Program Progress Performance Report for University Transportation Centers

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

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

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Project/Grant Period: November 30, 2016 - September 30, 2020
Reporting Period End Date: March 31, 2018
Report Term: Semi-Annual

Accomplishments

What are the major goals and objectives of the program?

Pacific Northwest Transportation Consortium (PacTrans) consists of institutions from all four states in our region with the University of Washington (UW) as the lead and Oregon State University (OSU), University of Alaska Fairbanks (UAF), University of Idaho (UI), and Washington State University (WSU) as partner institutions; and Boise State University (BSU) and Gonzaga University (GU) as educational partners. PacTrans' theme centers on "Providing Data-Driven Solutions for the Diverse Mobility Challenges of the Pacific Northwest". PacTrans will serve as a focal point within Region 10 to develop initiatives and facilitate collaborative activities with regional partners to maximize the effectiveness of their collective services and programs toward the U.S. Department of Transportation (USDOT) strategic goal of mobility. Major goals and objectives of PacTrans include:

Research – serving as Region 10's research engine, PacTrans is committed to funding research in both the categories of advanced and, more importantly, applied research.

Technology Transfer – PacTrans strives to be an applied technology showcase, providing additional funds to projects that are deemed as "Success Stories" to ensure dissemination of results to policy makers, educators, practitioners, other transportation professionals, and the general public.

Education – As a consortium of five prestigious universities, PacTrans is devoted to being an education leader. This involves continued evaluation and evolution of our transportation engineering programs as well as providing state-of-the-art research laboratories, student conferences and seminars, mentoring, and scholarship opportunities for our students and future workforce trainees.

Workforce Development – PacTrans endeavors to be a workforce development base: hosting activities that focus on the development of transportation professionals, building strong partnerships with transportation agencies and companies in our region, and designing training programs to address the workforce development needs, while connecting our students with quality jobs where they can implement the knowledge they gained through their education.

Outreach – Throughout all of these other goals and objectives, PacTrans seeks to be in a continual process of outreach: promoting and building the educational student base, making new industry and agency partners, attracting new research, and providing opportunities to share and learn about key outcomes and achievements that have been learned through research.

Collaboration – PacTrans desires to be a platform for participation and is always on the lookout for potential new partner and new opportunities with current partners to collaborate on transportation related endeavors.

What was accomplished under these goals?

During the period from June 1, 2017 – March 31, 2018, PacTrans was actively engaged in each goal and objective identified above. This was achieved through a breadth of activities that were conducted to ensure our transportation expertise contributes to the advancement of the region's transportation

research, technology transfer, education, workforce development, outreach, and collaboration.

Research

As Region 10's research engine, PacTrans has been actively engaged in two broader categories of research projects. We engage in multi-institutional research projects that require participation from at least two consortium universities, and typically have a larger budget. Such projects include multi-institutional general research projects, 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. Such projects are coded with SR and university acronym. Both categories of research are geared towards the goal of advancing the region's transportation research.

During this report period our first year of research funding was dispersed to consortium member universities and investigators have been fervently working on their respective projects. PacTrans has been overseeing the progress of these works and we are expecting draft reports by July of next year.

PacTrans has also initiated our second year of research funding by designing a new request for proposals, and distributing that request. Through this RFP process, PacTrans received twelve high-quality proposals for multi-institutional projects, each of which was sent out for external review and scoring. Once those reviews are all in, the PacTrans board will meet and decide on the top three projects which will be funded for the 2018-2020 research cycle.

Finally, the associate director of each respective consortium partner university has begun work to identify the small (single-institution) projects that they will be funding for the same research cycle. Once all of those projects have been identified, the board will review to make sure that no two projects are similar in scope.

Technology Transfer

As PacTrans has described in PPPRs for previous grants, one of our main avenues for technology transfer is through identification of success stories. Once a sufficient pool of projects have been completed, the center will solicit submissions for "success stories." Success stories are just that, research that merits the added funding and effort to make sure that the findings and conclusions of the project are disseminated to the appropriate entities. Thus PIs will submit proposals on how they would further disseminate and/or apply their findings in thoughtful and useful ways. Then PacTrans board of directors and advisory committees will select a handful of projects to receive sufficient funding to execute the proposed activity(s). We have not yet begun this process as our first year research projects have not yet been completed.

PacTrans has, however, actively engaged in many opportunities through conference, seminars, and workshops to showcase our accomplishments of the ongoing research projects. Several key examples of these events include:

In early October, PacTrans hosted our annual Region 10 Transportation Conference. One of the technical sessions was devoted to a **PacTrans research showcase where three investigators had the opportunity to present PacTrans funded research projects**. Further, each year during this conference, PacTrans

hosts a **poster session where each ongoing PacTrans funded projects is displayed**. In total, there were a total of forty posters present during the seventy-five minute session.

In December, PacTrans hosted a UTC Technology Transfer session at the annual Intelligent Transportation Systems (ITS) Washington chapter conference. During this session, three investigators presented PacTrans funded research projects.

During this reporting period, PacTrans consortium member UAF, has partnered with StoryCorps, an independent nonprofit project whose mission is to honor and celebrate the lives of everyday Americans by listening to their stories. UAF's role is leading and recording science-based stories and dialogues. PacTrans PI, University of Alaska Assistant Professor Nathan Belz, will be recording conversations related to transportation. This will serve as a powerful platform for presenting PacTrans funded research to the general public.

In early January, **PacTrans investigators and student research presented at over 120 lecturns, posture sessions, workshops, committees, and subcommittees, and submitted over 100 papers at the Transportation Research Board (TRB) 97th Annual Meeting**, at the Walter E. Washington Convention Center, in Washington, D.C. This meeting continues to be a great outlet for disseminating PacTrans funded research to practitioners and public agencies.

This past January, PacTrans hosted a half day technology workshop and research scan with DiDi, the Chinese ride-sharing company that provides transportation services for more than 450 million users across over 400 cities in China. Their interest was to visit and hear from university researchers with a broad range of expertise from artificial intelligence, to data driven smart transportation solutions, to voice recognition, to natural language processing. In total, five PacTrans investigators presented work to an audience of about thirty attendees.

Finally, this March, one of PacTrans' ongoing research projects, led by UW PI Dr. Anne Goodchild is titled, Final 50 Feet of the Urban Goods Delivery System: Pilot Test of an Innovative Improvement Strategy. Dr. Goodchild is the founding director of the Supply Chain and Transportation Logistics Center housed at the University of Washington, where this research is being conducted. Dr. Goodchild, along with her student researchers and staff, are partnering with the Seattle Department of Transportation (SDOT) to pilot test a common-carrier smart locker system in the Seattle Municipal Tower from late March through April 2018. The pilot will test the ability of new mini-distribution centers in cities – such as smart lockers – to create delivery density and reduce the time delivery people have to spend in urban towers to complete their work. The Lab is collecting 'before' and 'after' data to evaluate the pilot's premise: that when delivery trucks can pull into a load/unload space that's close to a mini-distribution node with delivery density (lots of deliveries in one place), everyone benefits.

Education

During this past performance period, PacTrans has been actively engaging students with a wide variety of activities and opportunities to further their education, experience, knowledge, and networks. Below is a summary of several such items:

In October, as part of the Region 10 Transportation Conference, PacTrans hosted the Region 10 Student Conference. Each year this is a wonderful opportunity to for students from around the region to gather, here from representatives of the private sector and public agencies, talk to recent graduates of transportation engineering programs, and hold their own poster session. This year, over fifty students representing five universities from the Pacific Northwest were in attendance. The day included two keynote talks, a recent graduate panel, and a poster session with twenty posters of students' research.

Each year ARTBA's Research and Education Division (RED) hosts a Student Video Contest promoting importance of U.S. Transportation Infrastructure. The annual contest encourages students to connect with current trends in American transportation infrastructure, focusing on topics of general transportation and safety. **This year four students from CUTC-affiliated universities won top prizes, including University of Washington's Daniel Shen, who won 1st place in the RED General Transportation category**. His video, "The Gas Tax," describes the low-cost, high-reward nature of the gas tax in his video, closely examining the tax's overall effects on both consumers and federal infrastructure.

This past January, PacTrans supported over fifty students from consortium universities to travel to Washington D.C. for the 97th Transportation Research Board (TRB) Annual Meeting. Among those students was a team from Oregon State University who was participating in the Traffic Control Devices Challenge, a TRB-Standing-Committee-on-Traffic-Control-Devices hosted content. The OSU team placed second. PacTrans also presented this year's Region 10 Michael Kyte Outstanding Student of Year Award to Oregon State University PhD student, Alireza Mostafizi. Lastly, during the Council of University Transportation Center Winter Banquet, PacTrans had two students win CUTC Outstanding Student of the Year Awards. These went to Oregon State University Master's Student, Kayla Fleskes, and University of Idaho PhD Student, Reagan Hansen.

This January, **PacTrans sponsored the ITE Western District Student Leadership Summit, which was hosted by PacTrans consortium member university OSU**. This, the fifth annual student leadership summit of the Western District, was a three-day event that included over 120 student from twenty-five different schools from the Western District and two students form U-Mass Amherst, who are preparing to host their first Student Leadership Summit in April, and professionals from several industry firms. The summit focused on leadership, networking, and professional development through a variety of small group and panel discussions, talks, and professional development workshops. The University of Washington also sent two ITE student representative to the summit.

This year, PacTrans student researcher Elyse O'Callaghan Lewis from the University of Washington, was selected for the Eno Future Leaders Development Conference.

Workforce Development

PacTrans had a number activities geared at workforce development during this reporting period. Notably, the continuing education and workforce development program, which is an ongoing education project from PacTrans, is well underway and is current set to be wrapping up in August of 2020. PacTrans will have more on this as the project continues to develop.

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

1. In November, UW hosted a seminar featuring Dr. Yueyue Fan, professor in Civil and Environmental Engineering at University of California, Davis. Her presentation was titled, "Probability Density Estimation of Travel Demand: Integrating Sensor Data with Soft Information."
2. In December, PacTrans hosted our quarterly Regional Transportation Seminar featuring Dr. Sherif Ishak, Professor and Department Chair of Civil Engineering at the University of Alabama in Huntsville. His talk was titled, "Developing a Crash Risk Index and Detecting Driver's Engagement in Secondary Tasks from Driving Behavior Attributes and Socioeconomic Characteristics: A Naturalistic Driving Study."
3. In January, PacTrans hosted another quarterly Regional Transportation Seminar featuring Dr. David Noyce, the Arthur F. Hawnn Professor of Transportation Engineering and Chair of the Department of Civil and Environmental Engineering at the University of Wisconsin – Madison. His talk was titled, "Developing Communication- and Connectivity-Driven Transportation Systems."

Lastly, PacTrans has set up a page on our website to promote internship opportunities for students around the Pacific Northwest. As these positions become available and PacTrans is notified of their availability, they are promptly posted to the page for students to use as a resource.

Outreach & Collaboration

During this reporting period, PacTrans was very active building new partnerships, strengthening current partnership, and discussing innovative way to better integrate companies and agencies outside of our institutions into our education, research, workforce development, and technology transfer efforts. Several key examples include:

1. In January, as part of the TRB Annual Meeting, PacTrans hosted the Region 10 Reception in Washington D.C. **With over 200 in attendance, this reception brings together researchers, students, and agency and private sector representatives from around the country and world.** This event provides a fruitful platform for connections to be made, conversations to be had, and new ideas to be circulated.
2. In October, PacTrans Director, Yinhai Wang, along with PacTrans Associate Director of Research, Jeff Ban, and several student researchers, met with Andrew Walstein, Director of Security Research and Development at Blackberry. Conversations were productive and several new ideas for partnership arose.
3.

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

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

Research: Through the lifespan of this grant, PacTrans annually selected research projects that offered

faculty and student researchers funding to conduct cutting edge research in a variety of areas directly tied to the USDOT strategic goals.

Education: PacTrans consortium partners offer a variety of other on-campus and online courses designed for professional development in addition to the regular degree programs. The online programs, such as the online master's program of sustainable transportation, are particularly good for working professionals because of the flexibility in schedule and location.

Outreach: PacTrans offers training and educational opportunities to K-12 students through its outreach activities. Examples include: UW engineering discovery days, OSU undergraduate engineering expo, and Alaska Summer Research Academy (ASRA), where high school students enrolled in the ASRA Civil Engineering Module applied basic design principles of statistics and structural analysis showing how engineering principles are used to solve problems.

Funding assistance: PacTrans has supported student education and research activities. Beyond our PacTrans fellows, for whom we fund tuition, we also give a significant amount of assistance to students to participate in competitions, conferences, and seminars such as the Hyperloop competition, IEEE Smart Cities Conference, the Oregon State University hosted Northwest Transportation Conference, and the Transportation Research Board Annual Meeting. This aides them with funds for presentation materials, travel expenses, and registration fees.

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

Internships: PacTrans internship program offers students training opportunities by partnering with local agencies and private industries. We have internship programs with WSDOT, Seattle DOT, Bellevue Transportation Department, Transpo Group, FEHR & PEERS, Parsons Brinckerhoff, Puget Sound Regional Council, ODOT, etc. Additionally, PacTrans also offers intern opportunities for both graduate and undergraduate students to work in university labs to gain hands on experience in transportation.

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

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

PacTrans' previous centers have had 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 have been posted on the PacTrans website, distributed through our *quarterly newsletter* and *annual reports*, and promoted through social media such as *Facebook* and *Twitter* and the University of Washington *press media*. We also regularly disseminate news, events and results via our website at www.pactrans.org. These endeavors will continue into this new center, and we are hoping to hire an undergraduate civil engineer to act as our social media person.

The second large component of our dissemination efforts have surrounded facilitating and attending various seminars, workshops and conferences. During this reporting period, PacTrans was well represented by faculty and students at the TRB annual meeting in Washington D.C. PacTrans PIs gave a total of 19 lectures, 56 poster presentations, hosted 5 workshops, and chaired 9 committees/subcommittees.

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.

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

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

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

Research

As already mentioned. PacTrans is in the process of identifying all of our year 2 research cycle (2018-2020) projects. We hope to have these projects identified by mid-May with the hope that each university will have funds in hand to be able to begin the projects by the first day of the 2018-2019 academic school year.

Technology Transfer

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

For example, in July, PacTrans Director, Yinhai Wang, will be chairing the ASCE International Conference on Transportation & Development (ICTD) in Pittsburgh. PacTrans is a cosponsor of the University Transportation Centers (UTC) Technology Transfer Workshop where several UTC investigators will have the opportunity to present funded work. Further, PacTrans has had about ten conference papers successfully accepted to the conference and plans to have a significant presence at the conference.

Education

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

1. PacTrans sponsors a number of student competition teams including steel bridge, concrete canoe, hyperloop, clean snowmobile, and big beam. Most, if not all, of these teams, will have their competitions during this upcoming performance period.
2. Most of our consortium partner universities have student outreach opportunities during the spring. PacTrans will host a booth at the UW Engineering Discovery Days, OSU will take part in their annual Student Expo, and UAF will play a major role in Engineering Days.

Workforce Development

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

1. The center will continue working with agency and academic partners to develop the PacTrans Workforce Development Institute. This includes analysis of survey results on workforce needs around the Pacific Northwest, as well as development of an administrative structure, business plan, and at least two courses.
2. Professor Xuemin Chen, of Xi'an Jiaotong-Liverpool University, will give a seminar in March.
3. Associate Professor Kari Watkins, from Geogria Institute of Technology, will deliver a seminar in May.
4. Professor Lily Elefteriadou, Director of the University of Florida Transportation Institute, will deliver a seminar in May as well.

Outreach

The center will continue sending faculty and student researchers to seminars, workshops, and conferences to further goal of making PacTrans and its research more visible to practitioners, decisions makers, students, educators and others in the transportation sector.

PacTrans will organize several mini-workshop in the summer quarter for communicating new technologies developed by PacTrans researchers to practitioners.

PacTrans plans to host a group of underrepresented students from Colorado's Educational Talent Search Program in June to demonstrate transportation technologies. Hopefully, this effort will attract some of them to study transportation.

Products (reporting period: June 1, 2017 – March 31, 2018)

	Total	UW	WSU	UI	OSU	UAF
Publications: peer reviewed journal articles	**22**	13	2	1	5	1
Publications: Book chapters and other edited manuscripts	**1**	1	0	0	0	0
Conference papers	**36**	18	3	6	8	1
Conference presentations	**45**	18	8	9	8	2
Lectures/Seminars /Workshops/ Invited Talks	**20**	14	1	2	3	0
Technologies or Techniques	**11**	3	1	3	3	1
Inventions, patent applications, and/or licenses	**0**	0	0	0	0	0
Websites or Other Internet Sites	**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	**17**	4	0	5	5	3

Examples of peer reviewed journal articles

Mason, H. B., Hurwitz, D., Buker, K.*, Adams, R., Slocum, R., & Scott, M. H. (In Press) "Increasing Student Understanding of Response Spectra: A Case for the Inductive Learning Approach," Earthquake Spectra. http://earthquakespectra.org/doi/10.1193/040417EQS060O

Mohebifard R.* and A. Hajbabaie. Real-time Adaptive Traffic Metering in Connected Urban Street Networks. Transportation Research Part C: Emerging Technologies, Submitted, 2017. J29.

Anderson, J. C., Salvador Hernandez, Eric Jessup and S. North. "Perceived Safe and Adequate Parking: A Random Parameters Binary Logit Analysis of Truck Drivers Opinions in the Pacific Northwest." International Journal of Transportation Science and Technology. Accepted for Publication 2018 / In Press.

Goodchild, Wygonik, Mayes (in press) "An Analytical Model for Vehicle Miles Travelled and Carbon Emissions for Goods Delivery Scenarios" Europena Transport Research Review

Abdel-Rahim, Ahmed, Kevin Chang, and Riannon Zender. "Evaluation of Vehicle Detection Systems for Traffic Signal Operations." Journal of Transportation Engineering, Part A: Systems 144, no. 2 (2017): 04017075.

Anderson, J.C., Hernandez, S., Jessup, E.L., North, E., 2018. Perceived safe and adequate truck parking: A random parameters binary logit analysis of truck driver opinions in the Pacific Northwest. International Journal of Transportation Science and Technology, 7(1), pp. 89-102

Yong Wang, Shouguo Peng, Kevin Assogba, Yong Liu, Haizhong Wang, Maozeng Xu, Yinhai Wang. Implementation of Cooperation for Recycling Vehicle Routing Optimization in Two-echelon Reverse Logistics Networks. Under Revision with Sustainability, March 2018.

Yong Wang, Yingying Yuan, Kevin Assogba, Ke Gong, Haizhong Wang, Maozeng Xu and Yinhai Wang. Design and Profit Allocation in Two-echelon Heterogeneous Cooperative Logistics Network Optimization. Accepted by Journal of Advanced Transportation, March 2018.

Harith Abdulsattar, Alireza Mostafizi, and Haizhong Wang. Surrogate Safety Assessment of Work Zone Rear-end Collisions in a Connected Vehicle Environment: An Agent-based Modeling Framework. Accepted by ASCE Journal of Transportation Engineering Part A: Systems. Nov, 2017.

Ke, Ruimin, Zhibin Li, Jinjun Tang, Zewen Pan, and Yinhai Wang. "Real-Time Traffic Flow Parameter Estimation from UAV Video Based on Ensemble Classifier and Optical Flow." IEEE Transactions on Intelligent Transportation Systems. In Press. Jan. 2018.

Kang B, Moudon AV, Hurvitz PM, Saelens BE. Differences in behavior, time, location, and built environment between objectively measured utilitarian and recreational walking. Trans Res D, 2017, (57):185-194 http://dx.doi.org/10.1016/j.trd.2017.09.026

Kang B, Moudon AV, Hurvitz PM, Saelens BE. Increased Walking's Additive and No Substitution Effect on Total Physical Activity. Med Sci Sports Exerc. 2018,50(3):468-475. doi: 10.1249/MSS.0000000000001450. PMID: 29016392.

Example of book chapters and other edited manuscripts

Yinhai Wang, Ziqiang Zeng. Overview of Data-driven Transportation Science. Yinhai Wang, Ziqiang Zeng, Data-driven Transportation Science: Methodologies and Applications, 2018, Elsevier, book, awaiting publication.

Examples of conference papers and presentations

Poster Presentation: Transportation Corridor Resiliency in the Face of a Changing Climate, Pactrans Annual Meeting, Seattle, WA. (October 6, 2017)

Olsen, M., Wartman, J., Leshchinsky, B. Rockfall Activity Index (RAI). 2017 PacTRans Yearly PI Meeting. Seattle, WA.

T68. Sattarov S.* and A. Hajbabaie. Driver Comprehension Survey of Left-Turn Signals. Asset Management Subcommittee of Traffic Signal Systems Committee Meeting, the 97th Annual Meeting of the Transportation Research Board, Washington, DC, January 7-11, 2018.

T64. Tajalli M.* and A. Hajbabaie. Collison Mitigation at Signalized Intersections Using Connected Vehicles Data and Technologies. The 97th Annual Meeting of the Transportation Research Board, Washington, DC, January 7-11, 2018.

Hernandez, S., Jessup, E. L. "Safe & Adequate Truck Parking in the Pacific Northwest: Analysis of Truck Driver Survey." Paper presented at the PacTrans Conference, Seattle, WA, October 2017.

Sheth, Ghodrat, Goodchild, Hurwitz, McCormack "An Examination of the Impact of Increasing Commercial Parking Utilization on Cyclist Safety in Urban Environments" PacTrans Regional Conference, Seattle WA (October, 2017)

Sheth, Ghodrat, Goodchild, Hurwitz, McCormack "An Examination of the Impact of Increasing Commercial Parking Utilization on Cyclist Safety in Urban Environments" International Urban Freight Conference, Long Beach CA (October, 2017)

Manali Sheth, Masoud Ghodrat Abadi, Anne Goodchild, David Hurwitz, Ed McCormack "The Impact of Increasing Commercial Parking Utilization on Cyclist Safety in Urban Areas" International Urban Freight Conference, Long Beach, California, October 17-20, 2017

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

Belakaria, Syrine, Mustafa Ammous, Sameh Sorour, and Ahmed Abdel-Rahim. "Optimal Vehicle Dimensioning for Multi-Class Autonomous Electric Mobility On-Demand Systems." arXiv preprint arXiv:1801.01763 (2018).

Simpson, C., C. Parrish, S. Sorour, A. Abdel-Rahim, and D. Hurwitz, 2017. Airborne Lidar Scanning and Deep Learning System for Real-time Event Extraction and Control Policies in Urban Transportation Networks. Pacific Transportation Consortium (PACTRANS) Region 10 Conference (Poster Session), 6 October, Seattle, Washington.

Pacific Northwest Transportation Consortium (PacTrans) Region 10 Conference, "Safe and Adequate Truck Parking in the Pacific Northwest: Analysis of a Truck Driver Survey" October 2017

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

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

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

Belz, N., Fulton, G., Prakash, A. (October 2017). The Application of Hyperspectral Remote Sensing to Measure Roadway Anti-Icing and Deicing Chemical Migration, 2017 Region 10 Transportation Conference, Pacific Northwest Transportation Consortium, Seattle, WA.

Yi Wang, Christopher Monsere, Chen Chen, and Haizhong Wang. Development of a Crash Risk Scoring Tool for Pedestrian and Bicycle Projects in Oregon. Accepted for presentation at the 97th Transportation Research Board Annual Meeting. October, 2017. (Paper 18-00738)

Example of lectures/seminars/workshops/invited talks

Comparisons between structure from motion and terrestrial lidar for rockslope assessments, Endeavour programme workshop: Earthquake-induced landslides and landscape dynamics: planning for, and avoiding landslide hazard and risk. at GNS Science, Lower Hutt, New Zealand, February 27, 2018.

Leshchinsky, B., Olsen, M. and M. Bunn. Assessing Geohazards with Lidar. Golden, Colorado, February 2018.

Ahmed Abdel-Rahim, "Allowing 129,000 lb Trucks on Local Highway, What's the Damage?", Idaho's Local Highway Technical Assistance Council (LHTAC) meeting, Boise, Idaho, December 2017.

Ahmed Abdel-Rahim, "Connected and Smart City Research Activities at the University of Idaho", Urbanova Stakeholder Meeting, Spokane, WA March 2018.

Parrish, C.E., and J. Park, 2018. ODOT/OSU Research Projects. ODOT Surveyors Training Seminar. 13 March, 2018, Salem, Oregon. {Note: although this seminar focused on ODOT research, results of our closely-related PacTrans research on UAS in transportation were also presented.}

Global Symposium on Smart Manufacturing. "Critical Technologies for Smart and Connected Communities." Hangzhou, Nov. 18, 2017.

Keynote at the 3rd International Forum on Transport Big Data Sharing & Collaboration. "Designing Future Mobility: A Critical Mission of Transportation Data Scientists." Shenzhen, Nov. 17, 2017.

Smart Cities Symposium at the Future Forum. "Get Ready for the Disruptive Technologies in Smart Transportation." Beijing, Oct. 28, 2017.

Technologies or Techniques

Surface-bonded PZT patch system in the evaluation of concrete Wave Modulus of Elasticity (WMoE)
Rockfall Activity Index - Time Evolution Model. Currently being packaged.
System to track location and orientation of worker on construction site.
Alaska DOT is adopting the Dust Column Palliative Test as an Alaska Test Method. The new Alaska Test Method will be published in May 2018
Simpson, C., R. Slocum, and C. Parrish, 2017. Low-cost, directly-georeferenced unmanned aircraft system (UAS) based lidar for transportation applications. (Technology)
Technique to determine optimal joint vehicle dimensioning, dispatching, and routing for autonomous and electric mobility on-demand systems.
Technique to determine optimal joint delay and cost of in-route charging for electric mobility on-demand systems.
Technique to identify vehicles from airborne LiDAR scans
Mobile Unit for Sensing Traffic -2 (MUST-2), funded by PacTrans and WSDOT Smart Road Sticker for Parking Space Detection, found by Sound Transit Project, March 2018

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

Rockfall Activity Index V2.0. Currently being packaged. Contour Connection Method V2.0.
Mason, H. B., Hurwitz, D., Buker, K.*, Adams, R., Slocum, R., & Scott, M. H. (In Press) "Increasing Student Understanding of Response Spectra: A Case for the Inductive Learning Approach," Earthquake Spectra. http://earthquakespectra.org/doi/10.1193/040417EQS060O
Report: Safety Data Management: Gathering and Using the Data
Simpson, C., and C. Parrish, 2017. Georeferenced UAS lidar point clouds for Newberg-Dundee construction site. (Data available on request via FTP site or portable hard drive.)
Truck Driver Survey Data
Software to determine optimal joint vehicle dimensioning, dispatching, and routing for autonomous and electric mobility on-demand systems.
Software to determine optimal joint delay and cost of in-route charging for electric mobility on-demand systems.
Software to identify vehicles from airborne LiDAR scans
Alaska Off-Highway Vehicle Count Database
Anti-Icing and Deicing Spectral Library
Pedestrian behavior monitoring module based on mobile sensing data MUST-2 based roadway surface condition monitoring tool
Near misses detected by the video software used for assessing the efficiency of the Mobileye Shield+ system, funded by PacTrans and TRB Transit IDEA.

Participant and Collaborating Organizations: Who has been involved?

What individuals have worked on the program?

- PacTrans Director, **Yinhai Wang**, Ph.D., Professor of Civil and Environmental Engineering at the UW, devotes 30 percent of his time directing PacTrans. Dr. Wang has overall responsibility for program management, oversight of PacTrans operations, including the Research Committee, the Education and Workforce Development Committee, and the Outreach and Technology Transfer Committee, and

Student Leadership Council. He is the regional and national leadership for PacTrans, and the contact person for management relationships with USDOT Research and Innovative Administration (RITA) and other USDOT organizations.

- PacTrans Associate Director in Research, **Jeff Ban**, Ph.D., Associate Professor of Transportation Engineering in Civil and Environmental Engineering at the UW spends 5 percent of her time managing the research program for PacTrans and coordinates the research collaboration across the five partner institutions.
- PacTrans Associate Director in Education and Workforce Development, **Anne Vernez-Moudon**, Dr. es SC, Professor of Architecture, Landscape Architecture, and Urban Design and Planning, Adjunct Professor of Epidemiology and in Civil and Environmental Engineering, devotes 5 percent of her time leading the Education and Workforce Development Committee. She is involved in curriculum changes, training program development, and educational enhancements among the partner institutions.
- PacTrans Associate Director in Oregon State University (OSU), **David Hurwitz**, Ph.D., Professor of Civil and Construction Engineering at OSU, devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within OSU. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in the University of Alaska Fairbanks (UAF), **Billy Connor**, Director of the Alaska University Transportation Center (AUTC), devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within UAF. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in University of Idaho (UI), **Ahmed Abdel-Rahim**, Ph.D., Associate Professor of Civil Engineering at UI, devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within UI. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in Washington State University (WSU), **Eric Jessup**, Ph.D., Associate Professor and Transportation Economist in the School of Economic Sciences at Washington State University (WSU), devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within WSU. He coordinates all results and outcomes with the UW on a regular basis.
- Assistant Director, **Cole Kopca**, devoted 90 percent of his time to the day-to-day operations in support of the PacTrans mission. His responsibilities include project management, grant management, events coordination and outreach, and managing the PacTrans operations team.
- PacTrans full-time Program Coordinator, **Melanie Paredes**, devoted 90 percent of her time to the Center's fiscal matters, support with events coordination and outreach and day to day administration.
- **Ziqiang Zeng**, Ph.D., Research Associate in the PacTrans STAR Lab at the University of Washington, devotes 30 percent of his time in providing research support and oversight.
- The Student Leadership Council, composed of graduate students at all Consortium partner universities, is an active part of the PacTrans management structure. The Student Leadership Council facilitates student and center communications and plans their own activities such as the Region 10 Student Conference.

- PacTrans has 28 fulltime faculty at the UW engaged in transportation research. Our consortium partners (OSU, UI, WSU, UAF) have 41 fulltime faculty directly involved in PacTrans research.

What other organizations have been involved as partners?

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

Partner	Type	Fund Match		Serve on EAB	Project Collaborator	Event Collaborator
		Financial	In Kind			
Alaska State Department of Transportation	Government	X		X		
Idaho Transportation Department	Government	X		X		
Oregon State Department of Transportation	Government	X		X		
Washington State Department of Transportation	Government	X		X		
City of Bellingham	Government					
City of Seattle	Government	X				
City of Lynnwood	Government				X	X
City of Bellevue	Government				X	X
City of Everett	Government					X
King County	Government				X	X
Snohomish County	Government					
Pierce County	Government				X	
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
Washington State Department of Ecology	Government	X				
Puget Sound Regional Council	Government			X		
Washington State Transportation Investment Board	Government Agency					X
American Society of Civil Engineers	Professional Association					X
Institute of Electrical and Electronics Engineers	Professional Association					X
Institute of Transportation Engineers	Professional Association					X
Port of Portland	Government			X		

BMW Group	Private Industry			X		
Western Trailers	Private Industry			X		
Coral Sales Co.	Private Industry	X				
National Institute for Transportation and Communities	University Transportation Center				X	X
Transportation for Livability by Integrating Vehicles and the Environment	University Transportation Center				X	X
Center for Environmentally Sustainable Transportation in Cold Climates	University Transportation Center				X	X
Aichele and Associates	Private Industry				X	
Alstom Grid Inc.	Private Industry				X	
Alta Planning and Design	Private Industry				X	
Battelle	Private Industry				X	X
Cascade Bicycle Club	Non-profit/ Foundation				X	X
Feet First	Non-profit/ Foundation					X
DKS Associates	Private Industry	X				X
Fehr and Peers	Private Industry				X	X
Inrix Inc.	Private Industry				X	
Transpo Group	Private Industry	X				X
Intelligent Transportation Systems of Washington	Professional Association					X
Luum	Private Industry				X	X
Kittelson and Associates	Private Industry			X		X
Microsoft	Private Industry				X	X
BlackBerry	Private Industry				X	X
PACCAR, Inc.	Private Industry				X	X
West Salem High School	Educational Institution				X	X

Impact

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

The State of Idaho Governor, Butch Otter, has recently issued an executive order, NO. 2018-01, creating an Autonomous and Connected Vehicle Deployment Committee. The Committee membership is comprised of the following standing members: the Director of the Transportation Department, the Director of the Department of Commerce, the Director of the Department of Insurance, the Director of the Idaho State Police, Legal counsel from the Office of the Governor, two members of the Idaho Legislature (one appointed by the Speaker of the House and one appointed by the President Pro Tempore of the Senate), and the Director of Information Security.

PacTrans Associate Director and Professor of Civil Engineering at the University of Idaho, Ahmed Abdel-Rahim, and PacTrans PI and Professor of Computer Science at the University of Idaho, Axel Krings, have been appointed to the technical advisory committee for this executive committee. PacTrans and its researchers are extremely devoted to the mission of efficiently and responsibly seeing the successful implementation of connected and autonomous vehicles into our vehicle fleets and the hope that this innovation in cutting edge technology will revolutionize mobility and the way people move in their every-day lives. This is one example of the many ways that PacTrans expertise is helping form the future of our transportation networks.

What is the impact on other disciplines?

The four states in region 10 constitute 24% of the total US land but only 5% of the population. We have two of the fastest growing metropolitan areas in Seattle and Portland, and many of the most rural and isolated communities in the country in Alaska. We are therefore confronted with the broadest assortment of mobility challenges for both people and goods. Further, as a regional University Transportation Center, we feel that we have a responsibility not onerously narrow our focus, which would result in many of our diverse mobility challenges going unexplored.

Our work, therefore, naturally touches on many tangential disciplines as can be seen in the diversity of research projects we have funded thus far. During our first research cycle under this grant, PacTrans has funded research concerning: connected and autonomous vehicles, freight and goods delivery, school crossings, work zones, seating accessibility for the disabled on public transit, mobility on demand services, electric charging networks, connected infrastructure, and dynamic metering and other innovative operations controls. These works intersect other disciplines with regard to schooling and education, public health, energy, computer science, electrical engineering, urban planning, and many, many more.

What is the impact on transportation workforce development?

For about a year now, PacTrans has been in communication with the Washington State Department of Transportation as they are rapidly approaching the incoming “brain drain” where a significant portion of their workforce will be retiring and most of that knowledge and experience will be lost. They have

conveyed a strong interest in reestablishing a continuing education and workforce development program as PacTrans has reported previously.

Since that time, PacTrans has identified that many of our consortium universities engage their respective state DOTs, to some extent or another, in similar efforts. It seems, however, that these efforts are fairly inconsistent and, in some places, chaotic. The PacTrans board decided, therefore, that it would pursue consolidated and congruent platform from which to build a continuing education and workforce development institute that offers all of the courses desired by state DOTs and that can also be expanded to become useful to other public agencies as well as private industry.

The first phase of this work, which is already underway, has collected survey responses from transportation professionals about the kinds and format of continuing education that they would find most useful. It also includes the development of a business plan and administrative structure from which to begin building the institute. Obviously there will be much more to come on this effort in coming performance periods, but PacTrans is very excited about the prospect of providing this much needed resource to our state and local agencies.

What is the impact on technology transfer?

One of PacTrans' ongoing research projects at the University of Washington is focused on the exploration of urban freight movement and, more specifically, innovative strategies for urban goods delivery systems. The investigators are partnering with the Seattle Department of Transportation (SDOT) to pilot test a common-carrier smart locker system in the Seattle Municipal Tower from late March through April 2018. The pilot will test the ability of new mini-distribution centers in cities – such as smart lockers – to create delivery density and reduce the time delivery people have to spend in urban towers to complete their work. They are collecting 'before' and 'after' data to evaluate the pilot's premise: that when delivery trucks can pull into a load/unload space that's close to a mini-distribution node with delivery density (lots of deliveries in one place), everyone benefits.

This project is a great example because the technology transfer is built right into the project. This work will expose building owners/operators and freight carriers about the benefits of new technologies in the urban goods delivery space.

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

With the five-year FAST Act grant, PacTrans has committed to making data used and generated during research, available to the public. As the University of Washington (the lead university of our UTC) does not have a centralized data sharing platform, this requires is to build our own repository for storing and sharing the data. While this is requiring some extra work, it is also providing a tremendous opportunity for our researchers, students and staff, to gain real-world experience with data management and analysis.

The PacTrans board has designed a structure where a significant portion of the data used and generated from research is housed on the Harvard Dataverse, while all of the data will be available and backed up

on our own servers. Our researchers, staff, and students will be responsible for upkeep of this repository and its contents. As this grows, it will become a significant resource to our department and our university from both a physical and informational context.

What is the impact on society beyond science and technology?

One of PacTrans' first-year funded research projects, being conducted at Oregon State University, is exploring accessible seating areas on next generation passenger rail cars using 3D modeling and virtual reality. This project extends work that was conducted for the US Access Board and the Federal Railroad Administration. Previous work conducted a preliminary spatial analysis to determine if two or more wheeled mobility devices (WhMD) could be accommodated in the seating compartment on the next generation passenger trains. The previous project identified that it is possible to spatially accommodate two WhMD. Additional analysis is necessary to develop detailed layouts for the accessible seating area to accommodate two WhMD and also provide for containment of both occupied and unoccupied WhMD to optimize occupant protection of people who use WhMD and other passengers. The original project showed that it is possible to accommodate two WhMD with the loss of one or two revenue seats. The significant concern is that occupant protection and containment of WhMD is severely compromised.

This project uses 3-D modeling tools, anthropometric digital human models, and virtual reality to design and evaluate passenger rail environments for inclusivity and safety while also considering design constraints for vehicle builders and operators. By itself, 3-D modeling provides a means of digitally evaluating design feasibility of potential accommodations. Including anthropometric human models into early phases of design then accounts for human factors and ergonomic factors as well, however a physical mockup would still be required to access validity and target user opinion. Creating a virtual reality environment based on evaluated 3-D models and using it for human subject evaluation will create a framework that eliminates the need for a potentially expensive and time-consuming physical mockup. Using digital evaluation would also permit the inclusion of analysis for many different types of WhMD, design scenarios, and anthropometric users within the same space. It is anticipated that one of the results of this project will be a framework for using 3-D modeling and virtual reality to evaluate and test spatial consumption, feasibility, human factors, and human environment interaction on other modes of rail travel as well, for example transit and light rail vehicles.

PacTrans is strongly devoted exploring the mobility concerns of traditionally underserved people groups, such as the disabled, and this is one such example of that focus.

Changes/Problems

NONE.

Special Reporting Requirements

NONE.