTrans itself also offers intern opportunities for both graduate and undergraduate students to work in the PacTrans consortium university labs to gain hands on experience in transportation. For example, the PacTrans Smart Transportation Applications and Research Laboratory (STAR Lab) offered five student internships during the reporting period.
- Conference channels. PacTrans provides travel funds to support student attendance at the TRB annual meeting and other important transportation conferences. For example, more than 100 academic papers and talks were delivered by PacTrans researchers at the 2015 TRB annual meeting and majority of the presenters were students that received PacTrans travel support packages to attend the conference. Furthermore, PacTrans also uses its Region 10 Transportation Conference and Region 10 Student Conference as important opportunities for training and professional development. A student committee has been set up in preparation of the Region 10 Student Conference scheduled on October 17, 2015. The goal of this conference is to provide an opportunity for students to organize a conference that is geared towards their own needs and a platform for regional student groups to meet and exchange research and work experience.
- PacTrans Partnership Program with Institute of Transportation Engineers (ITE). PacTrans has developed strong partnerships with local ITE chapters in student mentoring and training. For example, ITE Washington has a mentor program for university students. They offer student fellowships and also host events for student training. For example, the 2015 ITE Student Night event was hosted on May 12, 2015. A student project competition was conducted and winners received cash award donated by local transportation engineers and companies.

- **How have the results been disseminated? If so, in what way/s?**

PacTrans continues to enhance its outreach program to tie its connection with local and state transportation agencies and private partners in the region. Research outcomes are posted on the PacTrans website, distributed through our quarterly newsletter and annual reports, and promoted through meetings, workshops, and social media such as Twitter and the University of Washington press media. We have also participated and presented our research at the following events that were reported on our website at www.pactrans.org:

1. Partnership meetings. PacTrans scheduled specific meetings with transportation agencies and companies, including King County Metro, WSDOT, Washington Traffic Safety Commission (WTSC), Washington State Transit Insurance Pool (WSTIP), Bellevue Transportation Department, etc. to introduce and demonstrate its research findings. These meetings are fruitful. The joint TRB Transit IDEA proposal was developed after the research introduction meeting with WSTIP. PacTrans and WTSC are exploring possibilities to co-organize transportation safety related events. A research team has been formed by PacTrans researchers, Microsoft engineers, and Bellevue transportation staff to using relevant technologies to address intersection safety problems.
2. PacTrans technology transfer funds. Pactrans allocated technology transfer funds to six selected research projects with impressive success stories to promote. The funds are expected to help promote research findings and tools that may potentially useful in addressing real world problems.
3. PacTrans conferences and workshops. The Annual PacTrans Region 10 Transportation Conference brings together the Pacific Northwest's transportation community to network and share current research results for technology transfer and ideas for research, education, workforce development, and future collaboration. The 2015 conference focuses on the central PacTrans theme of transportation safety and is scheduled on October 16. People will discuss research and educational needs and developments in designing safe infrastructure, safe operations, and safe users at the conference. Showcasing research products completed in the 2014-2015 academic year and initiating possible technology transfer processes are important objectives of this conference. The spring regional safety workshop held on May 5 also serves as an outreach opportunity for PacTrans to communicate research directions and findings with transportation professionals in Region 10.
4. Conference presentations and invited talks. PacTrans researchers were invited to deliver presentations at conferences, workshops, and research institutes. For example, Professor Yinhai Wang, director of PacTrans, delivered his research on big data applications to urban sustainable growth at the annual conference organized by Arkansas Transportation and Highway Department; Smart Cities Workshop in Wuxi, China; and a Big Data Symposium in Novi, Michigan, etc. Dr. Ken Casavant, Director of the Freight Policy Transportation Institute at Washington State University and member of the Board of Directors of Pactrans presented a paper at the International Transportation Economics Association Conference on June 18, 2015. The paper, co-authored with Dr. Jeremy Sage as lead and You Zhou, was entitled "Applying Practical Design Methods to Multi-Modal Supply Chains." The overall aim of the conference was to promote scientific excellence in the field of transport economics and to provide a forum for stimulating scientific exchange. A total of 53 conference presentations and 49 invited talks were delivered by PacTans researchers to publicize PacTrans research findings.

5. Publications. PacTrans researchers are active in journal and proceedings publications. During the reporting period, PacTrans researchers have produced 83 peer-reviewed journal articles, four book chapters or other manuscripts. Also, a short video focusing on the PacTrans outreach project on teenage drivers' distracted driving has been produced and published online at https://www.youtube.com/watch?v=bM_iNEyVxcg.
6. International exchange. Located in Seattle, a busy port city for trade and exchanges, PacTrans receives numerous international delegations during the reporting period. For example, PacTrans hosted transportation professionals from Japan as part of an international exchange to share best practices in data, organizational collaboration, and road management on May 26. 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.
7. International collaborations. PacTrans established a research partnership with Norwegian Public Roads Administration. Professor Ed McCormack visited Norway for a joint research project during the reporting period. Also, PacTrans joined the new "2+2" initiative signed by the UW, Tsinghua University, Washington State, and Sichuan Province of China. Collaborative research ideas toward smart and low carbon cities were discussed during a symposium on the UW campus on Sept. 10.

- **What do you plan to do during the next reporting period to accomplish the goals?**

PacTrans will continue to follow its implementation plan to ensure that all PacTrans funded research, education, and outreach activities move forward as scheduled. Specifically, the following events have been planned for the ensuing months and endeavors mapped to meet our goals.

- PacTrans will work with consortium members in Region 10 to actively prepare for our Regional Transportation Conference and Region 10 Student Conference.
- PacTrans will work with the Southern Plains Transportation Center, Region 6 UTC, to set up a technology transfer workshop at the 2015 ASCE International Conference on Transportation and Development. Considering that major participants to this event are working professionals, it will offer a great opportunity for PacTrans and other UTC partners to showcase our research products and seek for technology transfer opportunities at the conference.
- PacTrans will follow the work plan developed at the PacTrans Retreat in September 2015 to optimize its operational team, establish a cloud-based data exchange system, and enhance the PacTrans website to include additional information about our projects and research findings.
- PacTrans Regional Transportation Seminar series and other PacTrans sponsored seminar and conference events will continue to attract top level speakers to deliver cutting edge research and practical engineering solutions to our audience.

2. Products (for the reporting period of April 1 – September 30, 2015)

	PacTrans Total	UW	WSU	UI	OSU	UAF
Publications: peer reviewed journal articles	83	68	8	0	6	1
Publications: Book chapters and other edited manuscripts	4	4	0	0	0	0
Conference papers	29	7	2	0	20	0
Conference presentations	53	26	3	3	20	1
Lectures/Seminars /Workshops/ Invited Talks	49	14	20	0	11	4
Inventions, patent applications, and/or licenses	1	0	0	0	0	1
Other products: data or databases, physical collections, audio or video products, software or NetWare, models, educational aids or curricula, instruments, or equipment	1	1	0	0	0	0

- **Examples of peer reviewed journal articles**

1) C. R. McGann, P. Arduino, and P. Mackenzie-Helnwein, (2015), *Stabilized single-point 8-node hexahedral element for dynamic analysis of fluid saturated porous media*. Computers and Geotechnics, Vol. 66, pp 126-141.

2) C. Mast, P. Arduino, G. Miller, and P. Mackenzie-Helnwein, P. Arduino, (2015), *Simulating granular column collapse using the Material Point Method*. Acta Geotechnica, Vol. 10, Issue 1, pp 101-116.

3) C. R. McGann, P. Arduino, and P. Mackenzie-Helnwein, (2015), *Stabilized single-point 8-node hexahedral element for dynamic analysis of fluid saturated porous media*. Computers and Geotechnics, Vol. 66, pp 126-141.

4) Strahler, A. W. Stuedlein, P. Arduino, (2016), *Stress-strain response and dilatancy of sandy gravel in triaxial compression and plane-strain*. Journal of Geotechnical and Geoenvironmental Engineering, under review.

5) Clayton, P.M, Tsai, C.Y., Berman, J.W., and Lowes, L.N., (2015). *Comparison of Web Plate Numerical Models for Self-Centering Steel Plate Shear Walls*. Earthquake Engineering and Structural Dynamics, Accepted, In Press, http://dx.doi.org/10.1002/eqe.2578.

6) Clayton, P.M, Berman, J.W., and Lowes, L.N., (2015). *Seismic Performance of Self-Centering Steel Plate Shear Walls with Beam-Only-Connected Web Plates*. Journal of Constructional Steel Research, Vol. 106, pp. 198-208, http://dx.doi.org/10.1016/j.jcsr.2014.12.017.

7) Pei, S., van de Lindt, J.W., Popovski, M., Berman, J.W., Dolan, J.D., Ricles, J.M., Sause, R., Blomgren, H.E., and Rammer, D.R. (2014). *Cross Laminated Timber for Seismic Regions: Progress and Challenges for Research and Implementation*. Journal of Structural Engineering, ASCE, Forum Paper, In Press, http://dx.doi.org/10.1061/(ASCE)ST.1943-541X.0001192.

8) Lehman, D.E., Kuder, K.G., Gunnerrson, A.K., Roeder, C.W., and Berman, J.W. (2014). *Circular Concrete Filled Tubes for Improved Sustainability and Seismic Resilience*. Journal of Structural Engineering, ASCE, Vol. 141, SPECIAL ISSUE: Sustainable Building Structures, http://dx.doi.org/10.1061/(ASCE)ST.1943-541X.0001103

9) Thonstad, T., Mantawy, I., Stanton, J.F., Eberhard, M.O., Sanders, D.H. (2015). *Shaking Table Performance of a New Bridge System with Pre-Tensioned, Rocking Columns*. submitted to Journal of Bridge Engineering, ASCE.

10) Motley, M.R., Wong, H.K., Qin, X. and Eberhard, M.O. (2015). *Tsunami-Induced Forces on Skewed Bridges*. submitted to Journal of Waterway, Port, Coastal and Ocean Engineering, ASCE.

11) Lattanzi, D.A., Miller, G.R., Eberhard, M.O., and Haraldsson, O.S. (2015). *Bridge Column Maximum Drift Estimation Via Computer Vision*. submitted to Engineering Structures,

12) Davis, Phillip M., Janes, Todd M., Haraldsson, O.S. Stanton, John F., Eberhard, Marc O., and (2015),*Unbonded Pre-tensioned Columns for Accelerated Bridge Construction in Seismic Regions*. to appear in Journal of Bridge Engineering, ASCE.

13) Nguyen, H., Stanton, J.F., Eberhard, M.O, and Chapman, D. (2015), *The Effects of Temperature Variations on the Camber of Precast, Prestressed Concrete Girders*. to appear in PCI Journal

14) Alexander D., Larson T.V., Vedal S., and Bolton S. (2015) *Systolic Blood Pressure Changes in Bolivian Women Associated with an Improved Cookstove Intervention*. Air Quality, Atmosphere and Health ,8(1), 47-53.

15) Yu R., Liu X.C., Larson T., Wang Y. (2015) *Coherent approach for modeling and nowcasting hourly near-road Black Carbon concentrations in Seattle, Washington*. Transportation Research Part D: Transport and Environment , 34, 104-115.

16) Fox J.R., Cox D.P., Drury B.E. , Gould T.R., Kavanagh T.J., Paulsen M.H., Sheppard L., Simpson C.D., Stewart J.A., Larson T.V. and Kaufman J.D. (2015) *Chemical characterization and in vitro toxicity of diesel exhaust particulate matter generated under varying conditions*. Air Quality, Atmosphere & Health DOI: 10.1007/s11869-014-0301-8.

17) Adar S.D., D'Souza J., Mendelsohn-VictorK., Jacobs D.R., Cushman M., Thorne P.S., Sheppard L., BurkeG.L., DaviglusM., SzpiroA., Diez RouxA.V., Kaufman J.D.,.Larson T.V. (2015) *Long-Term Exposure to Coarse Particulate Matter, Inflammation, and Coagulation: A Cross-Sectional*

Analysis from the Multi-Ethnic Study of Atherosclerosis. Environmental Health Perspectives DOI:10.1289/ehp.1308069.

18) Kim S-Y, Sheppard L., Larson T.V., Kaufman J.K., Vedal S. (2015) *Combining PM2.5 Component Data from Multiple Sources: Data Consistency and Characteristics Relevant to Epidemiological Analyses of Predicted Long-Term Exposures Environmental Health Perspectives.* DOI:10.1289/ehp.1307744.

19) Alexander D., Larson T.V., Vedal S. and Bolton S. (2015) *Associations between a cookstove intervention and lung function in indigenous Bolivian women: a small intervention study*. Global Public Health (accepted).

20) Adar S.D., D'Souza J., Sheppard L., Kaufman J., Hallstrand T.S., Davey M.E., Sullivan J.R., Jahnke J., Koenig J., Larson T.V., Liu L.J. *Adopting Clean Fuels and Technologies on School Buses: Pollution and Health Impacts in Children*. American Journal of Respiratory and Critical Care Medicine (accepted).

21) Zhang, Shen, Jinjun Tang, Hua Wang, and Yinhai Wang. *Enhancing Traffic Incident Detection Using Spatial Point Pattern Analysis in Social Media*. Transportation Research Record. In Press. 2015.
22) Tang, Jinjun, Yinhai Wang, Shen Zhang, Hua Wang, and Fang Liu. *On Missing Traffic Data Imputation Based on Fuzzy C-means Method by Considering Spatial Temporal Correlation*. Transportation Research Record. In Press. 2015

23) Yu, Runze, Cathy Liu, Timothy Larson, and Yinhai Wang. *Coherent Approach for Modeling and Nowcasting Hourly Near-Road Black Carbon Concentrations in Seattle, Washington*. Transportation Research Part D. Volume 34, 104–115, 2015. http://dx.doi.org/10.1016/j.trd.2014.10.009.

24) Tang, Jinjun, Guohui Zhang, Yinhai Wang, Hua Wang, and Fang Liu. *A hybrid approach to integrate fuzzy C-means based imputation method with genetic algorithm for missing traffic volume data estimation*. Transportation Research Part C. Vol.51, 2015, 29-40. http://dx.doi.org/10.1016/j.trc.2014.11.003.

25) Wang, Yong, Xiaolei Ma, Yunteng Lao, and Yinhai Wang. *Vehicle Routing Problem based on A Fuzzy Customer Clustering Approach for Logistics Network Optimization*. Journal of Intelligent & Fuzzy Systems. In Press. 2015. http://dx.doi.org/10.3233/IFS-151578.

26) Wang, Yong, Xiaolei Ma, Likun Wang, Yinhai Wang, Yong Liu, and Mao-Zeng Xu. *A Methodology to Exploit Profit Allocation in Logistics Joint Distribution Network Optimization*. Mathematical Problems in Engineering. Vol. 2015, Article ID 827021, 2015. http://dx.doi.org/10.1155/2015/827021.

27) Hurwitz, D., Miller, E., Jannat, M., Boyle, L., Brown, S., Abdel-Rahim, A., & Wang, H. (in press) *Improving Teenage Driver Perceptions Regarding the Impact of Distracted Driving in the Pacific Northwest*. Journal of Transportation Safety & Security.

28) Neill, J., Hurwitz, D., & Olsen, M. (Accepted 4/10/2015) *Alternative Information Signs: An Evaluation of Driver Comprehension and Visual Attention*. ASCE: Journal of Transportation Engineering.

29) Dong, S., Wang, H., Hurwitz, D., Zhang, G., & Shi, J. (Accepted 4/10/15) *Nonparametric Modeling of Vehicle-type Specific Headway Distribution in Freeway Work Zones*. ASCE: Journal of Transportation Engineering.

30) Michael Olsen, Joseph Wartman, Martha McAlister, Hamid Mahmoudabadi, Matt O'Banion, Lisa Dunham, Keith Cunningham (in review) *Point cloud surface modeling and volumetric analysis for rockfall magnitude-frequency relationship*. Journal of Remote Sensing.

31) Moss, R. E. S., Thompson, E. M., Kiefer, D. S., Tiwari, B., Hashash, Y. M. A., Acharya, I., Adhikari, B., Asimaki, D., Clahan, K. B., Collins, B. D., Dahal, S., Jibson, R. W., Khadka, D., MacDonald, A., Madugo, C. L. M., Mason, H. B., Pehlivan, M., Rayamajhi, D. and Uprety, S. (2015). *Geotechnical effects of the 2015 magnitude 7.8 Gorkha, Nepal earthquake and aftershocks*. Seismological Research Letters 86(6). 10.1785/0220150158.

- **Example of book chapters and other edited manuscripts**

1) Leshchinsky, B., Olsen, M., Tanyu, B., and Wartman, J. (2015) "The Contour Connection Method Inventorying and Classifying Landslides using Bare Earth Lidar," LIDAR, Vol. 5., No. 1, pp. 1-3.

2) Abdel Aziz, A. M, and Migliaccio, G. C. (2015) “Public-Private-Partnerships in the USA Transportation Sector”, in “PPP: An International Handbook” Book. Awaiting publication in the press room.

- **Example of lectures/seminars/workshops/invited talks**

1) Workshop of Innovative Technologies and Methods to Improve Transportation Systems. *Mobile Sensing for Pedestrian and Bicyclist Data*. Southwest Jiaotong University, China, July 29, 2015.

2) Georgia Tech's National Center for Transportation Systems Productivity and Management (NCTSPM). *Transportation Big Data Analytics for Smart Cities Applications*. Aug. 27, 2015.

3) Society for Knowledge Discovery in Distributed and Ubiquitous (KD2U) Environments. *Transportation Big Data Analytics for Network-wide Performance Analysis and Decision Support*. NGDM’15. June 2, 2015.

4) Arkansas Transportation Research Council Annual Conference. *DRIVE Net: A Large-Scale Online Data Platform for Performance Analysis and Decision Support*. May 21, 2015.

5) Wuxi’s Smart City Kickoff Workshop. *Smart Transportation: Challenges and Opportunities*. Wuxi City, China. May 18, 2015.

6) International Conference on Urban Traffic Safety. *Traffic Data Sensing Technologies*. April 30, 2015.

7) Developed a new graduate-level course. *Current Topics in Transportation Planning and Policy*.

8) Geotechnical Extreme Event Reconassance Association, Workshop, April 2015.

9) ASCE Seattle Section Geotechnical Group, Annual Seminar, May 2015.

- **Examples of technologies or techniques**

1) Digital Roadway Interactive Visualization and Evaluation Network (DRIVE Net) is a big data analytics system under development at the STAR Lab. PacTrans and WSDOT are co-sponsors of this project. Recently, WSDOT decided to transfer the reporting functions from other systems to DRIVE Net so that DRIVE Net can be a future data analytics tool for WSDOT to integrate multiple data sets to support planning, operation, and analysis functions needed in their practice.

- **Scheduled known academic talks for upcoming reporting period (Oct 1, 2015-March 31, 2016)**

1) Oklahoma Transportation Research Day. "DRIVE Net: A Large-Scale Online Data Platform for Performance Analysis and Decision Support." Oklahoma City, Oklahoma, Oct. 20, 2015.

2) ITS Washington Annual Meeting. "PacTrans and Its Data-driven Safety Research." Seattle, Washington, Nov. 3, 2015.

3. Participant and Collaborating Organizations: Who has been involved?

- **What individuals have worked on the program?**

- PacTrans Director, Yinhai Wang, Ph.D., Professor of Civil and Environmental Engineering at the UW, devotes 50 percent of his time directing PacTrans. Dr. Wang has overall responsibility for program management, oversight of PacTrans operations, including the Research Committee, the Education and Workforce Development Committee, and the Outreach and Technology Transfer Committee, and Student Leadership Council. He is the regional and national leadership for PacTrans, and the contact person for management relationships with USDOT Research and Innovative Administration (RITA) and other USDOT organizations.
- PacTrans Associate Director in Research, Linda Ng Boyle, Ph.D., Professor of Transportation Engineering with joint appointments in Industrial and Systems Engineering and Civil and Environmental Engineering at the UW spends 5 percent of her time managing the research program for PacTrans and coordinates the research collaboration across the five partner institutions.
- PacTrans Associate Director in Education and Workforce Development, Anne Vernez-Moudon, Dr. es SC, Professor of Architecture, Landscape Architecture, and Urban Design and Planning, Adjunct Professor of Epidemiology and in Civil and Environmental Engineering, devotes 5 percent of her time leading the Education and Workforce Development Committee. She is involved in curriculum changes, professional training program development, and educational enhancements among the partner institutions.

- PacTrans Associate Director in Outreach, Mark Hallenbeck is also the Director of the Washington State Transportation Center (TRAC) office located at the UW. Mr. Hallenbeck works closely with Associate Director Anne Vernez-Moudon and spends 5 percent of his time in organizing student seminars, internships, and fellowship programs.
- PacTrans Associate Director in Oregon State University (OSU), Chris Bell, Ph.D., Professor of Civil and Construction Engineering at OSU, devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within OSU. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in the University of Alaska Fairbanks (UAF), Billy Connor, Director of the Alaska University Transportation Center (AUTC), devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within UAF. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in University of Idaho (UI), Ahmed Abdel-Rahim, Ph.D., Associate Professor of Civil Engineering at UI, devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within UI. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in Washington State University (WSU), Ken Casavant, Ph.D., Professor and Transportation Economist in the School of Economic Sciences at Washington State University (WSU) and Director of WSU's Freight Policy Transportation Institute, devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within WSU. He coordinates all results and outcomes with the UW on a regular basis.
- From January to June 2015, Assistant Director, Ms. Maria Bayya, devoted 90 percent of her time to the day-to-day operations in support of the PacTrans mission. Her responsibilities include project management, grant management, events coordination and outreach, and managing the PacTrans operations team.
- Ms. Elysse Reyna is PacTrans Communications Manager. She devotes 23 percent of her time in managing and coordinating all aspects of PacTrans publications which include newsletters, website content and annual reports.
- PacTrans full-time Program Coordinator, Ms. Melanie Paredes, devoted 90 percent of her time to the Center's fiscal matters, support with events coordination and outreach and day to day administrative tasks.
- Weibin Zhang, Ph.D., Research Associate in the PacTrans STAR Lab at the University of Washington, devotes 30 percent of his time in providing research support and oversight of PacTrans consortium and center projects which include multi institution and small center projects.
- Graduate Student Assistant devotes 10 percent to assist with facilitating and coordinating seminars, workshops and events.
- The Student Leadership Council, composed of graduate students at all Consortium partner universities, is an active part of the PacTrans management structure. The Student Leadership Council facilitates student and center communications and plans their own activities. For example, one important student event on the PacTrans schedule is the Region 10 Student Conference, to be

held on the UW campus October 17, 2015. Leaders of the four UTCs in this region – PacTrans, the National Institution for Transportation and Communities (NITC), Center for Environmentally Sustainable Transportation in Cold Climates (CESTiCC), National Institute for Transportation and Communities, and Transportation for Livability by Integrating Vehicles and the Environment (TranLIVE) – are all in support of this traditional regional student conference.

- Additionally, PacTrans has 28 fulltime faculty at the UW engaged in transportation research. Our consortium partners (OSU, UI, WSU, UAF) have 41 fulltime faculty directly involved in PacTrans research.

- **What other organizations have been involved as partners?**

The state transportation agencies in Alaska, Idaho, Oregon, and Washington have all been extensively involved in PacTrans in terms of research, outreach, and technology transfer activities. Their research office directors are members of our PacTrans External Advisory Board (EAB), which provides strategic oversight to the PacTrans Board of Directors. In addition to the state DOTs, many other public transportation agencies and private companies are also actively involved in PacTrans activities. We have interactions and have partnered with Microsoft, City of Bellingham, City of Seattle, City of Lynnwood, City of Bellevue, City of Everett, King County, Snohomish County, Pierce County, Washington Traffic Safety Commission, Washington State Patrol, Washington State Transit Insurance Pool, Puget Sound Regional Council (PSRC), Washington Transportation Investment Board, American Society of Civil Engineers, and Institute of Transportation Engineers, etc.

The PacTrans EAB provides strategic guidance to the PacTrans Board of Directors. In addition to state DOT members on the PacTrans EAB, membership includes a representative from Toyota Corporate, Port of Portland, PSRC, as well as a representative from Idaho industry, Western Trailers.

PacTrans also collaborates with Portland State University's UTC (NITC), University of Idaho's TranLIVE, and UAF's CESTiCC on various Region 10 events.

4. Impact

- **What is the impact on the development of the principal discipline(s) of the program?**

Since the research projects funded in this program are in progress, the research side of impacts on our transportation program is still being observed and are not complete. Specifically, the following impact or potential impact has been observed:

– PacTrans keeps supporting multi-institutional research projects that require two or more institutions to work together. These projects typically involve local transportation agencies of multiple states and this creates a great platform for students, faculty, and practitioners to work together. In addition to the research benefits, each participating institution can learn from each other in enhancing its education curriculum with a clear understanding of the needs from our region.

- Our educational research project, entitled "Safety Data Management and Analysis: Addressing the Continuing Education Needs for the Pacific Northwest," with all five consortium partners involved has identified a clear need of integrating data-driven technologies and methods into our transportation safety education curriculums. Findings of this research project will definitely generate impacts on our transportation education curriculums.
- Our outreach project, entitled "Mitigation of Lane Departure Crashes in the Pacific Northwest through Coordinated Outreach," are very timely, given the increased crashes in the Pacific Northwest over the past year. Approximately 60 percent of fatalities on our nation's roadways are the result of lane departure crashes. A variety of transportation engineering solutions have been proposed to mitigate the occurrence of lane departure crashes but 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.
- Our regional seminars and conferences offer great input for our curriculum reform and research initiative development. A set of important strategic directions toward the center theme of "***Developing Data Driven Solutions and Decision-Making for Safe Transport in the Pacific Northwest"*** have been identified for future PacTrans activities and support. In response to these needs, several new faculty members are hired to enhance the research and educational strengths in the identified areas.

- **What is the impact on other disciplines?**

Faculty of multiple other disciplines worked directly or collaboratively with transportation faculty in our consortium. During this reporting period, we communicated and collaborated with professionals in environmental engineering, electrical engineering, computer science and engineering, public health, public policy, and mathematics for various PacTrans activities saying in the 2015 PacTrans Region 10 Transportation Safety Workshop in May, 2015. Our regional transportation needs are clearly delivered to people from these relevant disciplines.

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 have established a collaborative research partnership to test transit vehicle collision avoidance systems. This effort received TRB Transit IDEA funds. A total of 36 transit vehicles from local transit agencies will be tested with a collision avoidance system to evaluate the safety benefit of the new safety solutions.

- **What is the impact on transportation workforce development?**

PacTrans continues its dedication to transportation workforce development. In addition to the award-winning intern program with WSDOT and several other new intern programs recently established, PacTrans is making great efforts to merge the gap between practice and university education. One such effort is to sponsor training workshops to address practical issues on demand. Many similar events were sponsored by PacTrans, including the 2015 PacTrans Region 10 Transportation Safety Workshop, the coming 2015 PacTrans Regional Transportation Conference and Student Conference, etc.

Our four online transportation degree granting programs continue to play an important role in workforce development, serving over 130 continuing education students during the reporting period. Furthermore, we are actively working with local partners to develop or re-establish workforce development programs, including the PacTrans-WSDOT graduate level training program. This program had produced many very successful transportation professionals at local transportation agencies before it was closed due to financial crisis in 2008. We have scheduled a meeting to discuss ways to re-establish this program.

- **What is the impact on physical, institutional, and information resources at the university or other partner institutions?**

PacTrans has funded ten regional projects and 25 small projects in using 2014-2016 funds. These projects add new physical, institutional, and information resources and facilitate cross sharing of existing resources among consortium partners. For example, Professor Yinhai Wang will develop a connected vehicle test-bed for testing new sensors, connected vehicle devices, and data analysis methods. This effort is jointly sponsored by PacTrans, WSDOT, and the UW. The testbed will offer a great test platform for a variety of transportation safety solutions.

Professors Andre Barbosa, Ben Mason, and Dan Gillins of OSU and one student (all currently engaged in PacTrans projects) have been to Nepal in summer 2015 to contribute to the post-earthquake investigations on infrastructure safety. The research team was able to advance understanding of the related effects of large earthquakes and foster connections that can benefit regions of high seismic hazard around the world.

- **What is the impact on technology transfer?**

PacTrans emphasizes technology transfer and involves relevant parties early in those funded projects with a technology development component. In the 2015 PacTrans Region 10 Safety Workshop, important factors of technology transfer were specifically discussed among researchers and practitioners of Region 10. Additionally, a Call for Success Stories has resulted in six projects to receive technology transfer funds to facilitate the process. Furthermore, PacTrans has conducted several technology transfer events with regional partners, e.g. the technical tour at the ITS America's Seattle Symposium, will set up a demonstration desk at the 2015 IEEE Smart Cities Conference scheduled October 25 – 18, 2015, and is working with the Region 6 UTC to set up a technology transfer workshop at the 2015 ASCE International Conference on Transportation and Development.

- **What is the impact on society beyond science and technology?**

PacTrans researchers actively participated in various meetings and conferences to disseminate knowledge on traffic and safety issues. Because transportation is related to everyone's daily life, our research certainly adds benefit to everyone's life. Through regular open house and other domestic or international exchange events, PacTrans research laboratories have received thousands of visitors. In addition to showcasing PacTrans research products, researchers also took the opportunity to educate the general public for the correct behaviors to ensure transportation safety, sustainability, and mobility. For example, the short video focusing on PacTrans outreach research on teenage drivers' distracted driving has been produced and published online at https://www.youtube.com/watch?v=bM_iNEyVxcg.

5. Changes/Problems

NONE

6. Special Reporting Requirements

NONE