



## 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): Developing Data Driven Solutions and Decision-Making for Safe Transport in the Pacific Northwest**

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**Project/Grant Period:** June 30, 2014- September 30, 2018

**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. PacTrans' theme centers on "Developing Data Driven, Sustainable Solutions for the Diverse Transportation Needs 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 safety. Major goals and objectives of PacTrans include:

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

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

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

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

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

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

### What was accomplished under these goals?

During the period from April 1, 2017 – September 30, 2017, PacTrans was actively engaged in each goal and objective identified above. This was achieved through a breadth of activities that were conducted to ensure our transportation expertise contributes to the advancement of the region's transportation research, technology transfer, education, workforce development, outreach, and collaboration.

## Research

As Region 10's research engine, PacTrans has been actively engaged in two broader categories of research projects. We engage in multi-institutional research projects that require participation from at least two consortium universities, and typically have a larger budget. Such projects include multi-institutional general research projects, as well as a multi-institutional educational project, and a multi-institutional outreach project. We also engage in single institutional projects (referred to as small research projects) that only require participation from a single consortium university and typically have smaller budgets. Both categories of research are geared towards the goal of advancing the region's transportation research.

In the last six months, while PacTrans has been finishing up the external reviewer process for year 3 (2015-2016) and year 4 (2016) funding-cycle research project reports, year 5 (2016-2017) investigators have been working hard on their projects. Many of the draft reports of those projects have been submitted and the remaining projects are due at the end of April. The year 3 and 4 projects will soon be finalized and then disseminated to the proper repositories. These reports will then be promptly posted on the PacTrans website and upload to 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. As the year 5 draft reports are submitted, they are disseminated to external reviewers for comment and then returned to the PIs for edits. Once the reports have been finalized they will be resubmitted to the PacTrans office and will also be disseminated through the various avenues that were described above.

## Technology Transfer

PacTrans is making its best effort to promote technology transfer through the early engagement of interested partners in its research projects. For each selected multi-institutional projects, PacTrans requires the research team to deliver a product for tech transfer. \$20,000 technology transfer funds are reserved for the potential technology transfer activities upon the successful completion of the proposed research for each multi-institutional project. Once a sufficient pool of projects have been completed, the center solicits 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 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 selects a handful of projects to receive sufficient funding to execute the proposed activity(s).

During this past reporting period, PacTrans put out one such request of success story proposals to all PIs who have completed projects that were funded under this grant. In all, PacTrans received sixteen high quality proposals. The board reviewed each proposal and has elected to fund each of the sixteen technology transfer activities, totaling roughly \$200,000. These activities, and the subsequent reports for those activities, are due at the end of July.

During the reporting period, PacTrans PIs took 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.

## 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. 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 97<sup>th</sup> 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 from 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 & Collaborations

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. During this grant, the PacTrans Multi-Institutional Outreach project has focused on transportation safety promotion to college-, high school-, middle school-, and elementary school-age students. During this reporting period, **one interesting outcome/extension of this work included UI educators going into classrooms (grades 1 – 8) to teach about traffic safety. Each lessons consisted of 15 minutes of traffic safety education/discussion, then 20 minutes were allocated to art creation. Over 200 pieces of student art was created and then displayed at NIATT.** Leaders from the University, City and Schools were invited to attend a reception in February to celebrate and highlight the students’ work. Approximately forty-five people attended the reception (nineteen students, twenty-four adults).
2. 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.
3. In October, PacTrans Director, Yin Hai 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.

### 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 has a strong outreach program to local and state transportation agencies and private partners in the region, where PacTrans research outcomes are presented and demonstrated. Research outcomes are posted on the PacTrans website, distributed through our *quarterly newsletter* and *annual reports*, and promoted through social media such as *Facebook* and *Twitter* and the University of Washington *press media*. We also disseminate news, events and results via our website at [www.pactrans.org](http://www.pactrans.org).

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 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**

PacTrans will be publishing technical reports from year 3 (2015-2016) and year 4 (2016) funding-cycle projects. These will then be promptly disseminated to the proper repositories. Year 5 (2016-2017) funding-cycle project draft reports are due at the end of April and will be put through a peer review process as they come in.

### **Technology Transfer**

PacTrans will be overseeing the sixteen success stories that were funded during this performance period. As those materials and activities are completed they will be circulated to our mailing lists and published on our website for broadened use.

In July, PacTrans Director, Yin Hai 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. This May, PacTrans is sponsoring the 3<sup>rd</sup> annual Transportation Engineering Education Workshop to be held at Auburn University.
2. 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.
3. 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 Georgia 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 & Collaboration

As this center, which PacTrans refers to as “Center 2,” (the MAP-21 center) winds down, PacTrans will continue shifting focus from safety to mobility, which we see as a broader subject that includes safety. Therefore, outreach specifically geared toward this center will begin to taper while our steadfast commitment to promoting PacTrans as a premier regional university transportation center will sustain. There are several items already in the works for this upcoming reporting period.

For example, as previously discussed, PacTrans consortium partner engage expensively in their universities’ respective outreach activities to students. UW Engineering Discovery Days, OSU Student Expo, and UAF Engineering Week are all examples of university specific initiatives that seek to raise interest of middle and high school students in STEM education and careers.

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

	Total	UW	WSU	UI	OSU	UAF
Publications: peer reviewed journal articles	105	51	3	11	38	2
Publications: Book chapters and other edited manuscripts	8	0	0	0	0	0
Conference papers	111	56	8	17	27	3
Conference presentations	136	63	19	17	34	3
Lectures/Seminars /Workshops/ Invited Talks	104	54	8	9	29	4
Technologies or Techniques	28	8	1	12	6	1
Inventions, patent applications, and/or licenses	0	0	0	0	0	0
Websites or Other Internet Sites	7	5	1	0	1	0
Other products: data or databases, physical collections, audio or video products, software or NetWare, models, educational aids or curricula, instruments, or equipment	36	7	2	15	7	5

## Examples of peer reviewed journal articles

- O'Banion, M.S.\*, Olsen, M.J., Rault, C., Wartman, J., and Cunningham, K. (In Press). "Suitability of Structure from Motion for Rock Slope Assessment," *Photogrammetric Record*.
- Jung, J.\* Olsen, M.J., Hurwitz, D.S., Kashani, A.G.\*, and Buker, K. (2018). "3D Virtual Intersection Sight Distance Analysis Using Lidar Data," *Transportation Research Part C*, 86,563-579.  
<https://doi.org/10.1016/j.trc.2017.12.004>
- 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/10.1193/040417EQS0600>
- 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" *Europeana Transport Research Review*
- Lee, H.W., Harapanahalli, B.A.\*, Nnaji, C.\*, Gambatese, J., and Kim, J.\* (accepted for publication on February 7, 2018). "Feasibility of using QR Codes in Highway Construction Document Management." *Transportation Research Record: Journal of the Transportation Research Board*.
- 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.
- Sallehi, H., Ghods, P., and Isgor, O.B. (In review). "Formation factor of fresh cementitious pastes," *Cement and Concrete Composites. 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.
- Craig A. Davis, Ali Mostafavidarani, Haizhong Wang. Establishing Characteristics to Operationalize Resilience for Lifeline Systems. Accepted by *ASCE Natural Hazard Review*, Feb. 2018.
- Lei Jin, Haizhong Wang, Binglei Xie, L. Yu, & Lin Liu. A User Exposure Based Approach for Non-structural Road Network Vulnerability Analysis. *PLOS One*, 2017, 12(11):e0188790.  
<http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0188790>.
- 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.
- Shangjia Dong, and Alireza Mostafizi, Haizhong Wang, and Jia Li. A Stochastic Analysis of Highway Capacity: Empirical Evidence and Implications. *Journal of Intelligent Transportation Systems, Planning and Operations*, Pages 1-15, Oct. 2017.  
[\url{https://doi.org/10.1080/15472450.2017.1396898}](https://doi.org/10.1080/15472450.2017.1396898)

- 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.
- Li, Yunjie, Dongfang Ma, Mengtao Zhu, Ziqiang Zeng, and Yinhai Wang. "Identification of Significant Factors in Fatal-Injury Highway Crashes Using Genetic Algorithm and Neural Network." *Accident Analysis & Prevention*. Vol. 111, 354-363, 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

- Presentation: The Rocky Road: Proactive Management of Unstable Rock Slopes Near Highways. *PacTrans Annual Meeting*, Seattle, WA. (October 6, 2017)
- 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. Collision 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.
- T62. Islam S.M.A.\* and A. Hajbabaie. A Two-Stage Model for Predicting Crash Frequency by Severity Type. *The 51st Annual Pacific Northwest Regional Economics Conference*, Bend, OR, 2017 (Podium).
- 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)
- Lee, H.W., Harapanahalli, B.A.\*, Nnaji, C.\*, Gambatese, J., and Kim, J.\* (2018). "Feasibility of using QR Codes in Highway Construction Document Management." *Proc. 2018 Transportation Research Board (TRB) Annual Meeting*, Washington, DC.

- 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
- Saras, N. \*, Ibrahim, A., Abel-Rahim, A., Nielsen, R.J. "Allowing 129,000-Pound Trucks on Our Highways; What Is The Cost? What Are the Benefits?", 97th Annual Meeting of the Transportation Research Board, National Research Council, Washington, D.C. 2018.
- Nicholas Saras, Ahmed Ibrahim, Ahmed Abdel-Rahim, Richard Nielsen "Exploratory Examination of Allowing 129,000 lbs Trucks on our Highways", Proceedings of the TRB 97th Annual Meeting, Transportation Research Board, National Research Council, Washington, D.C., January 2018, Paper # 16- 18-01452.
- 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.
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- 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)
- Alireza Mostafizi, Haizhong Wang, Dan Cox, and Shangjia Dong. An Agent-based Model of Vertical Tsunami Evacuation Behavior and Shelter Locations: A Multi-Criteria Decision-Making Problem. Accepted to the 97th Transportation Research Board Annual Meeting. October, 2017. (Paper # 18-06293)

## 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/10.1193/040417EQS0600>
- 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 25 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. This number is down from previous reports because Dr. Wang has begun shifting his attention to the new center, Center 3.
- 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 Research Professor in the School of Economic Sciences at Washington State University (WSU) and Director of WSU’s Freight Policy Transportation Institute, 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 50 percent of his time to the day-to-day operations in support of the PacTrans mission. His responsibilities include outreach and marketing, communications, and oversight of the PacTrans operations team including: events coordination and research management number has reduced because Mr. Kopca has begun focusing half of his attention on PacTrans’ new center.
- PacTrans full-time Program Coordinator, **Melanie Paredes**, devoted 50 percent of her time to the Center’s fiscal matters, support with events coordination and outreach and day to day administration. This number has reduced because Ms. Paredes has begun focusing half of her attention on PacTrans’ new center.
- PacTrans full-time grants, finance, and research manager, **Christina Yarbrough**, devotes 50 percent of her time to matters for grant management, financial and budgeting processes, and research management. She spend the rest of her time on PacTrans’ new center.
- **Kristian Henrikson**, doctoral candidate and research assistant in the PacTrans STAR Lab at the University of Washington, devotes 25 percent of his time in providing research support and oversight.
- PacTrans has also hired a new graduate student intern, **Chris Gottsacker**, who is also a research assistant in the PacTrans STAR Lab at the University of Washington. Mr. Gottsacker commits 5 percent of his time miscellaneous tasks such as updating contact lists and keeping minutes during partnership meetings.
- 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?

The table below highlights the many partnerships that PacTrans has built over the duration of this grant:

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

## Impact

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

PacTrans’ ongoing multi-institutional education project has been to investigate the continuing educational needs of safety data management and analysis in the Pacific Northwest.

There are over five million traffic crashes reported annually in the United States [NHTSA] and the documentation process for every single crash begins at the scene of the incident with information gathered by a member of the law enforcement community or by the private citizens. This information is subsequently transmitted to a local and state agency for data entry, processing, and aggregation. Given the volume of incidents and the multiple handoffs between different parties, the likelihood for transmission error and interpretation deviation necessitate a cradle-to-grave examination of this reporting process. Furthermore, each state has developed its own independent tracking system, rendering data comparisons across state boundaries to be inconsistent. These collective issues justify the need to examine crash reporting and to identify a process where data entry is streamlined to best meet the needs of all system users that include, but are not limited to: law enforcement, local and state agency data analysts, national and state agency safety offices, and researchers and academicians who must rely on good data to draw conclusions and recommend purposeful safety improvements.

The objectives for the project respond to the current gaps in research and identify a methodology that will benefit all system users. These objectives include the following: develop a comprehensive understanding of needs and priorities with regard to safety data management and analysis; develop a set of core skills and knowledge required for safety data management and analysis; provide a comprehensive set of safety data workforce development resources that can easily be accessed for use

and distribution; and identify and utilize proven delivery pipelines to supplement program outreach efforts and activities in the safety data area.

### **What is the impact on other disciplines?**

PacTrans has a handful of researchers that have focused on safety in the movement of freight. During the final research cycle of this grant, one of those investigators, from the University of Washington, explored safe truck parking which has become a significant safety concern across the country.

An inadequate supply of parking spaces for long-haul drivers creates safety issues that may lead to severe or fatal crashes, as tired drivers face the decision of choosing between parking at unsafe locations or continuing to drive. To better understand the current use of truck parking facilities and safety issues caused by the lack of parking capacity in high-demand locations, the researchers then identified and provided a qualitative analysis of future trends that will affect this problem.

Finally, the research team developed and executed a survey of truck drivers at two long-haul trucking parking facilities. The research team focused on two high-volume multi-state truck corridors, the Interstate 5 and 90 corridors, that are of interest to the Washington Department of Transportation (WSDOT) and neighboring state DOTs.

The results of this work, which can be found in the technical report that will be published soon, highlight a number of important truths that will prove pivotal as state DOTs and local municipalities begin to explore how to better provide necessary havens for our freight movers in the future.

### **What is the impact on transportation workforce development?**

For several years, PacTrans has been involved in an evolving project that started as a TRB IDEA grant to look into bus-to-pedestrian detection censoring for public transit. Researchers from the University of Washington have partnered with the Washington State Transit Insurance Pool to install 20+ camera on transit vehicles around Washington State to pilot such technologies.

One of the key components of these works has been to train drivers on how the technology works, gather feedback from drivers about the technology, and build methods and algorithms for making the technology more useful to the those drivers. In some recently completed studies, we have found that many driver find the buzzing of the early warning sensors to be bothersome as, in many situations, the technology is “too sensitive.”

One interesting externality of this, however, is that many of those drivers have unconsciously altered their driving behavior to stay further away from potentially hazardous situations so as not to instigate the buzzing. This partnership between researchers/developers and transit operators has proven extremely fruitful in the bettering of this technology moving forward.

### **What is the impact on technology transfer?**

In our final research cycle under this grant, a PacTrans investigator from the University of Idaho explored safety of Idaho rural highways under 129K pound trucks. The technical report presents guidelines and procedures for local highway jurisdictions when evaluating requests to allow 129,000-pounds trucks on

local routes in the state of Idaho. The procedures outlined in this report are based on and followed the Idaho Code 49-1004A (1) which states “the authority having jurisdiction may designate routes ... for vehicles not exceeding ... 129,000-pounds, utilizing criteria established by the board based upon road and bridge structural integrity and engineering standards”.

This work has already generated significant interest around the state of Idaho and the PacTrans investigator on this project has been invited to present the findings and outcomes of the work to local officials in a half day workshop.

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

Each year, all of the PacTrans consortium member university are given a small education and outreach budget. These funds are to be used to support student activities and opportunities and/or to support initiative that our associate directors feel are in line with our mission as a regional University Transportation Center. Following are several examples of ways that these funds are used.

This year, PacTrans has elected to use some education and outreach funds to sponsor the 3<sup>rd</sup> Transportation Engineering Workshop that will be held in May at Auburn University. The two-day workshop and conference will provide an opportunity for transportation engineering faculty to work together to learn of best practices in engineering education, develop activities for their classes, and create or further develop their networks with other teaching faculty. There will also be at least one PacTrans Associate Director present for the workshop.

This year, for the first time, the ITE Western District Student Leadership Summit was held in the Pacific Northwest at Oregon State University. PacTrans sponsored this event, which brought together over 120 student from twenty-five different schools from the Western District and two students from U-Mass Amherst, who are preparing to host their first Student Leadership Summit in April. PacTrans will also be using some funds to send three students to UMass for their first ITE Student Leadership Summit.

Many of our education and outreach funds are used to afford student researchers the opportunity to travel to conferences around the country with the opportunity to share research through presentations and posters, discover new ideas and areas of emerging research, and meet others in the transportation world. Two quick examples include the University of Idaho sending several students the regional ASCE conference, and the University of Washington will be sending a handful of students to the ASCE International Conference on Transportation and Development.

### **What is the impact on society beyond science and technology?**

As has been shared in many previous reports during this grant, PacTrans has had an ongoing multi-institutional outreach project that has focused on reaching students, from college age all the way down to elementary school age, to educate them on such transportation safety topics as lane departure crashes. In this report above, it has been shared that one recent outcome has been a number of educator from the University of Idaho have gone into middle and elementary schools to speak with students and then had them create art based on what they learned.

One brand new development in this project is that our investigators were recently contacted by officials in Saudi Arabia. As has recently been reported in the media, Saudi will soon begin allowing women to drive in their country. This will effectively put millions of new drivers on the road, all at one time. Therefore, they have been scanning for programs that are specifically geared at educating inexperienced drivers about common dangers behind the wheel. They came across the great work that has been done by our investigators on this project and have reached out for help with designing similar outreach materials and programs.

## **Changes/Problems**

NONE.

## **Special Reporting Requirements**

NONE.