Program Progress Performance Report for University Transportation Centers

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

OST-R Sponsor Award Number: 69A355174110

Project title: **Pacific Northwest Transportation Consortium (PacTrans): Providing Data-Driven Solutions for the Diverse Mobility Challenges of the Pacific Northwest**

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

Submitting Official:
Cole Kopca
Assistant Director
E-mail: ckopca@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

Submission Date: October 30, 2018
DUNS: 605799469 **EIN:** 91-6001537
Report #3, PPPR reporting for six months (April 1, 2018 – September 30, 2018)

Project/Grant Period: November 30, 2016 - September 30, 2020
Reporting Period End Date: September 30, 2018
Report Term: Semi-Annual

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, Sustainable Solutions for the Diverse Transportation Needs of the Pacific Northwest". PacTrans serves as a focal point within Region 10 to develop initiatives and facilitate collaborative activities with regional partners to maximize the effectiveness of their collective services and programs toward the 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 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, other transportation professionals, and the general public.

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, mentoring, and scholarship opportunities for our students and future workforce trainees.

Workforce Development – PacTrans endeavors to be a workforce development base: hosting activities that focus on the development of transportation professionals, building strong partnerships with transportation agencies and companies in our region, and designing training programs to address the workforce development needs, while 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 and agency 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 period from April 1, 2018 – September 30, 2018, PacTrans was actively engaged in each goal and objective 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, and typically have a larger budget. Such projects include multi-institutional general research projects, as well as a multi-institutional educational project, and a multi-institutional outreach project. We also engage in single institutional projects (referred to as small research projects) that only require participation from a single consortium university and typically have smaller budgets. Both categories of research are geared towards the goal of advancing the region's transportation research.

PacTrans endeavors to begin research performance periods in coordination with the academic school year. This year we were successful in have funds distributed to our consortium partners and to our own PIs here at UW by the start of each university's school year for year 2 (2018 – 2020) projects. As usual we funded a multi-institutional education project (stage 2 of the education project funded last year), and multi-institutional outreach project (stage 2 of the outreach project funded last year), and three additional multi-institutional projects that were solicited through our RFP process. We also added fifteen new single-institution (small) projects to the sixteen we funded last year. Please visit PacTrans website for details of these new projects: http://depts.washington.edu/pactrans/research/.

During this reporting period we asked for research project progress reports from all active PIs with year 1 (2017 – 2019) funding, and several of those projects have already wrapped up. For those year 1 (2017 – 2019) projects whose draft technical reports have been submitted, they are currently going through the peer and technical review process and the rest will be due by September 2019.

Technology Transfer

As PacTrans has described in PPPRs for previous grants, one of our main avenues for technology transfer is through identification of success stories. 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 and/or apply their findings in thoughtful and useful ways. After the close of our year 1 research performance period, PacTrans will circulate an RFP asking for submission for these additional dollars.

As part of our recently created technology transfer plan, PacTrans is actively working to establish a formal technology transfer advisory committee. We are in the process now of developing guidelines for that group and their mission and process, and to identify ideal candidate for this committee.

During the reporting period, PacTrans PIs took many opportunities through conference, seminars, and workshops to showcase our accomplishments of the ongoing research projects.

One such example occurred in July of this year. **PacTrans Director, Yinhai Wang, co-chaired the ASCE International Conference on Transportation and Development (ICTD) in Pittsburgh July 15-18, 2018. In total, PacTrans sent twelve faculty and students to the conference to present PacTrans research and meeting with working professionals at the conference for possible tech transfer discussions.** Further,

Dr. Wang initiated a UTC technology transfer workshop with Dr. Laurence Rilett, director of Region 7 UTC at the University of Nebraska Lincoln, where several UTC representatives had the opportunity to present effective methods for impacts and implementations.

In August, PacTrans jointly sponsored a workshop with WSDOT on Commute Trip Reduction in the face of new mobility as a service provision. PacTrans Associate Directors, Jeff Ban and Anne Vernez Moudon, hosted the event with over 50 in attendance. Present were representatives from private industry such as new mobility service providers; public agencies such as transportation management agencies, cities, and public transit authorities; academic researchers, and nonprofits that help with CTR implementation.

Education

During this past six month performance period, PacTrans has been actively engaging students with a wide variety of activities and opportunities to further their education, experience, knowledge, and networks.

One such example occurred in May of this year. **PacTrans sponsored the third annual Transportation Engineering Education Workshop in Auburn, Alabama. The two-day workshop and conference invited transportation engineering faculty to share their best practices with one another, develop activities for their classes, and further build professional relationships.** Forty-five professors and a handful of PhD students were in attendance, as well as Prof. Kevin Chang, a PacTrans PI, from the University of Idaho as the guest speaker, and PacTrans Associate Director from OSU, David Hurwitz.

Dr. Yinhai Wang, director of PacTrans, received ITE Education Council's Innovation in Education Award in 2018 for his dedication to bringing together students and professionals in the transportation realm.

Another great example includes the student competition teams that PacTrans has been supporting over that last several years. The following is a summary of the accomplishments of several of these teams:

1. The PacTrans co-hosted a Fish Industry Transportation Challenge with Norwegian University of Science and Technology and Norwegian Public Road Administration from June through September, 2018. Eleven PacTrans students participated in this event and some of them received innovation awards.
2. The PacTrans sponsored UI Clean Snowmobile team brought home a number of awards from their annual competition including best acceleration, best handling, best value, and CAN-DO-E-Controls.
3. The PacTrans sponsored UW Steel Bridge team earned their first trip to the national competition in over a decade and placed sixteenth overall.

PacTrans consortium partners have also had significant success in recent years with summer research internship programs. Many of these internships are supported by PacTrans PIs and some have PacTrans financial support as well. A few examples include:

1. PacTrans continues its traffic control center intern program and tolling office intern program with WSDOT. These two programs offer approximately 15 opportunities to UW students this summer.

4

Pacific Northwest Transportation Consortium (PacTrans) – UTC for Federal Region 10
Report #3, Program Progress Performance Report (PPPR) for April 1, 2018 – September 30, 2018 reporting period

2. Washington State University has an undergraduate summer research program and many of those student contribute to PacTrans funded research.

Workforce Development

PacTrans had a number activities geared at workforce development during this reporting period. Notably, an ongoing multi-institutional education project titled *Workforce Development Institute*, is an ongoing project to scope the current and future continuing education needs of agencies and private industry in the Pacific Northwest. In the first year of this project, PIs scanned the resources and programs that are currently available nationwide, surveyed transportation professionals across the region about current and future continuing education needs, and began developing a business plan for the institute.

PacTrans hosted a number of great seminars during this reporting period to offer students the opportunity to hear from academic researchers and working professionals from public agencies and the private sector:

1. In May, PacTrans hosted Professor Kari Watkins, Frederick Law Olmsted Associate Professor in the School of Civil and Environmental Engineering at Georgia Tech. Her talk was titled, *OneBusAway: A Ten Year Retrospective*.
2. In May, PacTrans hosted our spring quarterly Regional Transportation Seminar featuring Professor Lily Elefteriadou, Director of the UF Transportation Institute (UFTI) and the Kisinger Campo Professor of Civil and Coastal Engineering at the University of Florida. Her talk was titled, *Traffic Signal Control with Connected and Autonomous Vehicles in the Traffic Stream*.
3. In May, PacTrans hosted Professor Junyi Zhang, from Hiroshima University in Japan. His talk was titled, *Life-oriented Behavioral Research for Urban Policy – A Focus on Mobilities*.
4. In May, Alec Bumgarner and Sayuri Koyamatsu from WSDOT and Chris Workman from Transportation Investment Board delivered guest talks on *transportation engineering practice* to undergraduate students.
5. In September, PacTrans hosted former Director of Transportation Mobility for the City of Denver, Ms. Crissy Franganello to speak at the third annual Michael Kyte Distinguished Lecture at the University of Idaho on *traffic signal systems, highway capacity and transportation engineering education*.

Outreach

One of PacTrans' main focuses with regard to outreach involved promotion of STEM education and Transportation Engineering to our youth and undergraduate students. During this reporting period, several of our consortium partners were actively engaged:

1. In April, the University of Washington hosts an event for elementary- and middle-school age students called Engineering Discovery Days. Here students visit campus and have an opportunity to see and participate in hands on demos for many of the labs that operate in the college of engineering. PacTrans hosts a booth showcasing transportation engineering principles through kids' games.
2. In May, Oregon State University hosts an undergraduate Engineering Expo where students are

5

invited to come all of the possibilities in the world of engineering.

3. Each May, University of Alaska Fairbanks' College of Engineering and Mines hosts an Engineering Week Open House where students are invited to come and tour the engineering facilities and see/participate in hands on demos from many of the labs that exist there.

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

Many of the specific details of these opportunities have been discussed above. More generally, PacTrans provides training and professional development opportunities through multiple channels:

Research: Through the lifespan of this grant, PacTrans annually selected research projects that offered faculty and student researchers funding to conduct cutting edge research in a variety of areas directly tied to the USDOT strategic goals.

Education: PacTrans consortium partners offer a variety of other on-campus and online courses designed for professional development in addition to the regular degree programs. 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. As an example, PacTrans student Elyse O'Callaghan Lewis was selected to attend the 2018 Eno Leaders Development Conference. PacTrans sponsored her to participate in this important education and leadership development event.

Outreach: PacTrans offers training and educational opportunities to K-12 students through its outreach activities. Examples include: UW engineering discovery days, OSU undergraduate engineering expo, and Alaska Summer Research Academy (ASRA), where 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.

Funding assistance: PacTrans has supported 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 competitions, conferences, and seminars such as the Hyperloop competition, ASCE ICTD 2018, the Oregon State University hosted Northwest Transportation Conference, and the Transportation Research Board Annual Meeting. 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 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 offers students training opportunities by partnering with local agencies and private industries. We have internship programs with WSDOT, Seattle DOT, Bellevue Transportation Department, Transpo Group, Zillow, FEHR & PEERS, Parsons Brinckerhoff, Puget Sound Regional Council, ODOT, etc. Additionally, PacTrans also offers intern opportunities for both graduate and undergraduate students to work in university labs to gain hands on experience in transportation.

6

Pacific Northwest Transportation Consortium (PacTrans) – UTC for Federal Region 10
Report #3, Program Progress Performance Report (PPPR) for April 1, 2018 – September 30, 2018 reporting period

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, where 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.

Along those lines, PacTrans recently elected to hire an undergraduate student communications intern. This allows us to be more active and effective on emerging media platforms like social media. It also give practical, real-world experience to a communications student at the University of Washington. Our current intern, Leona Vaughn, has already increased our social media presence by over 500% and allowed us to expand the quantity, quality, and depth of our online website posts.

Another avenue for dissemination that PacTrans leans on heavily is presentations at conferences, workshops, and symposia. Already mentioned in this report was the ASCE ICTD conference where PacTrans had twelve presenters on our work. Each year we send roughly one hundred PIs and students (about 50 students) to the TRB annual meeting where we participate in over 120 committee meetings, poster presentations, workshops, and lecturns. Our annual conference each October also provides an invaluable platform for our researchers to present work either through presentation or poster.

As has been mentioned above PacTrans also encourages new, innovative dissemination materials through the identification of success stories, where PacTrans offers limited additional funds to projects that have results with potentially strong impacts. These funds can then be used to explore new and innovative opportunities to get knowledge, methods, and products gained, into the hands of practitioners. This year these funds have been used to host workshops/training, produce informational videos, build online tools and procedure manuals, etc.

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

During this next reporting period PacTrans will continue to monitor all year 1 (2017 – 2019) and year 2

7

Pacific Northwest Transportation Consortium (PacTrans) – UTC for Federal Region 10
Report #3, Program Progress Performance Report (PPPR) for April 1, 2018 – September 30, 2018 reporting period

(2018 – 2020) projects. PacTrans will also be releasing our Request for Proposals for year 3 (2019 – 2021) project submissions. This will likely go out in November and those proposals will be put through the PacTrans research proposal selection process which includes review from the board, confirming that the subject of each proposal matches both our center's focus and the criteria of the RFP, and then peer review, seeking input from subject matter experts on the actual content of the proposals. Selection for year 3 (2019 – 2021) projects will likely occur around the end of this next reporting period.

Technology Transfer

PacTrans will likely not put out a request for success story proposals for another year or two as it requires that a large enough pool of our funded projects are wrapping up or completed. That said we will certainly continue to disseminate research results to all of the other outlets that we have always used.

During this next reporting period, PacTrans has several great opportunities for technology transfer. Two such examples are the PacTrans Region 10 Transportation Conference and the TRB Annual Meeting:

The PacTrans Region 10 Transportation Conference is held each October. This event attracts hundreds transportation professionals from public agencies, private industry, and academia each year. During the event, researchers have the option to present their work during moderated technical sessions or poster sessions.

The TRB Annual Meeting has always been one of the most influential opportunities for our researchers to disseminate their work. As mentioned previously, each year we send roughly one hundred PIs and students (about 50 students) to the TRB annual meeting where we participate in over 120 committee meetings, poster presentations, workshops, and lecturns.

Education

During this next reporting period PacTrans will be very busy with education endeavors. Each consortium partner receives some money each year for education and outreach activities. Those funds are at the discretion of the Associate Director (PI of the subaward) from each of the partner institutions. Those funds tend to be used to support the following:
1. Several members of the PacTrans consortium have partnered with their civil engineering departments to facilitate PacTrans fellowships. These programs vary in their scope but generally consist of tuition funding for the best and brightest candidates to our graduate programs. At UW for example, this fellowship is geared toward professional development with internships built into the curriculum. At OSU, these students tend to lean more toward the research side of the graduate studies.
2. We support professional organization student chapters, such as the Institute of Transportation Engineers, and student competition teams, such UI's clean snowmobile team, and UW's Hyperloop team.
3. Some of these funds are historically used to support the travel of students to conferences such as the Regional Transportation Conference and the TRB Annual Meeting to present their work.

PacTrans will also support students during this upcoming reporting period with several student award opportunities. We will facilitate election processes for the UTC Outstanding Student of the Year Award as well as the Region 10 Michael Kyte Outstanding Student of the Year Award.

8

Workforce Development

PacTrans has a few important focuses for workforce development over this next reporting period:

1. The center will continue working with agency and academic partners to develop the PacTrans Workforce Development Institute. This includes analysis of survey results on workforce needs around the Pacific Northwest, as well as development of an administrative structure, business plan, and at least two courses.
2. We will host both the Fall and Winter quarter Regional Transportation Seminars. The first will be in October and feature Professor Ram Pendyala, Professor and Interim Director, School of Sustainable Engineering and the Built Environment Director, TOMNET University Transportation Center at Arizona State University.

Outreach

The majority of opportunities for PacTrans consortium partners to engage in outreach activities geared toward younger students occur in the spring, however, during this upcoming reporting period PacTrans will focus heavily on outreach to prospective and potential partners.

One good example is the University of Washington Transportation Services Office. We have recently been in communication with them about potential collaboration opportunities. Currently we are working with them to identify ways that our PIs can leverage the UW campus for research purposes. This has synergistic benefits as UW Transportation Services has the opportunity to leverage researcher support, implementing new technologies and analytical methods, PacTrans researchers have the opportunity to test those same new technologies and analytical methods, and the University continues moving toward its goal of becoming a living laboratory for learning and innovation. The STAR Lab, directed by PacTrans Director, Yinhai Wang, will be looking into installing our new smart road stickers on several parking lots around campus to better analyze current parking situations and trends.

9

Pacific Northwest Transportation Consortium (PacTrans) – UTC for Federal Region 10
Report #3, Program Progress Performance Report (PPPR) for April 1, 2018 – September 30, 2018 reporting period

Products (reporting period: April 1, 2018 – September 30, 2018)

	Total	UW	WSU	UI	OSU	UAF	GU	BSU
Publications: peer reviewed journal articles	**69**	27	9	8	25	0	0	0
Publications: Book chapters and other edited manuscripts	**4**	3	0	0	1	0	0	0
Conference papers	**52**	16	3	12	17	1	3	0
Conference presentations	**77**	29	4	18	24	2	1	0
Lectures/Seminars /Workshops/ Invited Talks	**48**	25	8	6	7	2	0	0
Technologies or Techniques	**19**	5	1	7	4	2	0	0
Inventions, patent applications, and/or licenses	**0**	0	0	0	0	0	0	0
Websites or Other Internet Sites	**15**	10	0	0	4	1	0	0
Other products: data or databases, physical collections, audio or video products, software or NetWare, models, educational aids or curricula, instruments, or equipment	**32**	15	0	1	14	2	0	0

Examples of peer reviewed journal articles

Maalej, Yassine, Abdel-Rahim Ahmed, Guizani, Mohsen and Sorour, Sameh. "Tracking 3D LIDAR Point Clouds Using Extended Kalman Filters in KITTI Driving Sequences" Accepted for presentation at the IEEE Globecom2018 GCSN and for publication in its proceedings

Maalej, Yassine, Sorour, Sameh, Abdel-Rahim, Ahmed and Guizani. Mohsen. "VANETs Meet Autonomous Vehicles: Multimodal Surrounding Recognition using Manifold Alignment." IEEE Access (2018).

Ammous, Mustafa, Belakaria, Syrine, Sorour, Sameh and Abdel-Rahim, Ahmed. "Optimal Cloud-Based Routing With In-Route Charging of Mobility-on-Demand Electric Vehicles." IEEE Transactions on Intelligent Transportation Systems (2018)

Mohebifard R., Islam, S., and Hajbabaie, A. "Cooperative traffic signal and perimeter control in semi-connected urban-street networks." Transportation Research Part C: Emerging Technologies.

Islam S. and Hajbabaie, A. "A Two-Stage Model for Predicting Crash Frequency by Severity Type." Accident Analysis and Prevention.

Abadi, M. G., Hurwitz, D., & Macuga, K. (in 2nd review) "Towards Safer Bicyclist Responses to the Presence of Truck Near an Urban Loading Zone," Journal of Safety Research.

Abadi, M.G., Hurwitz, D., Sheth, M., McCormack, E., & Goodchild, A. (In 2nd review) "Factors Impacting Bicyclist Safety in Proximity to Commercial Vehicle Loading Zones: Application of a Bicycling Simulator," Accident, Analysis, & Prevention.

Chen, Peng & Shen, Qing. 2018. "Identify high-risk built environments for severe bicycling injuries." Revised and resubmitted to Journal of Safety Research.

Al-Bdairi, N.S.S., Anderson, J.C., Hernandez, S., Jessup, E.L., (2018). "Lane-Changing Behavior and the Opinions of Drivers of Large Trucks in the Pacific Northwest: A Multivariate Probit Analysis." IATSS (Under Review)

Claveria, J., Hernandez, S., Anderson, J.C., Jessup, E.L., (2018). "Understanding Truck Driver Behavior with Respect to Cell Phone Use and Vehicle Operation." Transportation Research Part F: Traffic Psychology and Behavior (Under Review)

Rodin, HR III, Nassiri, S., Yakkelar, M., Alshareedah, O., and Haselbach, L. "Evaluation of Frictional Properties of Pervious Concrete Slabs under Various Winter Conditions for Driver and Pedestrian Users", in American Society of Civil Engineers: Journal of Transportation Engineering, Part B: Pavements.

Example of book chapters and other edited manuscripts

Wang, Yinhai and Zeng, Ziqiang. Data-Driven Transportation Science: Methodologies and Applications. In Press. Elsevier. April 2018.

Siddique, N., Ban, X., 2018. Spectral analysis method for vehicle trajectory data, Submitted to the 23rd International Symposium on Transportation and Traffic Theory (ISTTT), 2nd revision.

Examples of conference papers and presentations

Belz, N.P., Sorensen, C. (July 2018). Use of Non-Motorized and "Off-Highway" Transportation Modes in Alaska, 15th International Conference on Travel Behavior Research, Santa Barbara, CA.

Ammous, M., Belakaria, S., Sorour, S., and Abdel-Rahim, A. "Optimal Local and In-Route Charging Management of Electric Mobility-On-Demand Systems," in Proc. of IEEE Vehicular Technology Conference (VTC'18- Fall), Chicago, IL, USA, September 2018.

Belakaria, S., Ammous, M., Sorour, S., and Abdel-Rahim, A. "Optimal Vehicle Dimensioning for Multi-Class Autonomous Electric Mobility On-Demand Systems," in Proc. of IEEE International Conference on Communications (ICC'18) - IEEE International Workshop on Communication, Computing, and Networking in Cyber Physical Systems, Kansas City, MO, USA, May 2018.

Ammous, M., Belakaria, S., Sorour, S. and Abdel-Rahim, A. "Joint Delay and Cost Optimization for Electric On-Demand Vehicles with In-Route Charging," in Proc. of IEEE International Conference on Communications (ICC'18), Kansas City, MO, USA, May 2018.

Chang, K. and Warmbrodt, S. (2018). "Crash Reporting in the Pacific Northwest: An Assessment Utilizing Law Enforcement Narratives," ITE Intermountain Section Meeting; Jackson, WY.

Chen, Xi, Ma, Xiaolei and Wang, Yinhai. "A Data-Driven Customized Bus Line Design Model based on Multi-Source Data." Proceedings of the 2018 ASCE International Conference on Transportation and Development. July 15-18, 2018, Pittsburgh, PA.

Zeng, Ziqiang, Chen, Huimiao and Wang, Yinhai. "A Framework of a V2X Communication System with Novel Technologies for Enhancing Vehicle and Pedestrian Safety." 2018 ASCE International Conference on Transportation and Development, Pittsburgh, PA, July 15-18, 2018.

Ash, John, Liang, Yunyi, Zeng, Ziqiang, Wang, Yinhai and Bailey,Ted. "Freeway Traffic Safety and Efficiency Enhancement through Adaptive Roadway Lighting and Control Enabled by Connected Sensor and Infrastructure Networks." 2018 ASCE International Conference on Transportation and Development, Pittsburgh, PA, July 15-18, 2018.

Siddique, C., Ban, X., 2018. "Self-adaptive sampling of GPS data." Presented at the 97th Annual Meeting of Transportation Research Board, Washington, DC.

Mostafizi, Alireza, Siam, Mohammad Rayeedul Kalam & Wang, Haizhong. "Autonomous Vehicle Routing Optimization in a Competitive Environment: A Reinforcement Learning Application." Accepted by ASCE International Conference on Transportation & Development, Pittsburgh, PA. July 15-18, 2018.

Example of lectures/seminars/workshops/invited talks

Abdel-Rahim, Ahmed "Connected Vehicle Deployment in Ada County, Idaho: Lessons Learned", Idaho Transportation Department Traffic Working Group, July 2018.

Abdel-Rahim, Ahmed "From Smart Cities to Connected Vehicles, Are We Ready for Connected Infrastructure?" Syracuse University Symposium, May 2018

Abdel-Rahim, Ahmed "Permissive Left-Turn Movement at Signalized Intersection Approaches - Redefining the High-Risk Groups", ITE meeting, Boise, Idaho, June 2018.

Goodchild, Anne Alliance for Logistics Innovation through Collaboration in Europe, "The Delivery Economy Changes Everything: New Requirements for Urban Freight Research" (9/18)

11

Pacific Northwest Transportation Consortium (PacTrans) – UTC for Federal Region 10
Report #3, Program Progress Performance Report (PPPR) for April 1, 2018 – September 30, 2018 reporting period

Goodchild, Anne, United States-European Commission Urban Freight Twinning Initiative, "Impacts of E-Commerce Panel" (9/18)

Assessing Slope Instability using Lidar, Colorado School of Mines, March 3, 2018.

Parrish, C., Slocum, R., and Simpson, C. 2018. UAS in Transportation Expo Final Report. Available http://depts.washington.edu/pactrans/wp-content/uploads/2018/09/UAS-in-Transportation-Report.pdf

Akin, Michelle (2018) "Fantastic Elastic Wind-Up Cars" Workshop at First Annual Palouse STEAM Summit, August 21, Pullman, WA.

Environmental & Ecological Engineering. "Environment, Economy, and Equity: Evidence on the Sustainability of Emerging Transportation Technologies." Purdue University. West Lafayette, IN. June 29, 2018.

"IoT and Edge Enabled Technologies for Smart Networks and Cities," University of Ottawa, Ottawa, ON, Canada, July 2018.

"IoT and Edge Enabled Technologies for Smart Networks and Cities," Queen's University, Kingston, ON, Canada, July 2018.

Technologies or Techniques

GIS-Based Traffic Data Collection Tool:
> https://uidaho.maps.arcgis.com/apps/CrowdsourceReporter/index.html?appid=a0d9806557c8458691cf0185ba71e018

Field collection and automated counting of OHVs using video data, Belz N.P. and Sayre, T. (2018)

Spectral Library of Road Salt and related chemicals, Belz, N.P. and Fulton, G. (2018)

Convolutional Vehicle Detection from Airborne LiDAR Scans of Traffic Corridors

Optimal Vehicle Dimensioning for Multi-Class Autonomous Electric Mobility On-Demand Systems

Optimal Local and In-Route Charging Management of Electric Mobility-On-Demand Systems

Manawadu, Y. Zhou, Z., and Qiao, P. (2018). Effectiveness of Surface-bonded PZT Patch System in the Determination of Wave Modulus of Elasticity (WMoE) of Concrete

Self-Adaptive Sampling (SAS) method of mobile sensing data

Jadon, A., Williams, Z., Kafka, C., Rotta, H., Roy, S. and Lum, C. "Characterization of Wireless

Communication Links for Unmanned Aerial Systems," AIAA SciTech Conference, Kissimmee, FL, Jan. 2018 and associated database http://uavchannel.ee.washington.edu:8080/index/

Louis, J. (2018) "Location and View-Frustum Tracking System of Workers for Safety Applications on Construction Work-zones" Technical Report.

Examples of Data/Database/Video/Software/Educational Aids/Curricula/Equipment

Jung, J., Olsen, M.J., Hurwitz, D., Parrish, C. Sight Object Distance Analysis Tool, learnmobilelidar.com.

2018 datasets were obtained for several sites at Glitter Gulch and Long Lake, Alaska. They have not formally been published.

http://uavchannel.ee.washington.edu:8080/index/

Training videos, Training calculators &Training presentations

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 30 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

12

Pacific Northwest Transportation Consortium (PacTrans) – UTC for Federal Region 10
Report #3, Program Progress Performance Report (PPPR) for April 1, 2018 – September 30, 2018 reporting period

person for management relationships with USDOT Research and Innovative Administration (RITA) and other USDOT organizations.

- PacTrans Associate Director in Research, **Jeff Ban**, Ph.D., Associate Professor of Transportation Engineering in 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, training program development, and educational enhancements among the partner institutions.

- PacTrans Associate Director in Oregon State University (OSU), **David Hurwitz**, 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), **Eric Jessup**, Ph.D., Associate Professor and Transportation Economist in the School of Economic Sciences at Washington State University (WSU), 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, **Cole Kopca**, devoted 90 percent of his time to the day-to-day operations in support of the PacTrans mission. His responsibilities include project management, grant management, events coordination and outreach, and managing the PacTrans operations team.

- PacTrans full-time Program Coordinator, **Melanie Paredes**, devoted 90 percent of her time to the Center's fiscal matters, support with events coordination and outreach and day to day administration.

- **Leona Vaughn**, undergraduate student in the College of Communications at the University of Washington was recently hire to do communications work for PacTrans. She's spends 20 percent of her time on website upkeep and social media networking and posting.

- **Ziqiang Zeng**, 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.

- 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 such as the Region 10 Student Conference.

- 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?

While this iteration of our center is still very young, PacTrans has continuing relationships with many partners that have been cultivated over the years. The table below highlights the many partnerships that PacTrans has built over the duration of the center:

Partner	Type	Fund Match		Serve on EAB	Project Collaborator	Event Collaborator
		Financial	In Kind			
Alaska State Department of Transportation	Government	X		X		
Idaho Transportation Department	Government	X		X		
Oregon State Department of Transportation	Government	X		X		
Washington State Department of Transportation	Government	X		X		
City of Bellingham	Government					
City of Seattle	Government	X				
City of Lynnwood	Government				X	X
City of Bellevue	Government				X	X
City of Everett	Government					X
King County	Government				X	X
Snohomish County	Government					
Pierce County	Government				X	
Sound Transit	Government Agency			X	X	
Washington Traffic Safety Commission	Government Agency					X
Washington State Transportation Insurance Pool	Government Agency	X				X
University of Alaska, Anchorage	Educational Institution		X		X	X
University of Washington Transportation Services	Educational Institution				X	
Washington State Department of Ecology	Government	X				
Puget Sound Regional Council	Government			X		
Washington State Transportation Investment	Government Agency					X

Name	Type					
Board						
American Society of Civil Engineers	Professional Association					X
Institute of Electrical and Electronics Engineers	Professional Association					X
Institute of Transportation Engineers	Professional Association					X
Port of Portland	Government			X		
BMW Group	Private Industry			X		
Western Trailers	Private Industry			X		
Coral Sales Co.	Private Industry	X				
National Institute for Transportation and Communities	University Transportation Center				X	X
Transportation for Livability by Integrating Vehicles and the Environment	University Transportation Center				X	X
Center for Environmentally Sustainable Transportation in Cold Climates	University Transportation Center				X	X
Aichele and Associates	Private Industry				X	
Alstom Grid Inc.	Private Industry				X	
Alta Planning and Design	Private Industry				X	
Battelle	Private Industry				X	X
Cascade Bicycle Club	Non-profit/ Foundation				X	X
Feet First	Non-profit/ Foundation					X
DKS Associates	Private Industry	X				X
Fehr and Peers	Private Industry				X	X
Inrix Inc.	Private Industry				X	
Nokia	Private Industry	X				
Transpo Group	Private Industry	X				X
Intelligent Transportation Systems of Washington	Professional Association					X
Luum	Private Industry				X	X
Kittelson and Associates	Private Industry			X		X

Microsoft	Private Industry				X	X
BlackBerry	Private Industry				X	X
PACCAR, Inc.	Private Industry				X	X
West Salem High School	Educational Institution				X	X

Impact

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

During our year 1 (2017 – 2019) research cycle, PacTrans funded a project titled, *An Airborne Lidar Scanning and Deep Learning System for Real-time Event Extraction and Control Policies in Urban Transportation Networks*. This effort is being led by Oregon State University Associate Professor, Chris Parrish, along with a team researchers from both OSU and the University of Idaho. This project combines new unmanned aircraft system (UAS) and light detection and ranging (Lidar) technology with emerging algorithms in deep learning and convolutional neural networks to automatically monitor traffic networks and detect traffic features of interest. Lidar data will be collected from a UAS at multiple project sites and used to develop and test the processing algorithms and procedures. Guidelines will be developed for operational use of these new technologies by transportation agencies.

While the performance period is not yet over the team has not completed their investigation, significant progress has been made. Two UAS-based Lidar data set have been collected over a portion of the OSU campus, including a parking lot with several parked vehicles. The Lidar data sets were subsequently used by UI project team members in developing and testing the vehicle-detection algorithms. A third Lidar data set was collected with the goal of simulating Lidar data collected by a stationary (hovering) UAS scanning an intersection. These sensors were used to collect 20 minutes of data from three different orientations. Analysis of the data revealed that vehicles were well detected and could be readily tracked in the Lidar scans.

A convolutional object recognition scheme, with adjustable resolution and search size, was implemented to detect vehicles from the Lidar scans. The developed process involves: 1) Reading point clouds from .las files; 2) Cleaning up the data and eliminating repeated points; 3) Preparing scan space and filters with required resolution; and 4) Convolving space with filter(s) and declaring areas with matches above a given threshold as vehicles. The results of this work thus far have been promising. The technical report is due by September of 2019.

This project has already gained significant interest as police department incident response team have already begun utilizing technologies and methods similar to those described above. For example, during the high speed train derailment in Washington State last September, officers sent a drone to the crash

16

site to take images with were then used to create a 3D virtual scene that allowed the clean up to begin days before it otherwise would have. This saved prevented significant economic losses from Interstate 5 being closed and the 3D virtual scene has been a valuable resource in the investigation that preceded the incident.

What is the impact on other disciplines?

Oregon State University Assistant Professor, Yelda Turkan, received PacTrans funds for a year 1 (2017 – 2019) research project investigating Bridge Structural Inspections using Bridge Information Models (BrIM) and Unmanned Aerial Vehicles (UAVs). This research project is developing a novel framework that implements Bridge Information Modeling (BrIM) and Unmanned Aerial Vehicle (UAV) technologies to improve current manual bridge inspection technique. UAVs enable safe and rapid collection of visual bridge inspection data in the form of digital images. BrIM, on the other hand, enables storing all bridge data, including its drawings and 3D models, material specifications, inspection notes, images and others, in a central object-oriented database that can be accessed from both the office and the field.

While the project has not yet been completed, her team has already made significant advancements in their investigation. Dr. Turkan has developed and implemented their framework on an existing bridge in Eugene, OR, which is classified as structurally deficient. The computer vision algorithms implemented enabled detection of cracks (including hairline cracks) automatically. This information was then manually entered into the BIM database (IFC-BIM). Currently they are working on getting feedback from DOTs using web-based surveys. This work has the potential to dramatically change the way much of the bridge inspection is done in our region and across the country.

What is the impact on transportation workforce development?

As reported on in our previous report, PacTrans has been engaged in multi-institutional education project titled, *PacTrans Workforce Development Institute*. The team is comprised of one member from each of our five consortium research members: lead by the University of Washington, Oregon State University, University of Idaho, Washington State University, and the University of Alaska Fairbanks. During the first year phase of this project the group conducted a series of qualitative interviews and surveys.

The interviews, totaling seventeen, were conducted with engineers, managers, and learning coordinators, in each of the four states in our region. The purpose was to assess the access and awareness of current training opportunities, record factors affecting attending trainings, gather urgent training needs, and promote the survey. Current training needs identified included, among others: safety, operations, maintenance, non-motorized, technology, and software.

The survey was responded to by almost two hundred individuals (sixty-three who considered themselves managers, and one hundred and nineteen that considered themselves engineers), again representing all four states in our region. Managers saw the top five training needs included: data storytelling, professional (soft skills), skip tracing/archive research, system operations, and aviation based training; while engineers saw: right of way, GIS training, team building, ADA compliance, and PE exam workshops.

17

Pacific Northwest Transportation Consortium (PacTrans) – UTC for Federal Region 10
Report #3, Program Progress Performance Report (PPPR) for April 1, 2018 – September 30, 2018 reporting period

During the year two phase of this project, the team intends to continue analyzing training needs while exploring qualified courses for integration, begin marketing existing training curriculums, build up a training program and course evaluation system, begin offering trail courses to receive feedback, and then work to improve either the course contents or the format of delivery.

Some of these activities are already underway. For example, PacTrans recently hosted our annual advisory board meetings concurrent with our Regional Transportation Conference. During that meeting we asked each advisory board member (including each of the research managers from each state DOT and five other members representing public agencies and private industry from around our region) to present current workforce development and training needs within their organization. Most of what we heard was data and technology related trainings. There was also significant concern about the amount of institutional knowledge that will soon be leaving the DOTs as a large generation of employees moves into retirement.

What is the impact on technology transfer?

Ada County Highway District (ACHD), the primary agency responsible for operating the Greater Boise Area traffic network is planning to implement vehicle to infrastructure (V2I) technology at 20 intersections as part of the FHWA's SPaT challenge. This past year, PacTrans funded a research project led by University of Idaho Professor, Ahmed Abdel Rahim, titled, *Field Evaluation of V2I Connected Vehicle Deployment in Ada County, Idaho - Validating Communication Architecture and Control Technology Readiness.* The primary objective of the project is to conduct a field evaluation of (V2I) connected vehicle deployment in Ada County, Idaho focusing on validating the communication architecture and control technology readiness for such implementations.

The technical report for this project will be published by September 2019, but Dr. Abdel Rahim's team has done some amazing work here that has already been partially put into practice. He has worked with four traffic controller vendors and Road Side Unit (RSU) and On Board Unit (OBU) vendors to test their equipment in the University of Idaho Lab Setting using a Hardware-in-the-loop model. Two of these vendors installed their equipment at two intersections in Ada County. The other two vendors are expected to install their equipment by the end of October 2018. This objective help accelerate the deployment of V2I technologies at intersections throughout the northwest and the nation.

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

Researchers in the University of Washington's Smart Transportation Applications & Research (STAR) Lab have been developing, over the last several years, a region-wide, web-based transportation decision support system called the Digital Roadway Interactive Visualization and Evaluation Network (DRIVE Net). Under the direction of PacTrans Director, Yinhai Wang, this system adopts digital roadway maps as the base, and provides data layers for integrating and analyzing a variety of data sources. DRIVE Net offers a platform for streamlining transportation analysis and decision making, and serves as a practical tool for visualizing historical observations spatially and temporally.

Perhaps the most powerful thing about this platform is the data that it makes available for analysis. Each day, millions of lines of code are collected from various sources and processed including missing data imputation and quality control and assurance. From this data, the DRIVE Net platform offers students and other researchers a strong venue for developing and testing new methods and techniques for evaluating our regional transportation system. Dr. Wang's team has already automated many challenging analytical tasks in the areas of: highway capacity analysis (LOS, comfort level of drivers), travel time reliability, and safety performance and analysis. Over the years, several dozen graduate students have had the ability to assist in the development of this platform and add more and more functionalities.

What is the impact on society beyond science and technology?

All five PacTrans research partners have been working on a multi-institutional, multi-year, outreach project titled, *Characterization of Underserved Population Perceptions and Mobility Needs in Connected-Vehicle and Smarter City Environments*. Cities across the nation are developing new smart city initiatives to integrate open data with new transportation systems so that people can move more freely in their communities. However, as technological innovation continues to progress at light speed, the country's underserved communities are increasingly left behind. The objective of this PacTrans outreach effort is to better understand and characterize underserved populations perceptions about mobility needs in connected and smarter city environments.

Thus far, the project team accomplished the followings:

1. Developed an interactive presentation to inform and educate the underserved groups about the potential improved mobility opportunities in connected-vehicle and smarter city environments,
2. Finalized the project data collection method using online-GIS platform. The data collection method allows participants from underserved population groups to record and post their mobility challenges, perceptions, and experiences (photo voice, windshield photography and captioned statements and stories) directly into a GIS database,
3. Established collaboration with representatives from three mobility underserved population groups in Idaho: disabled veterans, residents in tribal areas, and mature drives, and
4. Conducted pilot workshops with Native American Students at the University of Idaho

In the coming year they plan to use the data collected from the focus group meetings and the online data collection tool to assemble a quantitative and/or descriptive statistics for mobility challenges that face underserved populations in different areas, utilize citizen analytics tools to collect more data on the perception of underserved population and mobility needs in connected-vehicle and smarter city environments, conduct a second round of focus group discussions with stakeholders to share with them, in the form of visualized multiple narratives, and summary of the findings of the initial data collection activities and address the overlays from multiple capitals perspective. This will lead to an authentic characterization of needs. This project will have a tremendous impact on traditionally underserved populations across our region.

Changes/Problems

NONE.

Special Reporting Requirements

NONE.