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

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 and objectives 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:

Research – serving as Region 10's research engine, PacTrans is committed to funding cutting edge research in both the categories of advanced and, more importantly, applied research.
Technology Transfer – PacTrans strives to be an applied technology showcase, providing additional funds to projects that are deemed as "Success Stories" to ensure dissemination of results to policy makers, educators, practitioners, and others within the transportation industry.
Education – As a consortium of five prestigious Universities, PacTrans is devoted to being an education leader. This involves continued evaluation and evolution of our transportation engineering programs as well as providing state-of-the-art research laboratories, student conferences and seminars, and scholarship opportunities for our students and future workforce.
Workforce Development – PacTrans endeavors to be a workforce development base: hosting activities that focus on the development of people, building strong relationships with employers in our region, and connecting our students with quality jobs where they can implement the knowledge they gained through their education.
Outreach – Throughout all of these other goals and objectives, PacTrans seeks to be in a continual process of outreach: promoting and building the educational student base, making new industry partners, attracting new research, and providing opportunities to share and learn about key outcomes and achievements that have been learned through research.
Collaboration – PacTrans desires to be a platform for participation and is always on the lookout for potential new partner and new opportunities with current partners to collaborate on transportation related endeavors.

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

During the six month period from October 1, 2015 – March 31, 2016, PacTrans was actively engaged in each of the goals and objectives identified above. This was achieved through a breadth of activities that were conducted to ensure our transportation expertise contributes to the advancement of the region's transportation research, technology transfer, education, workforce development, outreach, and collaboration.

Research

As Region 10's research engine, PacTrans has been actively engaged in two broader categories of research projects. We engage in multi-institutional research projects that require participation from at least two consortium universities, typically have a larger budget. Such projects include multi-institutional general research projects (coded with MG), educational research projects (coded with ME), and multi-institutional outreach projects (coded with MO). We also engage in small research projects (referred to as single institutional projects) that only require participation from a single consortium university and typically have smaller budgets. Such projects are coded with SR and university acronym. Both categories of research are geared towards the goal of advancing the region's transportation research.

In the center's previous PPPR it reported on selected Multi-Institutional project selections for the funding cycle of 2015-2016 and small project selections for the both the 2015-2016 and the 2014-2015 funding cycles. PacTrans has been enforcing the management procedure for these selected projects and all of them are on track. All active project PIs were invited to the 2015 PacTrans Region 10 Transportation Conference and demonstrated their research progress to the participants from transportation agencies, private industry, and research institutes of all four states. As an example, PacTrans developed a mobile sensing technology for travel data collection and tested the technology with the UW transit services. This research story was reported by a variety of media outlets, including *Geekwire*, *Seattle Times*, *King 5 News*, and *ASCE Civil Engineering Magazine*, and generated immediate interests from China, Brazil, Austria, etc.

PacTrans is currently in the selection process for both multi-institutional and small projects for the 2016-2017 funding cycle. For the multi-institutional projects: PacTrans received twenty-six abstracts, from which the board of directors selected ten project to draft and submit full project proposals. Those ten proposals have been submitted and the center is currently working with its expert panel of reviewers to rank these project. Ultimately three multi-institutional projects will be funded for this 2016-2017 funding cycle based on a rigorous review and decision process.

With regard to small projects: each of the five consortium universities makes their initial picks based on their needs and expertise and then brings the selected projects to the PacTrans board for final decisions ensure PacTrans funds are properly applied to address the safety issues with regional importance.

Technology Transfer

PacTrans is making its best effort promoting technology transfer through the early engagement of interested partners in its research projects. For each selected multi-institutional projects, PacTrans requires the research team to deliver a product for tech transfer. $20,000 technology transfer funds are reserved for the potential technology transfer activities upon the successful completion of the proposed research for each multi-institutional project. Once a sufficient pool of projects have been completed, the center will solicit submissions for "success stories." Success stories are just that, research that merits the added funding and effort to make sure that the findings and conclusions of the project are disseminated to the appropriate entities. Thus PIs will submit proposals on how they would further disseminate their

findings in thoughtful and useful ways. Then PacTrans board of directors and advisory committees will select a handful of projects to receive sufficient funding to execute the proposed activity(s).

During the reporting period, PacTrans PIs took the opportunity of many conference events to showcase our accomplishments of the ongoing research projects. Examples of these events include: the 2015 IEEE Smart Cities Conference, the 2016 Transportation Research Board (TRB) Annual Meeting, PacTrans Region 10 Transportation Conference, Northwest Transportation Conference, ITS Washington Annual Meeting, Traffic Safety Commission Conference, etc. In particular, PacTrans delivered 120 talks at the TRB Conference, most of them were delivered by our student researchers.

Education

During this reporting period PacTrans universities continued to utilize the student researchers, data, instruments, and equipment from the transportation labs at each of the five participating consortium universities. These labs include:

University of Alaska at Fairbanks

- Alaska Center for Energy and Power
- Alaska University Transportation Center

Oregon State University

- Driving and Bicycling Simulator
- National Center for Accessible Transportation

University of Idaho

- National Institute for Advanced Transportation Technology

University of Washington

- Human Factors and Statistical Modeling Lab
- STAR Lab
- Urban Form Lab
- Washington State Transportation Center (UW)

Washington State University

- Center for Environmentally Sustainable Transportation in Cold Climates
- Freight Policy Transportation Institute
- Washington Center for Asphalt Technology
- Washington State Transportation Center (WSU)

PacTrans regularly sets up external tours for students to visit a variety of worksites. During this reporting period our students visited the Washington State Department of Transportation's Traffic Management Center (December 7, 2016). PacTrans universities' students also had the opportunity to participate in a

number of regional and nationwide competitions. The University of Washington Institute of Transportation Engineers Student Chapter team won gold at the 24th Annual Bill Kloos Traffic Bowl in Portland, Oregon (November 19, 2016).

PacTrans had three student researchers win awards during this reporting period. University of Washington PhD student John Ash and Oregon State University graduate student Andrea Mather won the 2015 PacTrans Outstanding Student of the Year awards and were honored and recognized at the CUTC banquet at this year's TRB annual meeting. University of Alaska, Fairbanks, PhD student Anthony Mullin received the 2015 Michael Kyte Region 10 Outstanding Student of the Year Award and was recognized at the PacTrans reception at this year's TRB annual meeting.

As part of the 2015 PacTrans Regional Transportation Conference, which will be discussed in the following subsection, PacTrans hosted its annual Region 10 Student Transportation Conference (October 17, 2015). This event brought together 50-plus students from the five consortium universities for a panel discussion with young transportation professionals, speakers from the industry, and research poster competitions.

Each of the five consortium universities is budgeted financial resources for student scholarship. This is an effort to retain the best and brightest minds in the country and the world to our universities. Each university is given discretion on how to use those funds. So for example, Oregon State University spreads their funding across each of the graduate level students to make the tuition more accommodating. At the University of Washington, scholarship funds are disseminated through the PacTrans Fellows program. Each year a handful of exceptional students are identified to receive financial support during their time at the UW. During this reporting period two fellows for next year have accepted PacTrans offer.

Finally the University of Washington, PacTrans lead university, is excited to announce a new educational opportunity for transportation interested students. The Master of Science in Construction Management degree will now be offering a Construction Management Occupational Safety and Health track. PacTrans universities make continued efforts to create more robust opportunities for learning and researching in transportation and transportation related fields.

Workforce Development

PacTrans had a number activities geared at workforce development during this reporting period: the 2015 PacTrans Regional Transportation Conference, the 2016 Northwest Transportation Conference, and four PacTrans Seminar Series guest lecturers.

On October 16, 2015 PacTrans hosted its third annual Regional Transportation Conference. Almost two hundred students, researchers, educators, practitioners, policy makers, and officials gathered at the University of Washington's Seattle Campus for a day of networking, education, collaboration, research sharing, research funding, and updates on cutting edge technologies. A session was dedicated to the

workforce development discussions and panelists presented in this session were agency and industry representatives. Mr. Shawn Leight, ITE vice president, also participated in the panel and shared his opinion on workforce development.

March 15 through 17, 2016, PacTrans cosponsored the biennial Northwest Transportation Conference hosted by Oregon State University and the Oregon Department of Transportation. With more than 400 transportation professionals from throughout Oregon and the Pacific Northwest in attendance, this event touts being the Northwest's premiere transportation event, "Since its inception in 1949, the Northwest Transportation Conference has served as a forum for engineers, designers, builders, operators, planners, and other transportation officials." PacTrans external advisory board member Michael Bufalino chaired the event and numerous PacTrans faculty and student researchers, as well as private industry partners facilitated, and presented at, conference sessions.

PacTrans also hosted four guest lecturers who participated in our Seminar Series. On November 4, 2015, Dr. Pitu Mirchandani from Arizona State University came and discussed the possible future of proactive traffic management systems. On January 29, 2016 Dr. Yahong Rosa Zheng from Missouri University of Science and Technology visited and presented on cutting edge research in bridge scour monitoring. On March 10, 2016, PacTrans external advisory board member Charlie Howard, Director of Planning at the Puget Sound Regional Council, came to campus and presented a comprehensive backdrop for our region's current transportation climate. Finally, on March 31, 2016, Walker-Ames distinguished lecturer Basile Chaix of the French National Institute of Health and Medical Research visited to discuss land use and its effects on human experience and public health.

Perhaps the most exciting development in this category during this reporting period was a meeting that took place between PacTrans director Dr. Yinhai Wang (along with several other University of Washington Faculty) and officials from Washington State Department of Transportation to discuss rebuilding a continuing education, workforce development, and training program for government agency employees. Years ago, the University of Washington's previous UTC hosted a similar program but unfortunately, due to a downturn in the economy, and a lack of reinvestment to keep the courses up-to-date, that program fell by the wayside. PacTrans is very, very excited about the prospect of bringing relevant training courses to the transportation professionals in our state and local DOTs.

Outreach

During this reporting period PacTrans made great use of the ample opportunities to participate in external functions that make the center more visible, show off our research, add expertise and influence, advertise to potential student, and build strong partnerships within the industry. The following is a brief list of these functions:

1. On October 6, 2015, PacTrans participated in a Beyond Traffic Forum with the Honorable Secretary Anthony Foxx, the City of Seattle, and other local agencies at the Seattle City Hall to provide direct insights on the draft "Beyond Traffic" framework, intended to ignite a national

conversation on how new technologies and public policy will shape U.S. transportation systems to enable new safety, mobility, growth, and economic benefits over the next 30 years.

2. On October 7, 2015, PacTrans Fellows promoted transportation as a field of study at CEE Undergraduate Orientation, HUB Ballroom and More Hall 110, University of Washington, Seattle.
3. On October 14, 2015, PacTrans Associate Director for Outreach Mark Hallenbeck of the University of Washington delivered a presentation on the rise of new transportation alternatives and an ORCA data analysis project at the ASCE/ITE/WTS joint meeting.
4. October 20, 2015 - PacTrans Director, Prof. Yinhai Wang, Guest Lecturer at Oklahoma Department of Transportation, and presented "DRIVE Net: A Large-Scale Online Data Platform for Performance Analysis and Decision Support."
5. On October 25 through 29, 2015, PacTrans PIs, researchers, and students attended/presented at the inaugural Institute of Electrical and Electronics Engineers (IEEE) International Smart Cities Conference in Guadalajara, Mexico. Participating students also hosted a PacTrans informational booth throughout the conference.
6. On October 29, 2015 Dr. Hallenbeck presented on Transportation, Growth, and Equity at the Urban@UW Fall Workshop.
7. At this year's annual Transportation Research Board meeting in Washington DC on January 10 through 14, 2016, PacTrans student and faculty researchers had over 100 papers accepted to, and presented at, the meeting; and those researchers participated in over 120 lecterns, poster sessions, workshops, committees, and subcommittees.
8. On January 27, 2016, PacTrans Director Dr. Yinhai Wang was one of three speakers representing ITS and Transportation Technology at the Washington State House of Representatives Transportation Committee Workshop.
9. On February 5, 2016, PacTrans hosted a meeting with prospective graduate transportation engineering students.
10. On February 8, 2016, PacTrans Director Dr. Yinhai Wang was the keynote speaker at the regional ITE/IMSA joint meeting on smart cities.
11. On February 23, 2016, PacTrans Director Dr. Yinhai Wang spoke in the transportation breakout session at the Smart Cities Regional Workshop hosted by Microsoft.
12. On March 30 and 31, 2016, PacTrans Director Dr. Yinhai Wang presented PacTrans research at the second annual UTC Safety Summit hosted by Carnegie Mellon in Washington DC.

Collaboration

During this reporting period, PacTrans had three meetings on potential collaboration:

1. On December 30, 2015, City of Bellevue teamed up met with PacTrans and Microsoft to form a partnership in hopes of creating a methodology for predicting bike accidents.
2. On January, 25, 2016, PacTrans met with leaders at INRIX to discuss a partnership where they would share their data for academic research and our STAR Lab would share our state-of-the-art data platform DRIVE Net.

3. On March 24, 2016, PacTrans director Dr. Yinhai Wang, along with PacTrans associate director, Mark Hallenbeck, met with experts at Microsoft and representatives from the City of Seattle to discuss the creation of a Trusted Big Data Sharing Platform.

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

Many of these opportunities have been discussed above. PacTrans provides training and professional development opportunities through multiple channels:

Research – All the selected and PacTrans funded research projects have and will continue to involve graduate students, which also provides many opportunities to work with state and local transportation agencies. By involving students, PacTrans provides students an invaluable opportunity to develop skills they need to be successful in their future careers in academia, industry, and government.

Education – Beyond the new online construction management track discussed in the above subsection, PacTrans consortium partners offer a variety of other on-campus and online courses designed for professional development. The online programs, such as the online master's program of sustainable transportation, are particularly good for working professionals because of the flexibility in schedule and location.

Outreach – PacTrans offers training and educational opportunities to K-12 students through its outreach activities. For example, PacTrans helped fund Alaska Summer Research Academy (ASRA). High school students enrolled in the ASRA Civil Engineering Module applied basic design principles of statistics and structural analysis showing how engineering principles are used to solve problems. PacTrans STAR Lab also hosted visitors from K-12 schools including both students and teachers at Engineering Discovery Days.

Funding assistance – PacTrans continues to support student education and research activities. Beyond our PacTrans fellows, for whom we fund tuition, we also give a significant amount of assistance to students to participate in conferences and seminars such as the Transportation Research Board Annual Meeting and the IEEE Smart Cities Conference. This aides them with funds for presentation materials, travel expenses, and registration fees.

Seminars, workshops, and conferences – As outlined above, PacTrans offers many opportunities for training and professional development through its seminar series, annual regional transportation conference, and various workshops. Furthermore, PacTrans also uses its Region 10 Transportation Conference and Region 10 Student Conference as important opportunities for training and professional development.

Internships – 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.

Partnerships – PacTrans has a partnership program with Institute of Transportation Engineers (ITE). PacTrans has developed strong partnerships with local ITE chapters in student mentoring and training. ITE Washington has a mentor program for university students. They offer student fellowships and also host events for student training.

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

PacTrans has a strong outreach program to local and state transportation agencies and private partners in the region, through which PacTrans research outcomes are presented and demonstrated. Research outcomes are posted on the PacTrans website, distributed through our *quarterly newsletter* and *annual reports*, and promoted through social media such as *Facebook* and *Twitter* and the University of Washington *press media*. We also disseminate news, events and results via our website at www.pactrans.org.

The second large component of our dissemination efforts surround facilitating and attending various seminars, workshops and conferences. Many of these have been outline and discussed in previous sections: Regional Transportation Conference (October 16, 2015), Student Transportation Conference (October 17, 2015), IEEE Smart Cities Conference (October 2015), Northwest Transportation Conference (March 15 – 17, 2016), and Seminar Series guest lecturers (November 4, 2015, January 29, 2016, March 10, 2016, and March 31, 2016).

Finally, per our obligation as a UTC, research results are posted on our website and are disseminated to all of the required repositories that include, TRID, USDOT, Transportation Library, Volpe National Transportation Systems Center, Federal Highway Administration Research Library and the US Department of Commerce National Technical Information Service.

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

PacTrans is excited for the busy season ahead. Below are the center's identified plans and strategies for accomplishing its goals and objectives over the next reporting period.

Research
As detail above, PacTrans is currently in the process of selecting both multi-institutional and small projects for the 2016-2017 funding cycle. Final decision notifications are schedule for July 1, 2016 and the one-year anticipated performance period will commence September 16, 2016.

Technology Transfer
The centers first funding cycle of projects is set to close June 15, 2016. Once these projects have been submitted, as detailed above, PacTrans will call for proposals for additional funding to complete a more

robust technology transfer for those projects that the board and advisory committee deem exceptional. The selection process for this will be completed during the next reporting period.

PacTrans is working with the Region 4 UTC at the University of Oklahoma to set up a technology transfer workshop at the 2016 ASCE International Conference on Transportation and Development. Considering that this conference attracts hundreds of practitioners to participate, this workshop offers a terrific opportunity for the UTC research products to be introduced.

Education

There will be a lot going on in the education subject during this upcoming reporting period.

1. PacTrans is currently in the process of identifying ongoing important infrastructure project site visits for current students.
2. The consortium has several teams competing in the ASCE Concrete Canoe competitions.
3. PacTrans will be hosting a group of visiting students from Tongji University in China in August.
4. PacTrans will be welcoming its new PacTrans fellows.

Workforce Development

The two main focuses for the center over this next reporting period will be guest lecturers and continuing the development of the continuing education, workforce development, and training platform outlined above for state and local DOTs. PacTrans is currently in the process of identifying and scheduling spring, summer, and fall guest lecturers. Further, the center has a number of meetings on the books with WSDOT to continue discussing state and local DOT needs with regard to continued training. The Center will also begin organizing this year's Regional Transportation Conference to be held in mid-October.

Outreach

The center will continue sending faculty and student researchers to seminars, workshops, and conferences to further goal of making PacTrans and its research more visible to practitioners, decisions makers, students, educators and others in the transportation sector. For example, PacTrans director Dr. Yinhai Wang has been invited to speak at the 2016 Gigabit City Summit in Kansas City on May 16 – 18, 2016. Further, PacTrans has just begun a comprehensive overhaul of its website. This is an effort to make the user experience more fluid and enjoyable, navigation more coherent, and the information found therein more robust. The center hopes to have the entire update completed within this next reporting period.

Collaboration

PacTrans has a number of exciting opportunities in the works for collaboration. For example, new PacTrans external advisory board member Frank Breust is the Vice President of Government and External Affairs at BMW. BMW just launched its new carsharing program in the City of Seattle. PacTrans

will be meeting with Mr. Breust in the coming months to discuss how a partnership could leverage the academic rigor of the center to do some innovative things with data collection and analytics.

2. Products (for the reporting period of October 1, 2015 – March 31, 2016)

	Total	UW	WSU	UI	OSU	UAF
Publications: peer reviewed journal articles	**128**	70	15	3	39	1
Publications: Book chapters and other edited manuscripts	**10**	7	1	0	2	0
Conference papers	**53**	23	5	3	14	8
Conference presentations	**111**	61	13	2	27	8
Lectures/Seminars /Workshops/ Invited Talks	**59**	51	2	1	2	3
Technologies or Techniques	**5**	0	0	0	0	5
Inventions, patent applications, and/or licenses	**2**	2	0	0	0	0
Websites or Other Internet Sites	**12**	9	0	0	2	1
Other products: data or databases, physical collections, audio or video products, software or NetWare, models, educational aids or curricula, instruments, or equipment	**27**	15	0	0	7	5

- **Examples of peer reviewed journal articles**

Chen, C; Ma, J.; Susilo, Y.; Liu, Y.; and Wang*, M. (2016). The promises of big data and small data for travel behavior (aka human mobility) analysis. Transportation Research Part C (in press).

Gonzalez-Feliu, J. A. Goodchild, and D. Guerrero (2016). Data-Driven Innovations in Policy-Oriented Freight Transportation Models and Planning Methods. 16 (1), pp.1-3.

Kaminsky, J. (2016). Cultured Construction: Global Evidence of the Impact of National Values on Renewable Electricity Infrastructure Choice. Environmental Science & Technology, 50 (4), 2108–2116. DOI: 10.102 1/acs.est.5b05756.

Stephen, M., Berg, L., Lehman, D., and Roeder, C. (2016). Seismic CFST Column-to-Precast Cap Beam Connections for Accelerated Bridge Construction. ASCE Journal of Structural Engineering, In Press. DOI: 10.1061/(ASCE)ST.1943-541X.0001505.

Wadud, Z., MacKenzie, D., & Leiby, P. (2016). Help or hindrance? The travel, energy and carbon impacts of highly automated vehicles. Transportation Research Part A: Policy and Practice 86, pp. 1-18.

Yu, H.1 & MacKenzie, D. (2016). Modeling Charging Choices of Small-Battery Plug-in Hybrid Electric Vehicle Drivers Using Instrumented Vehicle Data. Transportation Research Record: Journal of the Transportation Research Board. (accepted)

Wygonik, E., A. Bassok 2, E. McCormack, A. Goodchild, and D. Carlson. (2016). Forecasting Tools for Analyzing Urban Land use Patterns and Truck Movement: A Case Study and Discussion, Transportation Research Record. accepted for publication.

Ma, X., W. Yong, E. McCormack, and Y. Wang. (2016). Understanding Freight Trip Chaining Behavior Using Spatial Data Mining Approach with GPS Data, Transportation Research Record. accepted for publication.

Thonstad, T., Foan, A. and Stanton, J.F. (2015). How to Put Light Rail on a Floating Bridge: Experimental Evaluation of a Novel Approach. Accepted by Transportation Research Record.

Tang, Jinjun, Han Jiang, Zhibin Li, Meng Li, Fang Liu, and Yinhai Wang. (2016). A Two-layer Model for Taxi Customer Searching Behaviors using GPS Trajectory Data. IEEE Transactions on Intelligent Transportation Systems. In Press.

Hua, Xuedong Hua, Wei Wang, Yinhai Wang, Ziyuan Pu. (2016). Optimizing Phase Compression for Transit Signal Priority at Isolated Intersections. Transport. In Press.

Hua, Xuedong Hua, Wei Wang, Yinhai Wang, Min Ren. (2016). Bus Arrival Time Prediction Using Mixed Multi-Route Arrival Time Data at Previous Stop. Transport. In Press.

Ma, Xiaolei,Yong Wang, Edward McCormack, and Yinhai Wang. (2016). Understanding Freight Trip Chaining Behavior Using Spatial Data Mining Approach with GPS Data. In Press. Transportation Research Record.

Li, Meng, Xiqun Chen, Xi Lin, Dingyuan Xu, and Yinhai Wang. (2016). Connected Vehicle based Dynamic All-Red Extension for Adaptive Signalized Intersections. Journal of Intelligent Transportation Systems. In Press.

Dunlap, Matthew, Zhibin Li, Kristian Henrickson, and Yinhai Wang. (2016). Estimation of Origin and Destination Information from Bluetooth and Wi-Fi Sensing for Transit. In Press. Transportation Research Record.

Wang, Yong, Xiaolei Ma, Yong Liu, Ke Gong, Maozeng Xu, and Yinhai Wang. (2016). A Two-Stage Algorithm for Origin-Destination Matrices Estimation Considering Dynamic Dispersion Parameter for Route Choice. PLOS ONE, Jan. 2016, 11(1).http://dx.doi.org/10.1371/journal.pone.0146850

Lin, Dianchao, Wangjing Ma, Li Li, and Yinhai Wang. (2016). A Driving Force Model for Non-Strict Priority crossing Behaviors of Right-Turn Drivers. Transportation Research Part B. Vol. 83: 230-244. 2016. http://dx.doi.org/10.1016/j.trb.2015.10.007

Jiang, Han, Yajie Zou, Shen Zhang, Jinjun Tang, and Yinhai Wang. (2016). Short-term speed prediction using remote microwave sensor data: machine learning versus statistical model.” Mathematical Problems in Engineering, 2016. http://dx.doi.org/10.1155/2016/9236156

Tang, Jinjun, Fang Liu, Weibin Zhang, Shen Zhang, and Yinhai Wang. (2016). Exploring Dynamic Property of Traffic Flow Time Series in Multi-State Based on Complex Networks: Phase Space Reconstruction versus Visibility Graph. Physica A, 15(5), 635-648, 2016. http://dx.doi.org/10.1016/j.physa.2016.01.012

Tang, Jinjun, Shen Zhang, Yajie Zou, John Ash, Fang Liu, and Yinhai Wang. (2016). Travel Time Estimation Using Freeway Point Detector Data Based on Evolving Fuzzy Neural Inference System. PLOS ONE, Feb. 2016. http://dx.doi.org/10.1371/journal.pone.0147263

Wang, Zhongyu, Bing Wu, and Yinhai Wang. (2016). Comparison of Delay Estimation Models for Signalized Intersections Using Field Observations in Shanghai. IET Journal of Intelligent Transportation Systems. 10(3), 165-174, 2016.http://dx.doi.org/10.1049/iet-its.2014.0280.

Xu, Guangning, Yunteng Lao, Xiaoyue (Cathy) Liu, Yinhai Wang, and Shi An. (2016). Simulation-Based Tolling Evaluation for Traffic Network through Customized Route Choice Module. Journal of Transportation Engineering. 142(2), 2016. http://dx.doi.org/10.1061/(ASCE)TE.1943-5436.0000808

Zou, Yajie, Kristian Henrickson, Dominique Lord, Yinhai Wang, and Kun Xu. (2016). Application of Finite Mixture Models for Analyzing Freeway Incident Clearance Time. Transportmetrica A. 12(2), 99-115, 2016. http://dx.doi.org/10.1080/23249935.2015.1102173

Wang, Jiangfeng, Yinhai Wang, Chaofan Bi, Jinxian Weng, and Xuedong Yan. (2016). Modeling the Probability of Freeway Lane-Changing Collision Occurrence Considering Inter-Vehicle Interaction. Traffic Injury Prevention. Vol. 17(2), 181-187, 2016. http://dx.doi.org/10.1080/15389588.2015.1050721

Chen, Xiaofeng, Kristian Henrickson, and Yinhai Wang. (2016). Kinect-based Pedestrian Detection for Crowded Scenes. Computer-Aided Civil and Infrastructure Engineering. Vol. 31(3), 229-240. 2015. http://dx.doi.org/10.1111/mice.12163

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

Yeh, H., Barbosa, A.R., and Mason, B. (2015). Tsunamis Effects in Man-Made Environment. Book chapter, Pages 1-27, Encyclopedia of Complexity and Systems Science, Editor: Meyers, A.R., Springer Berlin Heidelberg ISBN: 978-3-642-27737-5, 10.1007/978-3-642-27737-5_623-1

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

Haselbach, L. (2016). Invited Participant: Sustainability Summit Engineers in Partnerships Creating a Sustainable World, A Summit Convened by the American Society of Civil Engineers Dulles Hyatt January 7 -9, 2016, Herndon, VA

Haselbach, L.: IBRACON. (2015). Keynote Speaker at the 57th Congresso Brasiliero do Concreto, October 28 – 30, 2015, Bonito, Brazil.

Davidson, C., Allenby, B., Haselbach, L., Heller, M. and Kelly, W. (2016). Educational materials on sustainable engineering: Do we need a repository? Elementa: Science of the Anthropocene: accepted

Langfitt, Q. and Haselbach, L. (2016). Coupled oil analysis trending and life cycle cost analysis for vessel oil change interval decisions, JMET Journal of Marine Engineering and Technology, Taylor and Francis Online, DOI 10.1080/20464177.2015.1126468.

Lowry, M., (with Hadden-Loh, T. and Valenzuela, A.) (2016). Improving low-stress bicycle access to schools through network connectivity analysis. Presented at the 5th Safe Routes to School National Conference, Columbus, Ohio.

Ahmad Hazem A.A. Hammad, Tao Xing, Ahmed Abdel-Rahim. (2016). Aerodynamic Effects on Two-Lane Rural Highway Safety. 2016 Idaho Academy of Science & Engineering Symposium, April 1 2016, Pocatello, Idaho, USA.

Drescher, Goodchild, McCormack. (2016). A Description of Fatal Bicycle Truck Accidents in the United States: 2000 to 2010. Annual Meeting of the Transportation Research Board, Washington DC.

Ge, Y., MacKenzie, D., & Keith, D. (2016). Role of Gas Anxiety in Charging Choices of Plug-in Hybrid Electric Vehicle Drivers. Transportation Research Board 95th Annual Meeting, Washington, DC, January 2016.

Ma, Xiaolei, Yong Wang, Edward McCormack, and Yinhai Wang. (2016). Understanding Freight Trip Chaining Behavior Using Spatial Data Mining Approach with GPS Data. Presented by Xiaolei Maat the 95thAnnual Meeting of Transportation Research Board, Jan. 2016.

McCormack, E., Saravanya S. Sankarakumaraswamy, M. Hallenbeck and A. Goodchild. (2015). Analysis of NPMRDS Data for Estimating Freight Transportation Performance Measures. 6th METRANS National Urban Freight Long Beach, California, October 20-23, 2015.

Stanton, J. F. (2015). An Innovative Bridge System designed for Rapid Construction and Superior Seismic Performance". Session: Innovative Bridge Systems, ACI Fall Convention, Denver.

Ma, Xiaolei, Yong Wang, Edward McCormack, and Yinhai Wang. (2016). Understanding Freight Trip Chaining Behavior Using Spatial Data Mining Approach with GPS Data. Presented by Xiaolei Maat the 95thAnnual Meeting of Transportation Research Board, Jan. 2016.

Qiujie Yang, Xianmin Song, Zhaowei Qu, Pengfei Tao, and Yinhai Wang, Huanfeng Liu. (2016). Study on Pedestrian Arrival and Release Characteristics and Their Application in Signalized Crosswalk. Presented by Qiujie Yangat the 95thAnnual Meeting of Transportation Research Board, Jan. 2016.

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- **Examples of technologies or techniques**
  1. Drones, Lidar, Change Detection
  2. Developed low cost RWIS prototype
  3. Roadway simulation of Turn again Arm, project on Lane Departure Crashes

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.
- 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.
- Cole Kopca is PacTrans new Communications Manager. He devotes 100 percent of his 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 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 continues to support 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.
- In October we hosted our second annual Regional Transportation Conference where over one hundred and eighty professionals from all across the transportation sector gathered to share, learn, train, and collaborate on issues surrounding safety in transportation.
- 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?**

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 Regional Transportation Conference as well as the Region 10 Student Transportation Conference.

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 is developing 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 offers a great test platform for a variety of transportation safety solutions.

Professor David Hurwitz has been exploring the causality of the “right hook crash,” where drivers making a right turn over a bike lane collide with cyclists continuing straight in their lane. These researchers at Oregon State University are using state of the art driving simulators with retinal videoing to identify how drivers interact with intersections with a variety of different programming methods.

- **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 Regional Transportation Conference, PacTrans offered researchers a valuable opportunity to share findings and technologies with the practitioners and educators in attendance. Additionally, as stated above, once the first cycle of reports have been completed, PacTrans will be making a call for Success Stories to provide additional funding to those projects deemed exceptional. Furthermore, PacTrans has conducted several technology transfer events with regional partners, e.g. the technical tour at the ITS America’s Seattle Symposium, a

demonstration desk at the 2015 IEEE Smart Cities Conference (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?**

Our STAR Lab developed Digital Roadway Interactive Visualization and Evaluation Network, or DRIVE Net, will offer users a power data gathering and analytics platform that will allow transportation professionals the ability to perform a multitude of complex tasks that provide practical information to decision makers.

The "right hook crash causality" research that was described above offers invaluable insight into the causes of one of the most common multimodal traffic incidents keeping our regions cities from reaching their Vision Zero goals. Knowledge about why incidents happen allows traffic engineers the ability to implement the proper adjustments.

PacTrans researchers actively participated in a variety of 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