Semi Annual Progress Report for University Transportation Centers

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

OST-R Sponsor Award Number: 69A355174110

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

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Submission Date: April 30, 2022
DUNS: 605799469 **EIN:** 91-6001537
Report #10, SAPR reporting for six months (October 1, 2021 – March 31, 2022)

Project/Grant Period: November 30, 2016 - September 30, 2023
Reporting Period End Date: March 31, 2022
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 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, 2021 – March 31, 2022, 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.

As mentioned in previous Semi Annual Progress Reports, PacTrans has shifted our last two research performance periods forward on the calendar in an attempt to maximize the amount of time researchers have to conduct their work while still ensuring that all projects will be completed on time and technical reports will be submitted to the necessary repositories before the grant ends. During this performance period PacTrans successfully selected the projects that will be funded during our sixth and final funding cycle under the FAST Act grant. These projects' profile pages are currently being built on our website and will be sent to the Research in Progress database in short order.

During this reporting period, PacTrans staff finalized and submitted roughly half of our Year 3 (2019 – 2021) technical project reports. Further, we began the collection, peer reviewing, and finalization of draft technical reports from Year 4 (2020 – 2022) projects. We monitored the progress of Year 5 (2021 – 2022) projects via Research Project Progress Reports, and have set up the budgets for all Year 6 (2022 – 2023) projects as well.

Finally, one major highlight from this reporting period on the subject of research pertains to the career advancement of one of our junior researchers. PacTrans aims to utilize our small projects funding to primarily support junior faculty as they explore new areas of research and establish their areas of expertise. During this reporting period, Barbara Simpson (OSU) was the recipient of the Faculty Early Career Development, or CAREER, award from the National Science Foundation. This award was based, in part, on research funded by PacTrans small projects.

Technology Transfer

During this past reporting period, PacTrans STAR Lab' first spinoff company, AIWaysion, Inc., signed a tech transfer agreement with the UW and received seed funding investment. This is an exciting event as PacTrans expects AIWaysion to set up an example for more technologies to be transferred. This company's core technology is a research product, called Mobile Unit for Sensing Traffic (MUST), developed by the UW STAR Lab. PacTrans is one of the sponsors that contributed to the development of this technology. AIWaysion submitted a proposal to the USDOT's Small Business Innovation Research (SBIR) Program and passed the first round of review. AIWaysion will deliver a pitch to compete for the SBIR funding this year.

PacTrans PIs and staff have been monitoring the progress of four 2021 success story projects as well as

the five 2022 success story projects. These projects are extensions of research that merit additional funding for the creation of outputs specifically geared toward industry in an attempt to make implementation one step closer for meaningful research results.

PacTrans and its PIs engaged in a number of great conferences, workshops, and symposiums during this reporting period that offered a great platform for us to showcase our research to a broader audience.

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). Due to restrictions caused by COVID-19, this activity was hosted in a fully virtual format. It began with an opening ceremony, keynote, and plenary session on Friday, October 15, 2021, and proceeded the following week with a single webinar each day to substantiate the technical breakout session component of the conference. With 167 unique participants in the conference activities, this event covered topics on post-COVID-19, technology development and the future of transportation system funding, innovative technology applications for safety enhancement, and road and trail rural safety. The conference also facilitated a virtual poster session where nineteen PacTrans funded projects had the opportunity to showcase their great work to the larger audience.

In November, PacTrans' award-winning partner, the City of Bellevue, WA, was honored with a 2021 National Roadway Safety Award for its Video Analytics Traffic Safety Program. A project that PacTrans has been a partner on for many years.

In early January, PacTrans investigators and student research presented at over 92 lecturns, posture sessions, workshops, committees, and subcommittees, and had over 100 papers accepted to the Transportation Research Board (TRB) 101th Annual Virtual Meeting. This meeting continues to be a great outlet for disseminating PacTrans funded research to practitioners and public agencies.

On February 24, PacTrans Director, Yinhai Wang, was a special guest panelist for a Women and Girls (WITI) Virtual Symposium on Artificial Intelligence organized by Office of Small and Disadvantaged Business Utilization.

Furthermore, during this reporting period, PacTrans hosted a total of three webinars focused on technology transfer. PacTrans PI and UW Professor of Urban Design and Planning, Qing Shen, along with partners from King County Metro, presented the results of a PacTrans Success Story project where they facilitated a tutorial on several geospatial analysis methods for evaluating the incorporation of ride-sourcing services into ADA Paratransit. PacTrans PI and UI Associate Professor, Kevin Chang, along with partners from the Seattle Department of Transportation, presented work on Safety Routes to School in Seattle, WA.

Finally, two UW PacTrans researchers, Wei Sun and Sam Ricord, co-presented the results of their safety data analytics tool with HollyAnna Littlebull, Tribal Traffic Safety Coordinator at Yakama Nation Department of Natural Resources Engineering Program. This traffic safety data analytics tool was designed and developed for Yakama Nation with the funding support from the USDOT Safety Data Initiative. Training events are scheduled in the next reporting period for Yakama Nation transportation professionals to learn how to use the tool.

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.

During this reporting period PacTrans hosted three installments of our quarterly doctoral webinar series. Presenters included Ziyuan Pu (UW), John Ash (UW), and Xiao Shi (UW).

This past January, PacTrans supported over fifty students from consortium universities to participate in the 100th Transportation Research Board (TRB) Annual Meeting. In concert with the TRB Annual Meeting, PacTrans has the opportunity to present two annual outstanding student-of-the-year awards: The Region 10 Michael Kyte Student of the Year award and the USDOT UTC Outstanding Student of the Year Award. This year's Michael Kyte Outstanding Student of the Year award went to OSU PhD student, Ananna Ahmed, and the PacTrans USDOT UTC Outstanding Student of the Year award went to OSU PhD student Brian Staes.

PacTrans also hosted our annual Region 10 Student Conference. This event was also co-organized with CSET and hosted virtually in concert with our main Region 10 Transportation Conference. This event spanned two half days installments and featured activities that included three speaker presentations, a career development panel, and the annual student poster competition.

Several other student related highlights from this reporting period included:

- UW's Peter Yu won the Best Poster Award from the TRB Standing Committee on Performance Effects of Geometric Design (AKD10)
- Two UW PacTrans PIs, Yinhai Wang and Jon Froehlich, received 2021 College of Engineering Outstanding Faculty Awards
- UW's Zhiyong Cui received the 2021 IEEE ITS Best Dissertation Award
- OSU's Helena Breuer received a Dwight David Eisenhower Transportation Fellowship Program fellowship
- A team of students from the UW's STAR Lab won second place in the Transportation Forecasting Competition (TRANSFOR 22)
- UW's Cole Kopca won the ASCE Transportation and Development Institute's 2021 Outstanding Younger Member Award
- UW's Ruimin Ke received the Chinese Overseas Transportation Association (COTA) Best Dissertation Award
- Two OSU students, Amy Wyman and Logan Scott-Deeter, were named 2022 Lifesavers Traffic Safety Scholars.

Workforce Development

PacTrans had a number of activities geared at workforce development during this reporting period.

The PacTrans workforce development institute (WDI) is dedicated to both professional workforce development training activities as well as K-12 education. For example, WDI developed "Transportation

Data Analysis and Tools" and delivered to WSDOT employees in February 2022. With great feedback received from the first delivery, the WDI will revise the course and deliver it again to a broader audience. In addition, the WDI is currently working with UW Teen and Youth Program to develop a course titled *Introduction to Autonomous Cars* that will be offered to sixth through eighth graders. This course targets middle school students. Participants will gain fundament knowledge on transportation engineering and automated vehicles. Transportation agency and industry leaders will share their knowledge and experience with students at this course. Students will also use legos to build automated cars and develop computer programs to control the cars. If successful, PacTrans will develop more such courses in the years to come.

Continuing to operate remotely, the PacTrans quarterly regional seminar series hosted Fred Mannering, Executive Director at Center for Urban Transportation Research, and a Professor of Civil and Environmental Engineering at the University of South Florida, for our winter quarter installment. His webinar, entitled *Risk Compensation and the Effectiveness of Vehicle Safety Features*, attracted over 300 participants from six countries.

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. PacTrans also supports a wide variety of student activities geared toward enhancing their educations. Several examples include: supporting ITE student chapter activities, travel support for students to present accepted work at conferences, sponsorship of student competition teams, and so much more.

Outreach: PacTrans offers training and educational opportunities to K-12 students through its outreach activities. Two quick examples include: (1) UW is currently working with UW Teen and Youth Program to develop a course titled *Introduction to Autonomous Cars* that will be offered to sixth through eighth graders, and (2) this past summer with PacTrans support, OSU hosted 17 students for their annual National Summer Transportation Institute.

Funding assistance: PacTrans financially supports students through their participation in research activities, as well as fellowships. During this past reporting period, PacTrans welcomed four new graduate fellows (three from UW and one from OSU), and funded two undergraduate research fellows. The Undergraduate Research Fellowship offers undergraduate students the opportunity to participate in research while receiving a stipend for things like conference travel, or research supplies. As an example,

PacTrans undergraduate research fellow, Peter Yu, received Best Poster Award from the TRB Standing Committee on Performance Effects of Geometric Design (AKD10).

Seminars, workshops, and conferences: As outlined above, PacTrans offers many opportunities for training and professional development through its webinar series and various workshops, such as the seven webinars we hosted during this reporting period. PacTrans also emphasizes our Region 10 Transportation Conference and Region 10 Student Conference as important opportunities for training and professional development.

Internships: PacTrans regularly posts internship opportunities on our website as a student resource. During this reporting period for example, PacTrans circulated thirteen 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.

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 upcoming International Conference on Transportation and Development.

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 monthly newsletter and annual reports, and promoted through social media such as LinkedIn and Facebook 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. Each year we send roughly one hundred PIs and students (about 70 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.

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 wrap up any outstanding year 3 (2019 – 2021) funded projects, continue processing year 4 (2020 – 2022) projects, and monitor year 5 (2021 – 2022) and year 6 (2022 – 2023) funded projects. As year 3 (2019 – 2021) 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 6 (2022 – 2023) projects will have profiles created on our website and they will also be uploaded to RiP.

Technology Transfer

PacTrans will release an RFP for success stories based upon our completed year 4 (2020 – 2022) research 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, including: the 2022 ASCE International Conference on Transportation and Development, the National Travel Monitoring Exposition and Conference (PacTrans is a co-host of this conference), and the Women in Transportation Conference.

Education

During this next reporting period PacTrans will be very busy with education endeavors. PacTrans director, Dr. Yinhai Wang, will organize an education workshop entitled "Addressing Teaching Challenges during the Pandemic" at the summer meeting of Council of University Transportation Centers (CUTC). This workshop intends to bring university educators together to share success stories and brainstorm for solutions on transportation course delivery and other educational activities.

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. PacTrans supports 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.

Two consortium partner universities have partnerships developed with our Civil Engineering Departments to offer PacTrans Fellowship. Both UW and OSU will be welcoming a new cohort of fellows along with the incoming class starting in the early fall.

Finally, PacTrans will continue to operation of our quarterly Doctoral Webinar Series.

Workforce Development

With the successful deliveries of several training courses in the previous and current reporting periods, the PacTrans WDI will continue identifying and cultivating new partnerships with agencies and industry to identify continuing education needs. In addition, the WDI will revise and re-deliver the following training courses to a broader audience.

- Transportation Data Analysis and Tools
- Understanding and Applying the Manual on Uniform Traffic Control Devices (MUTCD)
- Incorporating Human Factors into Roadway Design and Crash Diagnostics

In addition, we will also continue hosting webinars the provide insights as to the current state of the industry and emerging researching needs and cutting-edge technologies and techniques.

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.
- **Tasha Thakkar**, undergraduate business administration student in marketing analytics and information systems at the University of Washington, 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?

The following table highlights the institutions, organizations, agencies, and industry partners who have partnered with current PacTrans funded research projects to provide match, either cash or in-kind.

Partner	Type
Washington State Department of Transportation	Government
Alaska Department of Transportation and Public Facilities	Government
Oregon Department of Transportation	Government
Bellevue Department of Transportation	Government
Seattle Department of Transportation	Government

Further, 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
Alaska Department of Transportation and Public Facilities	Government
Idaho Transportation Department	Government
Oregon State Department of Transportation	Government
Washington State Department of Transportation	Government
City of Bellingham	Government
City of Seattle	Government
City of Lynnwood	Government
City of Bellevue	Government
City of Everett	Government
King County	Government
Snohomish County	Government
Pierce County	Government
Sound Transit	Government Agency
Washington Traffic Safety Commission	Government Agency
Washington State Transportation Insurance Pool	Government Agency
University of Alaska, Anchorage	Educational Institution
University of Washington Transportation Services	Educational Institution
Washington State Department of Ecology	Government
Puget Sound Regional Council	Government
Washington State Transportation Investment Board	Government Agency
American Society of Civil Engineers	Professional Association
Institute of Electrical and Electronics Engineers	Professional Association
Institute of Transportation Engineers	Professional Association
ITS Washington	Professional Association
HDR Engineering	Private Industry
Port of Portland	Government
BMW Group	Private Industry
Western Trailers	Private Industry
Coral Sales Co.	Private Industry
National Institute for Transportation and Communities	University Transportation Center
Transportation for Livability by Integrating Vehicles and the Environment	University Transportation Center
Center for Environmentally Sustainable Transportation in Cold Climates	University Transportation Center
Aichele and Associates	Private Industry
Alstom Grid Inc.	Private Industry
Alta Planning and Design	Private Industry
Battelle	Private Industry
Cascade Bicycle Club	Non-profit/ Foundation

Feet First	Non-profit/ Foundation
DENSO	Private Industry
T Mobile	Private Industry
DKS Associates	Private Industry
Fehr and Peers	Private Industry
FLIR	Private Industry
INRIX Inc.	Private Industry
Nokia	Private Industry
Transpo Group	Private Industry
Intelligent Transportation Systems of Washington	Professional Association
Luum	Private Industry
Kittelson and Associates	Private Industry
Microsoft	Private Industry
BlackBerry	Private Industry
Verizon	Private Industry
Q-Free	Private Industry
PACCAR, Inc.	Private Industry
West Salem High School	Educational Institution
The Bush School	Educational Institution

Outputs

	Total	UW	WSU	UI	OSU	UAF	GU	BSU
Publications: peer reviewed journal articles	**59**	20	12	3	18	4	0	2
Publications: Book chapters and other edited manuscripts	**22**	4	2	11	2	3	0	0
Conference papers	**67**	20	19	2	20	6	0	0
Conference presentations	**109**	35	29	4	32	9	0	0
Lectures/Seminars/Workshops/Invited Talks	**102**	26	31	4	23	18	0	0
Policy Papers	**2**	1	0	0	1	0	0	0
Websites or Other Internet Sites	**11**	4	1	1	3	2	0	0
New Methodologies, Technologies or Techniques	**16**	7	1	2	4	2	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	**37**	12	11	3	7	4	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	350
Number of software tools and technologies made available to practitioners	10	12

Examples of peer reviewed journal articles

Akin, I.D., Garnica, S.S., Robichaud, P.R., and Brown, R.E. (2021), "Surficial stabilization of wildfire-burnt hillslopes using xanthan gum and polyacrylamide," Geotechnical and Geological Engineering, https://doi.org/10.1007/s10706-021-01951-4

Che, E., Olsen, M.J., Jung, J. (2021). "Efficient Segment-based Ground Filtering and Adaptive Road Detection from Mobile Light Detection and Ranging (LiDAR) Data". International Journal of Remote Sensing, 42(10), pp.3633-3659.

Massey, C. I., Olsen, M. J., Wartman, J., Senogles, A., Lukovic, B., Leshchinsky, B. A., & Holden, C. (2022). "Rockfall activity rates before, during and after the 2010/11 Canterbury Earthquake Sequence". Journal of Geophysical Research: Earth Surface, e2021JF006400.

Jashami, H., Cobb, D., Hurwitz, D. S., McCormack, E., Goodchild, A., & Sheth, M. (2022). "The impact of commercial parking utilization on cyclist behavior in urban environments". Transportation research part F: traffic psychology and behavior, 74, 67-80.

Liao, H. F., & Lowry, M. (2021). "Urban Road Safety and Crash Severity during the 2020 COVID-19 Pandemic: The Case of Seattle, WA". Findings, 30007.

Hao Yang, H., Cai, J., Zhu, M., Liu, C., Wang, Y. (2022). "Traffic-Informed Multi-Camera Sensing (TIMS) System Based on Vehicle Re-Identification". Journal: IEEE Transactions on Intelligent Transportation Systems

Ziyuan P., Zhiyong C., Tang, J., Wang, S., Wang, Y. (2021). "Multi-Modal Traffic Speed Monitoring: A Real-Time System Based on Passive Wi-Fi and Bluetooth Sensing Technology". IEEE Internet of Things Journal

Wang, Y., Moudon, A.V. and Shen, Q. (2021). "How Does Ride-Hailing Influence Individual Mode Choice? An Examination Using Longitudinal Trip Data from the Seattle Region". Transportation Research Record, p.03611981211055669.

Wang, Y., Shen, Q., Ashour, L.A. and Dannenberg, A.L. (2022). "Ensuring Equitable Transportation for the Disadvantaged: An Examination of Paratransit Usage by Persons with Disabilities during the COVID-19 Pandemic". Transportation Research Part A: Policy and Practice.

Liao, H. and Lowry, M. (2021). "Urban Road Safety and Crash Severity during COVID-19: The Case of Seattle" Findings.

Examples of Book Chapters and Manuscripts

Neumann, C. (2021). "Fluid Structure Interaction for Cascading Seismic and Tsunami Events using Real-Time Hybrid Simulation", M.S. Thesis, Oregon State University, Corvallis, OR.

Richards, E. (2021). "An Evaluation of GPR techniques for analyzing the safety of interior Alaskan ice roads under varying river ice and environmental conditions". M.S. Thesis, University of Alaska Fairbanks.

Wei, H., Wang, Y., and Jianming Ma. (2022). "Disruptive Emerging Transportation Technologies Primer". ASCE Publication.

Examples of conference papers and presentations

Sun, F., and Whittington, J. (2022), "The Privacy Challenge of Governance of Urban Spatial Data", Annual Privacy Law Scholars Conference, UC Berkeley Law School.

Sun, F., and Whittington, J. (2022), "Urban Governance Challenges Posed by 'Smart City' Technologies: Managing Cybersecurity and Privacy Risks", 50th Urban Affairs Association Conference, Washington, D.C.

Sun, F., and Whittington, J., (2021), "The Challenge for Cities of Governing Spatial Privacy" Association of Collegiate Schools of Planning Annual Conference, Miami, Florida, [virtual].

McCabe, D., Ban, X. (2021). "Charging infrastructure location for battery electric buses". Presented at the PacTrans Annual Meeting, October, 2021.

Ahmed, A., Hohner, A.K., Robichaud, P.R., and Akin, I.D. (2022), "Geoenvironmental impacts of post-wildfire hillslope stabilization with xanthan gum and polyacrylamide," GeoCongress 2022, Charlotte, NC

Neumann, C., Simpson, B., Lomonaco, P., Schellenberg, A. (2021). Keynote Talk "Fluid Structure Interaction for Cascading Seismic and Tsunami Events using Real-Time Hybrid Simulation", Mechanistic Machine Learning and Digital Twins for Computational Science, Engineering, & Technology (IACM Conference): San Diego, CA: 09-2021.

Geyin, M., and Maurer, B.W. (2022). "An AI-Driven, Mechanistically Grounded Framework for Geospatial Modelling of Soil Liquefaction." Geocongress 2022: Geophysical and Earthquake Engineering and Soil Dynamics (A Lemnitzer and A.W. Stuedlein, eds.), Geotechnical Special Publication 334: 455-494. American Society of Civil Engineers. (Full Conference Paper)

Ahmed Abdel-Rahim. (2021). “Equity for Rural and Tribal Communities in Smart Transportation Environment: Opportunities and Barriers”, Conference on Advancing Transportation Equity - Transportation Research Board; September 2020, virtual.

Ahmed Abdel-Rahim. (2021). “Improving Safety for Rural and Tribal Communities – A Closer Look at Fatal and Severe injury Crashes on Unpaved Roads in Idaho”, Conference on Advancing Transportation Equity - Transportation Research Board; September 2020, virtual.

Motter, C., Phillips, A., Eberhard, M., Berman, J., and Maurer, B. (2021). Data-Driven Assessment of Post-Earthquake Bridge Functionality and Regional Mobility. PacTrans Region 10 Transportation Conference.

Olsen, M. (2022). “Vo-Norvana: A Versatile and Scalable Point Cloud Segmentation”. Geo Week 2022, Denver, CO. (02/06/2022)

D. Ji, Y. Turkan, P.M. Calvi. (2022). “AI-Enabled Drone Image Processing for Rapid Bridge Inspection and Management”, EMI 2022, May 31- June 3 2022, Baltimore, Maryland, US.

Technical Information Exchange, Innovations for Future Transportation Systems: Planning, Operations, and Safety, Safety Evaluation of Novel Intersection Treatments in a Bicycling Simulator, Washington, D.C., January 12, 2022.

Richards, E., S. Stuefer. (2021). "Ice measurements to explore safety of winter travel on the Yukon River to the conference." Accepted for presentation during the Cryosphere 2020: International symposium on ice, snow and water in a warming world. Conference was postponed to September 2021 due to pandemic.

Stuefer, S and E. Richards. (2020). River Ice Measurements for Transportation Safety in Rural Communities" for the 2020 PacTrans | CSET Regional Transportation Conference, Mobility for a Rapidly Changing Society

Richards, E. and S. Stuefer (2020). 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)

Chang, K. (2021). “Public Perceptions of Bicycle Rolling Stop Laws,” PacTrans Regional Conference; virtual.

Shi, X., Dey, K., Ashraf, Md. T., Carrola, A. (2021). Effect of Multimodal Connected Vehicle App on Transit Stop Catchment Area. 4th CAMMSE Research Symposium, Nov. 4, 2021, online.

Hurdman, J & Liao, Felix H.F. (2022). Food access and environment of vulnerable populations in Idaho's Treasure Valley. Annual Meeting of American Association of Geographers (AAG). Virtual Meeting. February 25-March 1.

Example of lectures/seminars/workshops/invited talks

Sun, F. (2021), "Advanced Topics in Real Estate Modeling", RE 506 Quantitative Methodology in Real Estate

Sun, F. (2022), "Advanced Topics in Real Estate Modeling", RE 397 Real Estate Data Modeling

V. Vasudevan (2022), Applications of LiDAR in Traffic Engineering, ITE Alaska Monthly Meeting, Anchorage, AK (Virtual), March 8, 2022.

V. Vasudevan (2022), Tracking Non-motorized Road Users Using LiDAR, CSET Webinar, Anchorage, AK (Virtual), March 14, 2022.

V. Vasudevan (2021), Developing a Portable Data Acquisition System to Capture Road User Behavior, PacTrans 2021 Region 10 Transportation Conference, Seattle, WA (Virtual), October 15, 2021.

Simpson, B. Invited talk, “Studying fluid-structure interactions via real-time hybrid experimental-numerical simulation,” University of California, Berkeley, SEMM Seminar, 12-2021

Simpson, B. Invited talk, Oregon State University, “Studying fluid-structure interactions via real-time hybrid experimental-numerical simulation,” Applied Mathematics and Computation Seminar, 11-2021

Simpson, B. Invited webinar, Imperial College London, “Mitigating computational and experimental constraints to study fluid-structure interaction with a hybrid simulation approach,” Structures Seminar, 10-2021

Leshchinsky, B. “Will it stay or will it go? Use of Lidar to Assess Slope Instability.” Canadian Geotechnical Society Chapter Meeting. Vancouver, BC. March 31, 2022. (Virtual)

Leshchinsky, B. “Will it stay or will it go? Use of Lidar to Assess Slope Instability.” American Society of Civil Engineers Oregon GeoInstitute Chapter Meeting. Portland, OR. October 6, 2021. (Virtual)

Eberhard, M. "Effects of MegaQuakes on Bridges in Washington State". 2/22 WSDOT Bi-monthly Seminar

Olsen, M.J., Senogles, A., and Wartman, J., Rockfall Activity Index Workshop, Oregon DOT, October 25, 2021

Hurwitz, D. Invited, Civil and Environmental Engineering Seminar Series at Michigan State University in Lansing, MI, UAS Operations Near Roadways: A Dynamic Roadside Distraction and Possible Mitigation, February 25, 2022.

Moudon, A. The RA and Postdoc who is working on the project gave two invited talks. One at the URBDP Research Talk Series and the other at the PacTrans Doctoral Webinar Series

Hurwitz, D. Invited, Role of an ITE Student Chapter Advisor, ITE Western District Board Meeting, January, 21, 2022.

Thesis defense by Elizabeth Richards was held on January 29, 2021. The defense was held virtually; it was open to the public and attended by 22 participants. Title: "An Evaluation of GPR techniques for analyzing the safety of interior Alaskan ice roads under varying river ice and environmental conditions."

Public seminar hosted by American Water Resources Association Alaska section. The seminar on GPR measurements for Ice Road safety was given by Elizabeth Richards on March 17, 2021, 12 1 pm via WebEx. This seminar was attended by more than 50 participants.

Elizabeth Richards, Svetlana Stuefer, 2019. River ice measurements, a public seminar for the Tanana community, October 24, 2019

Chang, K. (2022). "Exploring the Workforce Development Needs of Transportation Engineers," ITE Idaho Section Meeting; virtual.

Shi, X. Sustainable Road Maintenance Operations for Better Winter Mobility and Resilience. Keynote Presentation for the 20th and 21st Joint COTA International Conference of Transportation Professionals, Dec. 17, 2021. Online.

Wang, Y. University of Michigan NGTS Distinguished Lecture Series. "Edge-AI-Empowered Technology for Comprehensive Traffic Sensing and Cost-Effective V2X Applications." Ann Arbor, MI. March 31, 2022.

Wang, Y. Office of Small and Disadvantaged Business Utilization Women and Girls Virtual Symposia. Panelist for "Artificial Intelligence: The Future of Mobility." Feb. 24, 2022.

Wang, Y. Transportation Research Board Annual Meeting Lectern Session 1202: State of the Art and Future Vision on Artificial Intelligence Research and Applications in Transportation. "Vision on Artificial Intelligence and Advanced Computing Applications in Transportation." Jan. 11, 2022.

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

https://github.com/AI-Group-STAR-Lab-UW/yakama-nation-roadway-safety-data-portal

Examples of New Methodologies, Technologies or Techniques

Models, algorithms, and case studies of optimal charging stations for BEBs A web interface is also developed to demo the method

Development of real-time hybrid simulation to study wave loading on bridges.

Development of machine learning models to estimate the response of structural bridges.

UAF developed a mini-dust column that provides a portable means of measuring the ability of palliatives to reduce dust over time. We are in the process of building 4 of these devices of which 2 will go to the private sector and 2 will go to the Alaska DOT&PF.

Technique for assessing the potential for supplementing traditional ADA paratransit with TNC mobility service, developed by Ashour and Shen

Machine learning algorithms for learning statistical distributions of behaviors based on observations and generate examples using the distributions for use in a simulator.

Web-based safety data portal for Yakama Nation

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

A 3-minute short video was produced. Here is the link below.
https://www.youtube.com/watch?v=aEhth19TwL8&t=9s

UAF and UAA developed three project management coursed for the Alaska DOT&PF. They have been taught twice with a third offering during the summer of 2022.

A training video developed as a product of PacTrans technology transfer grant, by Ashour and Shen

Geyin, M. and Maurer, B.W. (2021). "RapidLiq: Software for Near-Real-Time Prediction of Soil Liquefaction." DesignSafe-CI. https://doi.org/10.17603/ds2-4bka-y039. (Software)

Machine Learning algorithms for learning statistical distributions of behaviors based on observations and generate examples using the distributions for use in a simulator.

A database of bridge properties for WA bridges.

Outcomes

OUTCOMES: Technology Transfer Plan Outcomes Metrics	Annual Targets	Numbers for Reporting Period
Number of early adopters of our research outputs	10	6
Changes made to the transportation system, or its regulatory, legislative, practice manuals, design standards, or policy frameworks	2	1

A great example of the outcomes produces from PacTrans funded research during this reporting period comes from the combined work of a multi-institutional research team (which includes UW, OSU, and UAF) on the Rockfall Activity Index projects over the past decade. In this work several algorithms and supporting software have been developed, called Rambo. In our most recent SAPR, PacTrans reported that this work has resulted in a spin-off company at OSU, called EZDataMD, for the purposes of further developing the software for broader industry adoption. During this reporting period, the research team has delivered a new version of Rambo to Oregon DOT (in conjunction with a hands-on training workshop for twenty-five people to learn the software and learn about the rockfall activity index). Rambo is also being used on three current ODOT research projects for analysis. Two are focused on analyzing coastal erosion and one is evaluating slopes of curb ramp for ADA compliance. The team has performed a demonstration and provided a demo version of the software to GNS Science in New Zealand who has been using it to analyze rockfall activity from the Kaikoura and Christchurch Earthquakes. They also facilitated a training session and delivered a current demo version to researchers at the University of California San Diego who are using Rambo to perform vegetation removal from extensive swaths of coastal cliffs. They are currently investigating other tools in Rambo for more advanced analyses.

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?

A project funded by PacTrans titled, "Roadway Traffic and Environmental Conditions Monitoring and Safety Alert System," is deploying sensors along roadways with high crash risks, such as segments with horizontal and/or vertical curves, locations with frequent snow or ice coverage, etc., particularly locations that traditional sensing devices would not work because of limited funding and personnel support. Specifically, the system will monitor the roadway conditions and detect events such as snow/icy/wet road surface, speeding, crash, stopped vehicles, queue, etc. utilizing edge AI technologies. In addition to monitoring and detecting abnormal events, the system will broadcast warning messages to transportation agencies and road users in real-time. The team is developing a mobile phone app to display real-time roadway monitoring information as well as broadcast warning messages. Other channels such as variable message signs, social medium, radio broadcast, etc. are also be explored for information dissemination. This work is helping avoid crashes with the warning messages provided by the system and by providing real-time road traffic conditions, the system can also improve traffic efficiency.

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?

During the course of this grant, PacTrans has funded a number of projects from UAF that focus on incorporating new technologies and methods into Road Weather Information Systems (RWIS). During this reporting period, one such RWIS has been installed at Atigun Pass. This RWIS has been used to detect avalanches and, in some cases, anticipate avalanches. This has allowed the Alaska DOT&PF to respond to avalanches faster, and in some instances, has informed them on situations where they needed to intentionally cause controlled avalanches to ensure safety of the travelling public. The research is still ongoing but the results are already being implemented.

What is the impact on the body of scientific knowledge?

A group of researchers at the UW have been working with the tribes of Yakima Nation as part of the USDOT Safety Data Initiative on a project titled, *Comprehensive Roadway Safety Data Visualization and Evaluation Platform for Yakima Nation*. During this reporting period, the research team hosted a webinar to explore the results of their work and had a lot of great questions and discussion about the

need for better data. Yakima Nation representative, Hollyanna Littlebull, noted that the first step to solving safety related issues is having the right data to properly identify what those safety related issues are. This work has been made open source for other tribal communities to follow Yakima National in taking those first steps to collecting and analyzing transportation related safety data.

What is the impact on transportation workforce development?

While much of our recent reporting on workforce development has revolved around the PacTrans Workforce Development Institute, it is also important to recognize the impact our funded research has had in the classroom. A few examples include:

- Michael Olsen (OSU): Rambo was used in course assignments and lectures in CE566 3D laser scanning and imaging in Fall 2021 and again in CE562 Digital Terrain Modeling for several assignments. Examples of analysis of the quality of UAS data for rockslopes from a prior PacTrans projects was incorporated in symposium training modules for the FHWA Every Day Counts Program, focused on surveying and mapping with UAS technology.
- Margaret Darrow (UAF): I have included research results into my courses, and specifically for the PacTrans-funded project. Project: The Long-Term Effect of Earthquakes: Using Geospatial Solutions to Evaluate Heightened Rockfall Activity on Critical Lifelines Impact: Use of joint data and photographs as examples for slope stability analysis in a technical elective course.
- Svetlana Stuefer (UAF): I developed teaching material for use in my UAF CE683 Arctic Hydrology and Hydraulic Engineering course based on results of my PacTrans funded work.
- Kevin Chang (UI): Previous work funded by PacTrans is informing the development of a new signal operations textbook.
- Chris Parrish (OSU): Work on PacTrans projects involving use of uncrewed aircraft systems (UAS) in transportation contributed to new UAS course materials.
- Qing Shen (UW): My course "Current topics in transportation planning and policy" incorporated some research findings from my PacTrans funded research projects.

Our research is being used to inform the next generation of transportation professionals in the classroom.

Changes/Problems

None.

Special Reporting Requirements

Research Project Requirements

Per our research update above, PacTrans recently selected and began new projects for the 2021 – 2022 research performance period. Those projects began in March. Records of these projects will be uploaded to RiP and put on our website 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

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 is currently finishing the publication of Year 3 technical reports and preparing to begin receiving draft technical reports for Year 4 funded projects.