Semi Annual Progress Report for University Transportation Centers

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

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

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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 seven 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 and education activities.

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 October 1, 2019 – March 31, 2020, 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 from safety, accessibility, efficiency, and reliability perspectives.

PacTrans endeavors to begin research performance periods in coordination with the academic school year. During this reporting period PacTrans released the 2020 Request for Proposals for our third year of research funding, which is expected to begin at the beginning of the 2020-2021 academic year. For multi-institution projects, we received fifteen abstracts which were then reviewed by our Board of Directors (BOD) for their relevance to our theme and by our External Advisory Board (EAB) for comments. Based on these two reviews, we made recommendations to the PIs of all fifteen abstracts to proceed to the full proposal stage. All fifteen PIs submitted full proposals, each of which was sent out for three academic peer reviews and the top three projects were selected based on those reviews. Each university is also currently in the process of selecting the small projects at their respective universities for funding.

During this reporting period we collected research project progress reports from all active PIs with year 2 (2018 – 2020) and year 3 (2019 – 2021) funding. The Year 1 (2017 – 2019) performance period has concluded and all of those technical reports are either already published on our website and submitted to the various required repositories or are currently going through the process of peer and technical review. Several Year 2 (2018 – 2020) projects have also submitted their draft technical reports which are currently going through the same process.

> SPECIAL COVID-19 ACTIVITIES: PacTrans BOD clearly envisioned the potential impacts of COVID-19 on transportation and put out a special request for proposals for quick and innovative research projects on transportation mobility and safety in response to COVID-19. More specifically, the goal is to fund several projects focused on data driven protection guidelines that could be implemented during this epidemic, and/or the collection/analysis of "perishable" data, that might not otherwise be available to answer specific questions revolving around transportation during these uncertain times. Proposals are due mid-April and PacTrans hopes to have these projects started by June 1. Additionally, PacTrans researchers are quantifying changes of traffic performances and vehicle miles of travel over the freeway network in the central Puget Sound area using traffic sensor data.

Technology Transfer

As PacTrans has described in previous PPPRs, one of our main avenues for technology transfer is through identification of success stories. Once a sufficient pool of projects has 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 circulated an RFP asking for submission for these additional dollars.

To help select projects with a great potential for technology transfer, PacTrans established a Technology Transfer Advisory Board (T2AB) in September 2019. T2AB members are representatives of transportation agencies and industry who understands practical needs and state of the practice very well. In total, PacTrans received fifteen such proposals and utilized the T2AB as well as the BOD to review and rank these projects. Ultimately, the top seven projects were funded and the performance period for those began in late January of 2020 and expected to complete later this year.

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

In early October, PacTrans hosted our annual Region 10 Transportation Conference and continued its partnership with the Center for Safety Equity in Transportation (CSET) Tier 1 University Transportation Center (UTC). With over two hundred in attendance, this venue remained a great platform or advertising the results of our research. Several PacTrans PIs had the opportunity to present their work during technical sessions, and, as usual, PacTrans hosted a poster session where each ongoing PacTrans funded projects was displayed. In total, there were twenty-two posters present during the seventy-five-minute session.

In early January, PacTrans investigators and student research presented at over 125 lecturns, posture sessions, workshops, committees, and subcommittees, and had over 100 papers accepted to the Transportation Research Board (TRB) 99th Annual Meeting. This meeting continues to be a great outlet for disseminating PacTrans funded research to practitioners and public agencies.

Finally, during this reporting period, USDOT provided several opportunities for PacTrans and other UTCs to showcase new technologies and techniques at conferences, summits, and shows across the country. In early January, PacTrans showcased the STAR Lab-developed Multi-camera Car Tracking and Re-identification System (McTris) for Transportation Applications at the 2020 Consumer Electronics Show in Las Vegas, NV. PacTrans also organized to attend South by Southwest in Austin, TX in March to showcase new applications of the STAR Lab-developed Mobile Unit for Sensing Traffic (MUST) sensor for accessibility and curb management. Unfortunately, this event was cancelled due to COVID-19.

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.

This past January, PacTrans supported almost seventy students from consortium universities to travel to Washington D.C. for the 99th Transportation Research Board (TRB) Annual Meeting. A Master's Student, Travis Larson, from Oregon State University won the Traffic Control Devices Challenge, a TRB-Standing-Committee-on-Traffic-Control-Devices hosted contest, and had the opportunity to present that work

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during the conference. PacTrans also presented this year's Region 10 Michael Kyte Outstanding Student of Year Award to University of Washington PhD student, Ruimin Ke. Lastly, during the Council of University Transportation Center (CUTC) Winter Banquet, PacTrans had one student win CUTC Outstanding Student of the Year Award. This year's award went to University of Washington PhD Student, Cole Kopca.

In coordination with our annual conference each October, PacTrans also hosts a Region 10 Student Conference. This event was also co-organized by CSET and hosted on the UW campus this past reporting period. Over fifty students spent the day hearing from government and industry professionals, such as Sayuri Koyamatsu, TMC Manager for the NW Region at Washington State DOT, and Darcy Akers, transportation engineer for City of Bellevue. There was a recent graduate student panel as well as a student poster competition with over twenty posters where the invited speakers judged the posters on content as well as effectiveness of communication.

This spring, University of Washington PhD student and PacTrans student researcher, Katherine Idziorek, was selected for the ENO Future Leaders Development Conference.

Finally, during this reporting period, PacTrans extended fellowship offers to a handful of outstanding incoming graduate transportation students and, so far, most of those invitations have been accepted.

Workforce Development

PacTrans had a number of activities geared at workforce development during this reporting period. Notably, an ongoing multi-institutional education project titled *Developing PacTrans Workforce Development Institute (WDI)*, is an ongoing project to scope the current and future continuing education needs of agencies and private industry in the Pacific Northwest. As reported previously, early work on this initiative gathered input on the courses most in need by many of our public and private partners. Most recent efforts have moved to course development and offering stages. The final goal is to establish PacTrans WDI in 2020 to address the regional transportation workforce challenges.

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 October, PacTrans Fall Regional Transportation Seminar featured Professor Kaan Ozbay from New York University who presented on urban transportation systems, and the potential to make them safer using connected and autonomous vehicle technology.
2. In November, PacTrans hosted a local seminar featuring Professor Xuesong Wang from Tongji University who delivered a talk titled, *Overview of Traffic Safety Research Program and Safety Improvement Activities*.
3. In November, PacTrans hosted a second local seminar featuring Professor Cara Wang from Rensselaer Polytechnic Institute who spoke on demand of "on-demand" freight.
4. In February, PacTrans Winter Regional Transportation Seminar featured Professor Henry Liu from the University of Michigan who presented on critical scenario generation for accelerated testing of autonomous vehicles.

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5. In March, PacTrans hosted a Leadership Development Seminar featuring Bob Skinner, former Executive Director of TRB. Mr. Skinner talked about his distinguished career and offered students some insightful suggestions in how to have a long and impactful career.

Finally, PacTrans regularly works with transportation firms of all sizes to develop activities for students to learn about what they do and to interact with working professional to build their networks. One such example, from this past reporting period, included a collaboration between PacTrans and HDR Engineering to host an informational session where over thirty students had the chance to hear from and interact with a handful of transportation related engineers about what they do and about opportunities for students to get involved.

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 selects research projects that offer 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 Katherine Idziorek was selected to attend the 2020 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 or 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 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 Transportation Research Board Annual Meeting, the ITE Traffic Bowl Competition, the Traffic Control Devises Challenge; and also, student competition teams such as the UW Hyperloop team, the UI Clean Snowmobile team, and the

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UAF Steel Bridge team. This provides 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.

Partnerships: PacTrans has developed strong partnerships with many agencies, companies, and non-profit organizations. For example, 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. PacTrans is also in a strong partnership with American Society of Civil Engineers in organizing the 2020 International Conference on Transportation and Development in Seattle.

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 (www.pactrans.org), distributed through our *quarterly newsletter* and *annual reports*, and promoted through social media such as *Facebook* and *Twitter* and the University of Washington and consortium partner *press media*.

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

PacTrans has also begun a new webinar series that will be launching in mid-April. This series will mainly focus on research results from PacTrans funded work and will also, from time to time, feature professional from practice in the region to share with our PIs about emerging research needs in the Pacific Northwest.

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.

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

The past several months, with the outbreak of the novel corona virus COVID-19, has caused unprecedented disruptions to our way of life. During this upcoming reporting period. PacTrans will endeavor to continue facilitating as many of our regular activities and initiatives as possible, while adapting other to meet the needs of our students, researchers, partners, industry, and region, in these uncertain times.

Research

During this next reporting period PacTrans will wrap up year 2 (2018 – 2020) funded projects, monitor year 3 (2019 – 2021) projects, and finish selection of all year 4 (2020 – 2022) projects. Funding and the performance period for year 4 (2020 – 2022) projects will commence at the beginning of the 2020 – 2021 academic year. As year 2 (2018 – 2020) project technical reports are submitted, we will send them out for peer review, and then to a technical editor before considering them complete. We will then post the reports on our website and send them to TRID and Research Hub. Year 4 (2020 – 2022) projects will have profiles created on our website and they will also be uploaded to RiP.

SPECIAL COVID-19 ACTIVITIES: As mentioned previously, during this reporting period PacTrans made a special call for proposals in the area of transportation mobility and safety in response to COVID-19. These projects will be reviewed by our board and the selection process will take place in late April. These projects will begin June 1, 2020, with a performance period up to one year.

Technology Transfer

PacTrans will release an RFP for success stories based upon our completed year 2 (2018 – 2020) projects. This RFP will likely be released in September or October and those projects will begin in early 2021.

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 of 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 conference planning committee is currently working to identify the most productive format for this event, taking into consideration travel restrictions and the constrained budgets of many of our public and private partners. It is likely there will be strong virtual component to this year's conference.
- 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.

As discussed in previous semi-annual reports, PacTrans has begun to require, as a deliverable of each of our funded projects, a webinar, seminar, training, or workshop with practitioners. Attendees are to

include partners who provided match for the work, potential implementers of the outputs of the work, and others who might take specific interest in the research results. These activities will begin during this next reporting period.

SPECIAL COVID-19 ACTIVITIES: The spring and summer reporting period is traditionally the time when the PacTrans Conference Planning Committee is busy organizing the content for our Regional Transportation Conference that occurs each October. This year the planning committee is beginning this work by exploring alternative platforms that PacTrans might use to deliver that same content while taking into consideration that it may not be feasible to have an in-person conference as usual. PacTrans, along with our conference partner, CSET Tier 1 UTC, are committed to hosting a conference in October in Moscow, Idaho, but the delivery platform may look different to ensure safety of participants.

Education

All our education tasks will be carried as scheduled, but the delivery method during this next reporting period is going to look significantly different due to the disruptions caused by COVID-19. Each of our consortium partner institutions are operating remotely through the remainder of the academic year and several of the institutions have already made plans to continue with remote learning through at least part of the summer. Therefore, the PacTrans Board has had extensive discussion surrounding how we might continue to be a resource to our teachers and students during the epidemic. PacTrans will host a webinar with online education experts serving on the webinar panel to share their valuable experience with faculty and students on online teaching and learning skills.

SPECIAL COVID-19 ACTIVITIES: PacTrans will continue to offer graduate student fellowships. However, because all courses have moved to remote learning this spring, many of our incoming students are questioning if they can participate in our courses remotely next academic year. PacTrans faculty are developing alternative education plans to provide convenience to students while ensuring education quality. Meanwhile, PacTrans will host a couple of webinars to help address challenges encountered during the remote learning and online education activities.

Workforce Development

PacTrans is working hard on the first set of training courses identified through our online survey and discussions with transportation agencies and companies. During this next reporting period, PacTrans is scheduled to launch its WDI and offer several of these short-term courses for the first time, such as a *Human Factors in Transportation* will be delivered to the Washington State Department of Transportation (WSDOT). Each course will also be available online through the UW's eLearning platform. To ensure quality of these short-term training courses, PacTrans will develop a course evaluation system suitable for such workforce development courses.

SPECIAL COVID-19 ACTIVITIES: Although the current plan is to offer the first several training courses through onsite sessions and launch the PacTrans WDI, PacTrans is also working on online sessions as an alternative given the uncertainty associated with COVID-19. Also, as our regular in-person seminars will not be possible with campuses closed down, PacTrans Board has decided to launch a new webinar series. This series will provide a mix of content from regular transportation focused talks, very similar to

what our in-person seminars have consisted of in the past, to broader topics such as managing mental health. The first of these webinars will be given by DKS Associates Principal, Eric Shimizu, who will deliver a talk titled, *Managing Sudden Change*, where he explores routines that one can built to make them more resilient to sudden change.

Participant and Collaborating Organizations: Who has been involved?

What individuals have worked on the program?

- PacTrans Director, **Yinhai Wang**, Ph.D., Professor of Civil and Environmental Engineering at the UW, devotes 50 percent of his time directing PacTrans. Dr. Wang has overall responsibility for program management, oversight of PacTrans operations, including the Research Committee, the Education and Workforce Development Committee, and the Outreach and Technology Transfer Committee, and Student Leadership Council. He is the regional and national leadership for PacTrans, and the contact person for management relationships with USDOT Research and Innovative Administration (RITA) and other USDOT organizations.

- PacTrans Associate Director in Research, **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 75 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 Finance, Grants, and Research Manager, **Christina Yarbrough**, devoted 100 percent of her time to the Center's budget, expenditure, and research management.
- PacTrans part-time Program Coordinator, **Melanie Paredes**, devoted 40 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, outreach, and workforce development support and oversight.
- PacTrans has 28 fulltime faculty at the UW engaged in transportation research. Our consortium partners (OSU, UI, WSU, UAF, GU, BSU) 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			X	X	

	Agency						
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
ITS Washington	Professional Association						X
HDR Engineering	Private Industry						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
DENSO	Private Industry					
T Mobile	Private Industry					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
Verizon	Private Industry				X	X
Q-Free	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	**104**	31	10	7	53	3	0	0
Publications: Book chapters and other edited manuscripts	**3**	0	0	0	2	1	0	0
Conference papers	**81**	30	3	9	30	8	0	1
Conference presentations	**170**	50	32	12	65	11	0	0
Lectures/Seminars /Workshops/ Invited Talks	**121**	21	4	4	66	25	0	1
Policy Papers	**2**	2	0	0	0	0	0	0
Websites or Other Internet Sites	**9**	4	1	0	3	1	0	0
New Methodologies, Technologies or Techniques	**26**	8	2	2	13	1	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	**43**	9	24	2	8	0	0	0

OUTPUTS: Technology Transfer Plan Output Metrics	Annual Targets	Numbers for Reporting Period
Number of publications, presentations, and posters made at conferences or workshops explaining or promoting the research outputs	200	476
Number of software tools and technologies made available to practitioners	10	26

Examples of peer reviewed journal articles

Barnes, D.L., Connor, B., Trost, B., McTigue, E., Krauss, K., and Bluehorse, B. (2020). Managing Alaska's Road-Dust Problem: A Model for Road Dust-Impacted Regions, ASCE Journal of Transportation Engineering, Part A: Systems, DO):10/1061/JTEPBS.0000314

Chan, K., Louis J., Albert A. (2020) Incorporating Worker Awareness in the Generation of Hazard Proximity Warning. Sensors. 20(3):806.

Madkour, F., Umair, M., Sorour, S., Hefeida, M., and Abdel-Rahim, A. (2020). Reliability Study on Connected Vehicles V2V and V2I Communications, Transportation Research Board.

Chang, K., Lutz, B., Brown, S., and Adam, S. (2020). Workforce Development Needs and Objectives of Today's Transportation Engineering Professional: Regional Perspectives from the Pacific Northwest. Transportation Research Board. Transportation Research Record. Journal of the Transportation Research Board.

Rodin, HR III, Nassiri, S., Yakkelar, M., AlShareedah, O., and Haselbach, L. (2019). Evaluation of frictional properties of pervious concrete slabs under various winter conditions for driver and pedestrian users. Road Materials and Pavement Design, 1-19.

Sallehi, H., Ghods, P., and Isgor, O.B. (2018). Formation factor of fresh cementitious pastes. Cement and Concrete Composites, 91, 174-188

Ke, R., Zhuang, Y., Pu, Z. and Wang, Y.,(2020). A Smart, Efficient, and Reliable Parking Surveillance System with Edge Artificial Intelligence on IoT Devices. arXiv preprint arXiv:2001.00269.

Cui, Z., Henrickson, K., Ke, R. and Wang, Y., (2019). Traffic graph convolutional recurrent neural network: A deep learning framework for network-scale traffic learning and forecasting. IEEE Transactions on Intelligent Transportation Systems.

McCormack, E., A. Goodchild, M. Sheth and D. Hurwitz, (2019). Developing design guidelines for commercial vehicle envelopes on urban streets. International Journal of Transport Development and Integration, 3(2), 132-143.

Abadi. M.G, Hurwitz, D. Sheth, M. McCormack, E., and Goodchild, A. (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

Mohamed, M., Skinner, A., Abdel-Rahim, A., Kassem, E., and Chang, K. (2019) Deterioration Characteristics of Waterborne Pavement Markings Subjected to Different Operating Conditions. Journal of Transportation Engineering, Part B: Pavements 145, 04019003.

Hammad, A., Xing, T., Abdel-Rahim, A., Durgesh, V., and Crepeau, J. (2019) Effect of crosswinds on the aerodynamics of two passenger cars crossing each other. International Journal of Automotive Technology 20, no. 5, 997-1008.

Belakaria, S., Ammous, M., Smith, L., Sorour, S., and Abdel-Rahim, A. (2019). Multi-Class Management with Sub-Class Service for Autonomous Electric Mobility On-Demand Systems. IEEE Transactions on Vehicular Technology 68, no. 7, 7155-7159.

Examples of conference papers and presentations

Mohebifard, R., and Hajbabaie, A. Optimal Traffic Metering Locations and Levels in Urban Transportation Networks. The 99th Annual Meeting of the Transportation Research Board, Washington, DC, January 12-16, 2020. (Poster).

Mohebifard, R., and Hajbabaie, A. Optimal Traffic Metering Locations and Levels in Urban Transportation Networks. INFORMS Annual Meeting, Seattle, WA October 20-23, 2019 (Lectern).

Parrish, C., Hurwitz, D., Simpson, C., Sorour, S., and Abdel-Rahim, A. Lidar, Unmanned Aircraft Systems, and Machine Learning for Traffic Network Monitoring. 2019 PacTrans, CSET Regional Transportation Conference, Seattle, Washington, October 2019. (Poster)

Saha, M. Interactive Computational Tools for Assessing and Understanding Urban Accessibility at Scale. SIGACCESS Newsletter 2020.

Chang, K., Warmbrodt, S., Hurwitz, D., and Simpson, E. A Regional Assessment of Crash Reporting Processes, Transportation Research Board Conference; Washington, DC. January 13, 2020.

Khanal, M., Hasan, M., Sterbentz, N., Johnson, R., and Weatherly, J. Statistical Accuracy Comparison of Aerial Lidar, Mobile-Terrestrial Lidar, and UAV Photogrammetric Capture Data Elevations over Different Terrain Types. 99th Annual Meeting of the Transportation Board, January 13, 2020.

Chang, K., Lutz, B., and Brown, S. Workforce Development Needs and Objectives of Today's Transportation Engineering Professional: Regional Perspectives from the Pacific Northwest. Transportation Research Board Conference; Washington, DC. January 13, 2020.

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Chang, K. Examining the Effects of Topography on Walking and Bicycling to School Trips. Safe Routes to School National Conference; Tampa, FL. 2019.

McCormack, E., and Goodchild, A. Developing Design Guidelines for Commercial Vehicle Envelopes on Urban Streets. International Urban Freight Conference, Long Beach, CA. October 2019.

Sun, F., Moudon, A.V., Ban, X., Shen, Q., and Lowry, M. The Impact of Shared Mobility on Travel Demand Poster, Association of Collegiate Schools of Planning ACSP. Greenville SC. October 2019

Sun, F., Moudon A.V., Ban, X., Shen, Q., Lowry M., and Lee, B. The Impact of Shared Mobility on Travel Demand. PacTrans Conference, Seattle, October 2019. (Poster)

Shi, X., Moudon, A.V., and Chen, Y., and Claybrooke, C. Washington State Walkability Index. PacTrans Conference, Seattle, October 2019. (Poster)

Sun, F., Moudon, A.V., Shen, Q., Ban, X., and Lee, B. The Impact of Shared Mobility Options on Travel Demand. 99th Annual Meeting of Transportation Research Board, Washington, DC. January 13, 2020.

Shen, Q., Moudon, A.V., Sun, F., Wang, Y., Lowry, M., Lee, B., Wandler, M., and Knuth, C. New Shared Mobility Options and Travel Demand. PacTrans, CSET Regional Transportation Conference, Seattle, Washington, October 2019. (Conference Session).

Watanabe, R., Sorour, S., Hefeida, M., and Abdel-Rahim, A.Towards Real-Time Traffic Monitoring using Airborne LiDAR. IEEE Wireless Communications and Networking Conference (WCNC). 2019.

Madkour, F. E., Mohammad, U., Sorour, S., Hefeida, M., and Abdel-Rahim, A. A Vendor-Independent Reliability Testing Model for Vehicle-to-Infrastructure Communications. Transportation Research Board 99th Annual Meeting. Washington D.C. January 2020.

Zou, T., Khaloei, M., and MacKenzie, D. Effects of Charging Infrastructure Characteristics on Electric Vehicle Preferences of U.S. Private Car Owners: A Comparative Analysis between New and Used Car Buyers. Transportation Research Board 99th Annual Meeting. Washington, DC. January 2020. (Paper No. 20-05154)

Shi, X., He, Y., and Akin, M. Exploring Weather-Related Connected Vehicle Application for Improved Winter Travel. Transportation Research Board 99th Annual Meeting. Washington D.C. January 2020.

Darrow, M., Freeman, A., Daanen, R. Exploring subsurface temperature dynamics of frozen debris lobes though thermal modeling. 18th International Conference on Cold Regions Engineering, Québec City, Canada. August 18-22, 2019.

Conner, B. Selecting the Right Palliative for Dust Management. BIA Providers Conference, Anchorage, AK. October 2019.

Conner, B. Managing Dust on Village Roadways. Alaska Tribal Environmental Conference, Anchorage, AK. October 2019.

Conner, B. Use of Ground Penetrating Radar to Asses Ice Thicknesses on River Ice Roads. Bethel Regional Transportation Conference, Bethel, AK. March 2020.

Mohammad, U., Madkour, F., Hefeida, M., Sorour, S., and Abdel-Rahim, A. A Vendor-Independent Reliability Testing Model for Vehicle-to-Infrastructure Communications. PacTrans, CSET Regional Transportation Conference, Seattle, Washington, October 2019.

Pu, Z., Guo, X., Cui, Z., Zhu, M., and Wang, Y. Mining Public Transit Ridership Flow and Origin-Destination Information from Wi-Fi and Bluetooth Sensing Data. 99th Annual Meeting of Transportation Research Board, Jan. 2020.

Cui, Z., Lin, L., Pu, Z., and Wang, Y. Graph Markov Network for Traffic Forecasting with Missing Data. 99th Annual Meeting of Transportation Research Board, Jan. 2020.

Ke, R., Zhuang, Y., Pu, Z., and Wang, Y. A Smart, Efficient, and Reliable Parking Surveillance System with Edge Artificial Intelligence on IoT Devices. 99th Annual Meeting of Transportation Research Board, Jan. 2020.

Mostafizi, A., Wang, H., and Dong, S. Understanding the Multimodal Evacuation Behavior for a Near-field Tsunami. Transportation Research Board Annual Meeting, Washington D. C., Jan. 2019.

Wang, H., Siam, R., Wang, Y., and Deng, S. A Multi-agent Modeling of Human-Like Socially Intelligent Signalized Intersections with Memory and Learning: A Machine Learning Approach. Transportation Research Board Annual Meeting, Washington D. C., Jan. 2019.

Olsen, M.J., Forecasting increased rockfall activity following seismic events, Northwest Transportation Conference, Corvallis, OR, March 2020.

Jung J., An Efficient Approach to Automated Detection and Classification of Pavement Markings from Mobile Lidar Data, Northwest Transportation Conference, Corvallis, OR, March 2020

Olsen, M.J., and Wartman J. Rockfall Impacts on Mobility (RIM) database for the Pacific Northwest, Pactrans Annual Meeting, Seattle, Washington, (October 2019).

Shen, Q., Wang, Y., and Gifford C. Building Partnership between Transit Agency and Shared Mobility Company: An Incentive Program for App-Based Carpooling in Seattle Region. Transportation Research Board 99th Annual Meeting. Washington, DC. January 2020. (Paper)

Sun, F. et al. The Impact of Shared Mobility Options on Travel Demand. Transportation Research Board 99th Annual Meeting. Washington, DC. January 2020. (Poster)

Richards, E., and Stuefer, S. Snow and ice measurements to explore safety of winter travel on the Yukon River, Western Snow Conference, April 20-23, 2020, Whistler, Canada (cancelled due to COVID 19)

Example of lectures/seminars/workshops/invited talks

Parrish, C., Simpson, C., and Slocum, R. UAS-Based Lidar and Structure from Motion (SfM) Photogrammetry and Operational Implementation. Caltrans UAS Workshop, Sacramento, California. Feb 2020

Olsen, M.J., Rockfall hazard analysis using O-Help, Cascadia Lifelines Program Fall Meeting, Portland, OR. November 2019

The Impact of Shared Mobility Options on Travel Demand. Tongji University. Shanghai, December 2019.

Richards, E., and Stuefer, S. River ice measurements, a public seminar for the Tanana community, October 24, 2019

Connor, B. and Richards, E. Using GPR for river ice measurements, invited talk at the Tribal Transportation Training Session in Bethel, AK, March 3 and 4, 2020

Moudon, A. V. Urban built environment and health behaviors: A review of theories and methods. Invited lecture at Chalmers University of Technology, Dec 2019.

Wang, Y. Customized Machine Learning for Safer and Smarter Transportation Applications. The Warren Lecture Series at the University of Minnesota. Jan. 31, 2020.

Wang, Y. Artificial Intelligence for Smarter Transportation and Infrastructure Systems. The Florida Agricultural and Mechanical University – Florida State University Civil Engineering Seminar. Tallahassee, Florida, Nov. 22, 2019.

Examples of Website(s) or other Internet site(s)

http://ses.wsu.edu/research-project-videos/
http://uwdrive.net/STARLab
http://tps.uwstarlab.org/
http://projectsidewalk.io/
http://fdlalaska.org/

Examples of New Methodologies, Technologies or Techniques

Proof-of-concept experiment using machine learning methodology as a proxy for a fluid-structure interaction simulation.

RAMBO: Rockfall Analysis - Software Package.

Side Walk Project New features to http://projectsidewalk.io/.

New extruder for 3D printer for concrete.

Video sensing technologies and edge computing devices for sensing vehicles and pedestrians.

Several New AASHTO standards Developed as a part of PP-84 and associated tests

Pavement marking classification algorithm. Algorithm to extract and classify complex pavement markings. Rockslope facet detection- algorithm to detect individual facets (smooth surface regions) on the rock slope face was developed.

Developed a traffic counting application for an iPad or similar device that can be used in rural areas. The traffic-counting app, UAF Traffic, demonstrated its ability to count traffic and turning movements for cars and trucks, as well as ATVs, snow machines, pedestrians, bicycles, and dog sleds.

Using fuzzy-logic method to evaluate public transit in terms of mobility for people with disabilities has never been used before.

Development of an algorithm to quantify the walkability of neighborhoods around all Washington State Schools. The product is the Washington School Walkability Score or WS*2. The report is being submitted PacTrans and USDOT

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

Rockfall Database at Long Lake, posted on DesignSafe-CI

Rockfall Impacts on Mobility Database - ongoing development of a database recording impacts of rockfall activity on road closures and repairs that affect mobility.

Created video for 2019 PacTrans, CSET Regional Transportation Conference highlighting results of PacTrans multi-institution project: "An Airborne Lidar Scanning and Deep Learning System for Real-time Event Extraction and Control Policies in Urban Transportation Networks"

The research team identified areas of legal regulation for shared micro-mobility: Definitions, Age Restrictions, Safety Equipment, Licensing Requirements, Where to Ride, Riding-Under the Influence, Insurance Requirements, Sidewalk Clutter, and Shared Micro-Mobility Regulations. The research team then developed a searchable database in Microsoft Access to facilitate the collection, storage and analysis of the state laws, and employed graduate students from the University of Idaho College of Law for the summer of 2019 to research the laws in each state and input them into the database.

Database with truck parking events at rest areas.

Database of roadway safety related data in rural areas.

Database of traffic and geometrics data for weaving, merge/diverge sites.

https://www.youtube.com/watch?v=x4yOQEX6XCE

https://www.youtube.com/watch?v=7JpA2hQG674

Outcomes

OUTCOMES: Technology Transfer Plan Outcomes Metrics	Annual Targets	Numbers for Reporting Period
Number of early adopters of our research outputs	10	8
Changes made to the transportation system, or its regulatory, legislative, practice manuals, design standards, or policy frameworks	2	1

A UW researcher, with an ongoing PacTrans funded project titled, *Combining Crowdsourcing and Machine Learning to Collect Sidewalk Accessibility Data at Scale*, has been creating an open source, crowdsourcing application for collecting sidewalk accessibility data. During this past reporting period there have been two major developments in this work. First, a company, PathVu, has begun to use this code base to develop their own Project Sidewalk version. Second, an NGO in Mexico called Liga Peatonal has helped the PI fully translate Project Sidewalk into Spanish and has co-led the first international deployment of the application in Mexico City.

Last year, PacTrans funded an OSU-led project titled, *Efficient Extraction and Evaluation of Complex Pavement Markings from Mobile Laser Scan Data*. The goal of this project has been to develop an automated way for transportation agencies to periodically assess the conditions of pavement marking to ensure they meet public safety requirements. In particular, the retroreflectiveness of the markings tends to degrade over time due to vehicles passing over them and weathering. During this past reporting period the PI has been working with the Oregon Department of Transportation to beta test the software with the intent to full implementation very soon.

Several years ago, PacTrans funded a multi-institution project that was led by UAF titled, *Mixed Use Safety on Rural Facilities in the Pacific Northwest*. This work addressed issues associated with providing safe accommodation, limiting the improper use of public rights-of-way, and maintaining mobility, and provide future guidelines for design, education, and enforcement for mixed-use rural facilities, specifically with regard to off-highway vehicles (OHV) such as ATVs and snow machines. During this past reporting period Alaska DOT&PF has begun exploration of new policies related to OHV use as a direct result of this work.

Impact

IMPACTS: Technology Transfer Plan Impacts Metrics	Annual Targets	Numbers for Reporting Period
Number of research outputs that positively contribute to the reduced roadway vehicle to vehicle or vehicle to ped/bike crash rates	3	2
Number of research outputs that positively contribute to improving roadway travel reliability, efficiency, accessibility	7	3

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

PacTrans researchers are also working with Washington State Patrol and WSDOT to develop solutions to the trucking parking problems. With the quick increase of truck traffic, truck parking facility shortage becomes a huge problem for transportation safety and efficiency. Two trucking parking lots have been selected along the I-5 corridor to test the algorithm and app developed by PacTrans researchers. Also, the PacTrans intern programs with WSDOT and other transportation agencies provide assistances in day to day operations of the traffic control systems, including ramp metering, signal control, and managed lanes.

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?

Two years ago, PacTrans funded a UW-led project titled, *Washington State School Walk Score*, where researchers developed a method for quantifying the pedestrian infrastructure and its connectivity

surrounding schools. This method is now being used by the WSDOT in its management of the Safe Routes to School program, which is having a measurable impact on both pedestrian and roadway safety.

What is the impact on the body of scientific knowledge?

UW researchers led a multi-institution project last year titled, *The Impact of Shared Mobility Options on Travel Demand*, that explored travel patterns with the recent inclusion of new shared mobility options. This work has been presented to practitioners at the State and local MPOs and results of this work has been implemented into Washington State's efforts for Commute Trip Reduction. This program is improving roadway travel reliability, efficiency of the network, and accessibility for commuters.

What is the impact on transportation workforce development?

Since the Transpeed program terminated due to the financial crisis in 2009, there has been no short-term training programs in transportation in Washington. PacTrans' effort in establishing its WDI triggered a region-wide discussion on how PacTrans as a consortium of top universities of the region can help address the workforce development needs in the Pacific Northwest. WSDOT and Alaska Department of Transportation & Public Facilities have committed resources to help PacTrans launch the WDI and use the PacTrans WDI services. For example, WSDOT committed $100,000 for the three training courses they need immediately. PacTrans WDI is expected to address a wide range of transportation workforce challenges in a quick and cost-effective way in the Pacific Northwest.

Changes/Problems

None.

Special Reporting Requirements

Research Project Requirements

Per our research update above, PacTrans recently selected new projects for the 2020 – 2022 research performance period. Those projects are scheduled to begin in August, but records of these projects will be uploaded to RiP and put on our website within one month of final selection. 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

As final versions of technical project reports are completed and checked for ADA compliance, they are then uploaded to our repository and linked on the research project profiles on the PacTrans website. Then they are submitted to TRID and Research HUB as well. PacTrans staff are busily wrapping up completion of our Year 1 final technical reports. All draft technical reports are in and while about half have been published, the other half are currently at various points through the review process. We are also preparing to begin receiving draft technical reports for Year 2 funded projects.