



Semi Annual Progress Report for University Transportation Centers

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Technology (OST-R)

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

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Report #5, SAPR reporting for six months (April 1, 2019 – September 30, 2019)

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Reporting Period End Date: September 30, 2019

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 research partners, as well as Boise State University (BSU) and Gonzaga University (GU) as education partners. PacTrans' theme centers on "Developing Data Driven Solutions for the Diverse Mobility Needs of People and Goods in 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 mobility. 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, 2019 – September 30, 2019, 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 mobility research.

PacTrans endeavors to begin research performance periods in coordination with the academic school year. During this reporting period PacTrans completed the RFP and selection process for our year 3 (fiscal year 2019 – 2020) funding cycle and those selected projects commenced at the beginning of this academic year. In total there were three selected multi-institutional projects along with the multi-institutional education and outreach projects, as well as thirteen small projects at the individual consortium partner university level.

During this reporting period we asked for research project progress reports from all active PIs with year 1 (fiscal year 2017 – 2018) and year 2 (fiscal year 2018 – 2019) funding, and most of the year 1 funded two –year projects have already been wrapped up. As draft technical reports are submitted to us we put them through a round of peer review, technical editing review, and an ADA compliance review. Once the PI has made all necessary edits based on those three reviews, we are publishing the final technical report, along with project data and metadata, on our website and various other repositories. Details about the outputs, outcomes, and impacts of these projects will be discussed in the last several sections of this report.

Technology Transfer

During this reporting period, PacTrans has taken significant steps toward strengthening our technology transfer program. Namely, we identified a total of ten practitioners that were invited to join our newly formed technology transfer advisory board (T2AB). On September 5, we convened the inaugural meeting of the T2AB here on the University of Washington campus. This half day meeting was spent introducing our new board members to the UTC program, as well as PacTrans and its activities, mainly focusing on our technology transfer efforts. Moving forward, it is our vision for this board that they help us to continually evolve and strengthen our technology transfer practices, participate in the review of research proposals and success story funding proposals, and help us identify new external partners for developing work with stronger ties to practice.

In September 2019, PacTrans also released an RFP for success story funding. This funding is meant to supplement a PI in an effort to help them move already completed, meaningful research results into practice.

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

- Our director, Yin Hai Wang, was also serving as the president of the ASCE Transportation and Development Institutes president. He had co-chaired their International Conference on Transportation and Development (ICTD) in 2018, and will be co-chairing ICTD 2020 with Washington State Department of Transportation Secretary, Roger Millar. As majority participants of ICTD are practitioners, it is a great venue for technology transfer. Therefore, for the second year in a row, PacTrans PIs and students had a significant presence at ICTD 2019 in Alexandria, Virginia. In total, PacTrans had seven representatives contributing in a variety of ways including: welcome address, moderating plenary sessions, organizing technical break out sessions, presenting in technical break out sessions, and presenting posters. This conference has provided a compelling platform for PacTrans research to be presented to hundreds of attendees over the past several years.
- In April, PacTrans assistant director, Cole Kopca, attended the Mobility Summit of University Transportation Centers hosted by Carnegie Mellon in Washington D.C. to present to the audience about PacTrans and our research portfolio. He also attended the Careers in Transportation Conference hosted by the Conference of Minority Transportation Officials (COMTO) to discuss education and workforce development needs for minority populations.
- In May, PacTrans director, Yin Hai Wang, and assistant director, Cole Kopca, traveled to Washington D.C. to take part in the UTC Spotlight Conference where we had the opportunity to showcase many of our great projects to staffers for both Senators and Congressmen and women. Dr. Wang participate in a panel discussion in the morning and then they both presented a poster in the afternoon session.
- Also, in May, PacTrans PI from the University of Idaho, Kevin Chang, hosted an *Introduction to Variable Speed Limits* webinar sponsored by ASCE Continuing Education.

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.

- In May, PacTrans had the opportunity to support a student lead event called, *Sustainable Transportation: A Conversation with Regional Leaders*. Students from the UW chapters of the American Public Works Association, Institute of Transportation Engineers, and the Planning Student Association organized this event which brought together five regional leaders in transportation to discuss emerging issues surrounding sustainable transportation. This event was attended by over one hundred practitioners and students who then also had the opportunity to network and discuss what they heard.
- Gonzaga University PI and PacTrans representative, Rhonda Young, was awarded the ITE Western District Outstanding Educator of the Year.
- PacTrans welcomed five new PacTrans Fellows at the beginning of this school year; four from the University of Washington and one from Oregon State University. These are high achieving master's students who receive tuition funding from PacTrans in partnership with our respective

departments. While in school, these students must maintain a high grade point average and will all participate in internships to better prepare then for careers after they graduate.

- A team of students from Oregon State University placed in the top three 3 in North America, Enhanced Safety of Vehicles (ESV) Competition, sponsored by USDOT, NHTSA. PacTrans supported the prototype development of an in-vehicle safety system for this competition.
- PacTrans Universities were honored to support two students, one from the University of Washington and one from Oregon State University, who were selected as two of the twenty students to attend the Eno Student Leadership Conference in Washington D.C.
- Oregon State University PacTrans student researcher, Dylan Horne, volunteers at the 2019 World Scout Jamboree that was attended by 42,000 people from 61 countries. While there he taught transportation engineering principals to students seeking merit badges in transportation.

Workforce Development

PacTrans researchers have communicated with local transportation agencies and companies for their training needs. Such needs have been summarized in the PacTrans funded educational research project that leads to the development of PacTrans Workforce Development Institute (WDI). In particular, WSDOT will contract PacTrans WDI to provide training services on several topics in the traffic operations field. This is an important milestone for the new WDI. Additionally, 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. Examples are:

1. In May, PacTrans hosted our quarterly Regional Transportation Seminar, featuring Paul Waddell, Professor of City & Regional Planning at UC Berkeley for a talk titled, *Integrated modeling to address energy impacts of emerging travel modes*.
2. Mr. Daniel Lai, senior ITS engineer at the City of Bellevue and president of ITE Washington, delivered a talk to undergraduate students on transportation career and opportunities at the University of Washington in June.
3. Also in June, PacTrans hosted a local seminar series talk by Scott Le Vine, transportation planner with Transpo Group, for a talk titled, *Modeling Increasing Pressure on the Curbside, and Insights from Popular Music into Whether we've Fallen out of Love with the Car*.
4. In September, University of Idaho hosted their annual Michael Kyte Distinguished Lecture which featured Darcy Bullock - Lyles Family Professor of Civil Engineering at Purdue University and Director of the Joint Transportation Research Program – for a talk titled, *Our Vehicles Know More about our Transportation Infrastructure Than We Do*.

Outreach

PacTrans views outreach in two fundamental ways: (1) the promotion of STEM learning and specifically transportation engineering to high school, middle school, and elementary school students, and (2) developing new partnerships with external entities to better align our research and other activities with the needs of practitioners. During this reporting period, PacTrans was heavily involved in both types of outreach. A few examples include:

- PacTrans staff met with representatives of the Bush School, a K through 12 college preparatory

school in Seattle, to discuss the development of a new three-week intensive course for high school students on contemporary issues surrounding transportation.

- In April, PacTrans Associate Director from University of Alaska Fairbanks helped to facilitate an annual event called Kids2College, which seeks to bring college awareness to students early in their educational careers and foster a community in which more individuals are motivated to pursue a higher education.
- PacTrans staff and fellows hosted a booth at the UW Engineering Discovery Days where middle school and high school students come to campus to explore everything that engineering has to offer.
- PacTrans met with representatives of the Tulalip Tribes here in Western Washington to discuss opportunities for future collaboration and issue that current face their community from a transportation perspective.

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.

Internships: PacTrans regularly posts internship opportunities on our website as a student resource. During this reporting period for example, PacTrans circulated twelve separate announcements for internship opportunities. Further, we regularly work with our external partners to develop internship programs for our students. With the WSDOT for example, we have set up internship opportunities both with their traffic management center and their tolling operations group.

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 Fellowship for Master's level students, PacTrans has recently created the undergraduate student research fellowship where student will identify an adviser to oversee their work on a research project. PacTrans will then provide a small stipend for that student to either purchase materials that are

necessary to conduct the research or to travel to a conference to present the work.

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.

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.

Another avenue for dissemination that PacTrans leans on heavily is presentations at conferences, workshops, and symposia. 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 lecterns. 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.

New to PacTrans upcoming 2019 – 2021 research cycle, each PI will be required to host a seminar/webinar at the conclusion of their project. They were already asked during the proposal period to name invitees to their seminar/webinar which further reinforced the focus on technology transfer from the beginning stages of their research.

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 finish processing and disseminating all year 1 (2017 – 2019) projects. We will also continue to monitor all year 2 (2018 – 2020) and year 3 (2019 – 2021) projects. PacTrans will also be releasing our Request for Proposals for year 4 (2020 – 2022) 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 4 (2020 – 2022) projects will likely occur around the end of this next reporting period.

Technology Transfer

During this next reporting period PacTrans will complete the selection process for the success story funds that were mentioned in the previous section. These projects are slated to begin before the end of the year and PIs will have six months to finish the proposed activities.

Also 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 lecterns.

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 activities such as the following:

1. 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. Most of these teams have regional and national competitions during the spring.
2. 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.

We will also host the 2019 Region 10 Student Conference in October where students will have the opportunity to learn from practitioners, ask questions of a recent graduate panel, compete in a poster competition, and network with their student colleagues.

Workforce Development

PacTrans will continue to build its WDI so that Region 10 will have an open platform to address the workforce development needs in the Pacific Northwest. Through the past two years of research, we have built a good understanding of the workforce needs. PacTrans will continue its research on how to address these needs. Additionally, we will start to develop training courses in response to several top priority needs in the coming year. Furthermore, we will finalize the business model for WDI by partnering with consortium universities and the existing workforce development service providers.

We will host both the Fall and Winter quarter Regional Transportation Seminars. The first will be in October and feature Professor Kaan Ozbay, Professor at NYU Tandon School of Engineering and Center for Urban Science and Progress (CUSP). The second will feature Prof. Henry Liu, director of Center for Connected Automated Transportation at the University of Michigan.

To enhance leadership development training, PacTrans will also host a leadership development seminar. Mr. Bob Skinner, former executive director of TRB, has agreed to be the speaker of this seminar.

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 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.
- **Wei Sun**, 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	Government	X		X		

Transportation						
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 Board	Government Agency					X
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
FLIR	Private Industry				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
The Bush School	Educational Institution				X	X

Outputs

	Total	UW	WSU	UI	OSU	UAF	GU	BSU
Publications: peer reviewed journal articles	133	43	33	22	34	1	0	0
Publications: Book chapters and other edited manuscripts	6	2	0	2	2	0	0	0

Conference papers	92	35	3	15	37	0	1	1
Conference presentations	136	54	8	17	52	3	2	0
Lectures/Seminars /Workshops/ Invited Talks	103	55	13	3	29	3	0	0
Policy Papers	12	9	2	0	1	0	0	0
Websites or Other Internet Sites	5	2	1	0	1	1	0	0
New Methodologies, Technologies or Techniques	40	8	11	6	12	3	0	0
Inventions, patent applications, and/or licenses	0	0	0	0	0	0	0	0
Other products: data or databases, physical collections, audio or video products, software or NetWare, models, educational aids or curricula, instruments, or equipment	25	15	2	0	5	3	0	0

As part of the PacTrans’ newly adopted Technology Transfer Plan, we committed to tracking the following output metrics:

(1) Number of publications, presentations, and posters made at conferences or workshops explaining or promoting the research outputs: **during this reporting period PacTrans had a total of 418 such instances reported by our Principal Investigators (refer to the table above and examples highlighted below).**

(2) Number of software tools and technologies made available to practitioners: **during this reporting period PacTrans had a total of 40 such instances reported by our Principal Investigators (refer to the table above and examples highlighted below).**

Examples of peer reviewed journal articles

Hammad, Ahmad, Tao Xing, Ahmed Abdel-Rahim, Vibhav Durgesh, and John C. Crepeau. "Effect of Crosswinds on the Aerodynamics of Two Passenger Cars Crossing Each Other." International Journal of Automotive Technology 20, no. 5 (2019): 997-1008.

Belakaria, Syrine, Mustafa Ammous, Lauren Smith, Sameh Sorour, and Ahmed Abdel-Rahim. "Multi-Class Management with Sub-Class Service for Autonomous Electric Mobility On-Demand Systems." IEEE Transactions on Vehicular Technology 68, no. 7 (2019): 7155-7159.

Belakaria, Syrine, Mustafa Ammous, Sameh Sorour, and Ahmed Abdel-Rahim. "Fog-Based Multi-Class Dispatching and Charging for Autonomous Electric Mobility On-Demand." IEEE Transactions on Intelligent Transportation Systems (2019).

Abadi. M.G, Hurwitz, D. Sheth, M. McCormack, E., and A Goodchild (2019) Factors Impacting Bicyclist Lateral Position and Velocity in Proximity to Commercial Vehicle Loading Zones: Application of a Bicycling Simulator, Accident Analysis and Prevention, 125: 29-39.

Abadi. M.G, Hurwitz, D. Sheth, M. McCormack, E., and A Goodchild (2019) Factors Impacting Bicyclist Lateral Position and Velocity in Proximity to Commercial Vehicle Loading Zones: Application of a Bicycling Simulator, Accident Analysis and Prevention, 125: 29-39.

Xiaojun Li; Kun Zhang; Amirmohammad Bahadori; Balasingam Muhunthan" Modification of Asphalt Materials to Resist Studded Tire Wear on Pavements",ASCE's Journal of Materials in Civil Engineering, Accepted for Publication.

Fleskes, K., & Hurwitz, D. (2019) "Influence of Bicyclist Presence on Driver Performance during Autonomous Vehicle Take-Over Requests," Transportation Research Part F: Traffic Psychology and Behaviour, Volume 64, 495-508

- McCormack, E., Goodchild, A., & Hurwitz, D. (2019) "Developing design guidelines for commercial vehicle envelopes on urban streets," *International Journal of Transport Development and Integration*, Volume 3, Number 2, Pages 132-143.
- Ghodrat Abadi, M., Hurwitz, D., Sheth, M., McCormack, E., & Goodchild, A. (2019) "Factors Impacting Bicyclist Lateral Position and Velocity in Proximity to Commercial Vehicle Loading Zones: Application of a Bicycling Simulator," *Accident, Analysis, & Prevention*, Volume 125, 29-39.
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- Zhou, You, Eric Jessup, Xiaodong Lang. "Improved methodology for benefit estimation of highway pavement projects." *Research in Transportation Economics*, September 2019, In Press
<https://www.sciencedirect.com/science/article/pii/S0739885919302513?via%3Dihub>
- Harith Abdulsattar, Alireza Mostafizi, Mohammad RK Siam, Haizhong Wang. Measuring the impacts of connected vehicles on travel time reliability in a work zone environment: an agent-based approach. *Journal of Intelligent Transportation Systems*, Pages 1-16, 2019.
- Alireza Mostafizi, Haizhong Wang, Dan Cox, Shangjia Dong. An agent-based vertical evacuation model for a near-field tsunami: Choice behavior, logical shelter locations, and life safety. *International Journal of Disaster Risk Reduction*, Volume 34, Pages 467-479, 2019.
- Sun, F., Moudon, A., Shen, Q., Ban, X., Lee, B., 2019. The impact of shared mobility option on demand. Submitted to the *Journal of Transportation Research Record*.
- Chen, P. and Q. Shen. 2019. Identifying High-Risk Built Environments for Severe Bicycling Injuries. *Journal of Safety Research*, Vol. 68, pp. 1-7.
- Claveria, J., Hernandez, S., Anderson, J.C., Jessup, E.L., (2019). Understanding Truck Driver Behavior with Respect to Cell Phone Use and Vehicle Operation. *Transportation Research Part F: Traffic Psychology and Behaviour*, vol 65, pp. 389-401.
- M. Ammous, S. Belakaria, S. Sorour, and A. Abdel-Rahim "Joint Delay and Cost Optimization of In-Route Charging for On-Demand Electric Vehicles," accepted for publication *IEEE Transactions on Intelligent Vehicles*.
- S. Belakaria, M. Ammous, S. Sorour, and A. Abdel-Rahim, "Fog-Based Multi-Class Dispatching and Charging for Autonomous Electric Mobility On-Demand," accepted for publication in *IEEE Transactions on Intelligent Transportation Systems*.

Example of book chapters and other edited manuscripts

- Harith Abdulsattar, Alireza Mostafizi, Mohammad RK Siam, Haizhong Wang. Measuring the impacts of connected vehicles on travel time reliability in a work zone environment: an agent-based approach. *Journal of Intelligent Transportation Systems*, Pages 1-16, 2019.
- Evolution and Role of Autonomous Electric Mobility on Demand (AEMoD) systems in Future Smart Cities (Submitted)
- N. Yamin, S. Belakaria, S. Sorour, and M. Hefaida" Evolution and Role of Autonomous Electric Mobility on Demand (AEMoD) systems in Future Smart Cities", submitted.

Examples of conference papers and presentations

- Shang, L., and Abdel Aziz, A. (2019). "An Investigation of the Contractual Roadway Safety Terms in Transportation PPPs." The 10th International Structural Engineering and Construction Conference, May 20-25, Chicago, Illinois
- Rafael Akio Alves Watanabe, Sameh Sorour, Mohamed Hefaida, and Ahmed Abdel-Rahim, "Towards Real-Time Traffic Monitoring using Airborne LiDAR", *IEEE Wireless Communications and Networking Conference (WCNC 2019)*, Marrakech, Morocco, April 2019.
- Goodchild, A., E. McCormack, M. Sheth, D. Hurwitz "Including All Users: Measuring Commercial Vehicle Envelopes on Urban Streets" *Canadian Transport Research Forum*, Vancouver, British Columbia (May, 2019)
- Jabbari, P.1, Khaloei, M.1, & MacKenzie, D. Estimating potential demand for long-distance electric vehicle travel in Washington State. *TRB Paper No. 19-05264*, Transportation Research Board 98th Annual Meeting. Washington, DC. January, 2019.
- Edward McCormack, Developing Design Guidelines for Commercial Vehicle Envelopes on Urban Street, *Urban Transport Conference*, Aveiro, Portugal June 26th, 2019.
- Lowry, M. (with Furth, P. and Gardner, S.) (2019). "Bike Network Evaluation: Low Stress Bike Accessibility and Connectivity" Presented at the Association of Pedestrian and Bicycle Professionals Conference, Portland, Oregon.

- Pimentel, R. (with Pimentel, D. and Lowry, M.) (2019). "If you provide, will they ride? Motivators and deterrents to bike share use" Presented at the Association of Pedestrian and Bicycle Professionals Conference, Portland, Oregon.
- R. Alves Wantabe, S. Sorour, M. Hefeida, and A. Abdel-Rahim, "Towards Real-Time Traffic Monitoring Using Airborne LiDAR", in proc. of IEEE WCNC' 19, Morocco, April 15-18, 2019.
- Generating Weather Alerts Including High Wind Blowover Hazards Using Pikalert[®] for the Wyoming Connected Vehicle Pilot Project." Presented at the 2019 Annual Meeting of the Transportation Research Board, Washington, D.C., January 2019.
- Pimentel, R., M. Lowry, D. Pimentel, T. Koglin, A. Glazer, G. Moe, M. Knysh, If You Provide, Will They Ride? Motivators and Deterrents to Bike Share (2019). Accepted for APBP Conference, 2019, and PacTrans CSET Regional Conference, 2019. Submitted to TRB for 2020.
- Robins, G., Hernandez, S. "An exploratory study using big data for improved safety and operational efficiency: a New Zealand case study." ITS European Conference, Eindhoven, Netherlands, May 2019
- X. Gao, G. Xing, S. Roy and H. Liu, "Overview of Automotive Radar Test-bed at U. Washington," Proc. Asilomar Conf., Pacific Grove, CA, 2019.
- R. Watanabe, S. Sorour, M. Hefeida, and A. Abdel-Rahim, "Real-time Monitoring of Transportation Corridors using Airborne LiDAR," in Proc. of IEEE Wireless Communications and Networking Conference (WCNC'19), Marrakech, Morocco, April 2019.

Example of lectures/seminars/workshops/invited talks

- Puget Sound Regional Council (PSRC) in Downtown Seattle. PSRC and WSDOT co-sponsored the event. The workshop was moderated by Drs. Anne V Moudon, Jeff Ban and Qing Shen, UW. Presenters included Feiyang Sun and Yiyuan Wang, UW doctoral students; Dr. Mike Lowery (project co-Principal Investigator), U of Idaho. Drs Brian Lee (PSRC) and Michael Wandler (WSDOT) contributed to the discussion with the audience of about 30 transportation professionals. October 11, 2019. PacTrans Annual Conference, session on New Shared Mobility Options and Travel Demand. Session was moderated by Drs. Anne V Moudon and Qing Shen, UW. Presenters included Feiyang Sun and Yiyuan Wang, UW doctoral students; Dr. Mike Lowery, U of Idaho; Charlie Knut of SCOOP carpooling. Drs Jeff Ban (UW), Brian Lee (PSRC) and Michael Wandler (WSDOT) fielded questions from the audience of about 60.
- Keynote Address, 2019 New Student Convocation, Oregon State University, Corvallis, OR, September 24, 2019
- Invited, Transportation Operations and Safety Research at Oregon State University at Tongji University in Shanghai, China, September, 09, 2019
- Invited, Round Table Discussion with Congressman Peter DeFazio, School of Planning, Public Policy and Management at University of Oregon in Eugene, OR, April 22, 2019.
- Alireza Mostafizi, Haizhong Wang, and Shangjia Dong. Understanding the Multimodal Evacuation Behavior for a Near-field Tsunami. Accepted to present at the 98th Transportation Research Board Annual Meeting, Washington D. C., Jan. 2019.
- Haizhong Wang, Rayeedul Kalam Siam, Yong Wang, and Shejun Deng. A Multi-agent Modeling of Human-Like Socially Intelligent Signalized Intersections with Memory and Learning: A Machine Learning Approach. Accepted to present at the 98th Transportation Research Board Annual Meeting, Washington D. C., Jan. 2019.
- Rayeedul Kalam Siam, Changqiao Shao, and Haizhong Wang. An Efficiency-Based Formulation of Freeway Capacity: Analytical Properties and Practical Implications. Accepted to present at the 98th Transportation Research Board Annual Meeting, Washington D.C., Jan. 2019.
- Darrow, M. M., and Daanen, R. P. (2019). "Tears of a Rapper: the science and history behind the art of frozen debris lobe rap videos." Invited presentation, BLM Arctic Interagency Visitor Center (AIVC), July 2019, Coldfoot, Alaska.

Examples of New Methodologies, Technologies or Techniques

- Control the movement of connected and automated vehicles in roundabouts
- Optimize the movement of connected and automated vehicles in signalized intersections with human driven vehicles
- Optimize the location of traffic metering gates and rates in urban street networks
- An end-to-end processing system, implemented in C++, capable of real-time vehicle recognition with processors that can be mounted on unmanned aircraft systems (UAS)

Highway project type classification framework
Highway project type database wireframe
Tangible interface for interacting with traffic simulations
The software "RAMBO" was developed as a technical transfer product from the PacTrans-supported Rockfall Activity Index work.

Tested backpack-mounted LiDAR data acquisition for use in change detection and analysis of landslides in permafrost.
Development of an algorithm to extract and classify complex road markings from mobile lidar data.
Development of a GUI to support the Rockfall Activity Index Code. The GUI was funded by ODOT in another research project; however, much of the initial code has been developed to support PacTrans research.
An independent tool to measure reliability of RSU/OBU communication
Impact detection algorithm for concrete structures

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

Produced a video, "Lidar, Unmanned Aircraft Systems, and Machine Learning for Traffic Network Monitoring," highlighting our PacTrans multi-institution project. The video is currently available on an FTP site and will be added to a project website.

Peters, L. & MacKenzie, D. Seattle bike share survey. Mendeley Data V1 (2019), 10.17632/9zfrh6r4p9.1

A survey of Seattle bike sharing users and potential users was conducted in February - March 2018. Respondents included users of Pronto (222 respondents) and dock-less bike sharing (505 respondents), and potential Seattle bike sharing users who had not yet used any Seattle bike sharing offerings.

GIS data set of rockfall road closures

Developed a short video describing the backpack-mounted LiDAR technique and pros and cons with the method.

www.fdlalaska.org

Two promotional videos were developed for the 2019 PacTrans Conference.

We have also begun the development of a Rockfall Impacts on Mobility database, which catalogs rockfall impacts on highway closures.

We have collected an additional field survey of our sites at Glitter Gulch and Long Lake Alaska. Supplemental surveys (3) have been supported by NSF.

Outcomes

As part of the PacTrans' newly adopted Technology Transfer Plan, we committed to tracking the following output metrics:

- (1) Number of early adopters of our research outputs: **during this reporting period we have had 4 such instances reported by our Principal Investigators (please see text below for further description).**
- (2) Changes made to the transportation system, or its regulatory, legislative, practice manuals, design standards, or policy frameworks: **during this reporting period we had 0 such instances reported by our Principal Investigators.**

In past reports, PacTrans has discussed a funded project titled, *Final 50 Feet of the Urban Goods Delivery System: Pilot Testing an Innovative Improvement Strategy*, as well supplemental success story funding for several extensions of this Common Carrier Locker system work. Over the past year, the Seattle Department of Transportation, the match partner on the original project, has established the Common Carrier Locker system as one of the primary urban freight strategies. These lockers operate in the same way that Amazon delivery lockers operate but can be used by any major carrier service in an effort to minimize delivery time and free us valuable locking dock and curb space.

PacTrans has also reported extensively on the Rockfall Activity Index methodology that has been developed through a series of PacTrans funded research project. During this past year, the Oregon Department of Transportation has officially adopted this methodology to monitor and track critical slopes that are directly adjacent to roadway infrastructure. This methodology promises to better evaluate potential safety risks to road users but also allow for more proactive controls which prevent costly road closures.

Several years ago, PacTrans funded a project titled, *3D Virtual Intersection Sight Distance Analysis using Lidar Data*, which developed a 3D virtual visibility sight distance analysis algorithm using lidar data. PacTrans identified that the developed algorithm had a great potential for supporting evaluation of SD constraints for many transportation agencies worldwide. To promote wider distribution and rapid dissemination of the program, the research team applied for, and received, supplemental success story funds from PacTrans that enabled them to cleanup, optimize, package, and disseminate the code into an easy to use program with a simple, yet powerful, graphical user interface (GUI) that can readily be used by a typical transportation engineer in their workflows. Over the past year, this Sight-Object Distance Analysis Tool has been utilized by a consulting company evaluating sight distance with mobile lidar data. This tool/research has also been used and cited by other researchers.

PacTrans currently has an ongoing multi-institution project titled, *The Impact of Shared Mobility Options on Travel Demand Principal*, investigating the potential of ride-hailing and car and bike sharing to affect future mode share; to substitute for or complement SOV or transit. Early results of this work have showed that that ride hailing and car sharing increases accessibility and decreases trips by other modes. While new shared mobility constitutes a small fraction of trips, longitudinal data shows substantial increase in the use of these modes. In August, the research team hosted a workshop at the Puget Sound Regional Council's (PSRC) offices to present this work to our local MPO. PSRC is currently in the process of using this data to update both their models and also their regional travel survey.

Impact

As part of the PacTrans' newly adopted Technology Transfer Plan, we committed to tracking the following output metrics:

- (1) Number of research outputs that positively contribute to the reduced roadway vehicle to vehicle or vehicle to ped/bike crash rates: **during this reporting period we have had 3 such instances reported by our Principal Investigators (please see text below for further description).**
- (2) Number of research outputs that positively contribute to improving roadway travel reliability, efficiency, and accessibility: **during this reporting period we have had 1 such instances reported by our Principal Investigators (please see text below for further description).**

What is the impact on the effectiveness of the transportation system?

PacTrans recently funded a University of Alaska Fairbanks led project titled, *Measuring the Impact of a Landslide on Transportation Infrastructure to Improve Mobility and Safety*. Frozen debris lobes (FDL) are

slow-moving landslides in permafrost, many of which are located along the Dalton Highway in Alaska's southern Brooks Range. The collision of FDL-A with the abandoned Dalton Highway embankment represents a unique opportunity; it is not often that engineers can observe a landslide impacting a roadway in a safe and controlled way and on a predictable schedule. This project is doing just that. Ongoing monitoring of eight frozen debris lobes along the Dalton Highway corridor is providing state agencies and private companies with information needed to maintain their infrastructure and to consider mitigation options. This is both keeping Dalton Highway road users safe and moving efficiently.

Gonzaga University researcher Rhonda Young has been working on a Wyoming Connected Vehicle Pilot Deployment project, which uses connected vehicle technology to reduce vehicle crash rates during adverse conditions. The research corridor is regularly hit with high and unpredictable winds that cause large trucks to swerve unexpectedly or even flip on their side, both of which constitute a major hazard to both the safety and mobility of the other road users. This connected vehicle deployment is already showing positive results as it is increasing the travel reliability of the project corridor.

What is the impact on the adoption of new practices, or instances where research outcomes have led to the initiation of a start-up company?

Several years ago, PacTrans funded a Washington State University led project titled, *Developing of Surface-Mounted Smart Piezoelectric Modules for Bridge Damage Identification and Safety Monitoring*. The data that was gathered through use of these modules has informed further work by Dr. Qiao in the development of ultra-high-performance concrete (UHPC). During this past year, the UHPC material developed by the WSU team has been adopted by the Washington State Department of Transportation for bridge connection. Which is showing signs of significantly out performing traditional concrete materials and so slowing the rate of bridge damage.

What is the impact on the body of scientific knowledge?

An Oregon State University led project titled, *An Airborne Lidar Scanning and Machine Learning System for Real-Time Event Extraction and Control Policies in Urban Transportation Networks*, has resulted in newly developed procedures and algorithms for the use of unmanned aircraft systems (UAS) for traffic network monitoring. These procedures and algorithms are making it safer for UAS operators as well as the road users being monitored. They are also making the process speedier and more efficient.

What is the impact on transportation workforce development?

PacTrans WDI makes transportation workforce development and training more accessible and cheaper. PacTrans has multiple discussions with transportation agencies and companies in Region 10 about training needs and services from PacTrans. In particular, WSDOT and PacTrans has agreed on the first three training courses the PacTrans WDI will deliver to WSDOT employees.

Additionally, director Yin Hai Wang has been invited to join the Washington State AV Executive Committee. Future workforce development is among the key areas this committee will oversee.

Furthermore, PacTrans PI Yinhai Wang helped launch an Education and Workforce Development Council under the ASCE Transportation & Development Institute while serving as president of the Institute to ensure this important topic is sufficiently addressed nationally.

Changes/Problems

NONE.

Special Reporting Requirements

Research Project Requirements

Per our research update above, PacTrans has recently completed the selection process for new projects for the 2019 – 2021 research performance period. We are currently finishing the creation of website project profile pages and will be uploading these projects into RiP in the coming weeks. Further, PacTrans has begun include the requirement for an ORCID number from each PI before their project funds are released.

Submission of Final Research Reports

PacTrans has begun to receive the draft reports from our year 1 (2017 – 2019) funding. As draft technical reports are submitted to us we put them through a round of peer review, technical editing review, and an ADA compliance review. Once the PI has made all necessary edits based on those three reviews, we are publishing the final technical report, along with project data and metadata, on our website and various other repositories. Then we update the submission in RiP.