Program Progress Performance Report for University Transportation Centers

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Accomplishments

What are the major goals and objectives of the program?

Pacific Northwest Transportation Consortium (PacTrans) consists of institutions from all four states in our region with the University of Washington (UW) as the lead and Oregon State University (OSU), University of Alaska Fairbanks (UAF), University of Idaho (UI), and Washington State University (WSU) as 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 October 1, 2016 – March 31, 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 (coded with MG), multi-institutional educational projects (coded with ME), and multi-institutional outreach projects (coded with MO). 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.

In the last six months PacTrans has completed its selection process for our year 5 (2016-2017) funding cycle projects. In all there are four multi institutional general research projects, one multi-institutional educational project, one multi-institutional outreach project, and eighteen single-institution projects. Funds for these projects have been distributed and projects began in December of last year. Topics from this year's research project include: exploration of new crash reporting processes, adaptive roadway lighting and control, transportation corridor resiliency, commercial vehicle crashes, rural bridge safety, safety of left-turn operations, near-miss detection methods using onboard video cameras, safety at transit stops, and others. **Each project, and its new project hot sheet, has been uploaded to our website (http://depts.washington.edu/pactrans/research/) for easy online access.** Each has also been put into the Research in Progress (RiP) database.

PacTrans is currently working with our network of external reviewers to complete the reviews of all year 3 (2015-2016) and year 4 (2016) funding-cycle research project reports and is preparing to finalize those reports so that they can be 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.

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 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). With all of the year 3 (2015-2016) and year 4 (2016) research currently being submitted, PacTrans will solicit such "success story" submissions soon.

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:

Without a doubt the largest opportunity for PacTrans PIs to engage in tech transfer over the last six months was our annual Regional Transportation Conference. It was held on the University of Washington campus on Friday, October 14, 2016. With the theme of *Inclusive Technology for Tomorrow's Transportation*, this one day event featured four moderated panel sessions ((1) Research Focus: Safety, (2) Technology Transfer, (3) Workforce Development, and (4) Research Hot Topics: Looking Ahead), a poster sessions, and a networking reception. **This year's event drew record numbers and had a total of nearly 220 registered in attendance.** Each PI who had active research at the time of the event had a poster presenting their work to an audience of academic colleagues, private industry professional, and government agency representative (there were 32 posters in all).

PacTrans also had a number of important people reach out about various completed and ongoing research projects. For example, PacTrans director, Dr. Yinhai Wang, sat down with Washington State Senator Joe Fain (of the 47th Legislative District) to discuss PacTrans and STAR Lab research efforts. Senator Fain also sits on the Transportation (Budget Leadership) Committee. Senator Fain was enthusiastic about the work we presented.

Mr. Torgeir Vaa attended the PacTrans Region 10 Transportation Conference on behalf of Norwegian Public Road Administration (NPRA) and showed interest in applying the mobile sensing technology developed by the PacTrans STAR Lab to monitor their busy freight corridors. Dr. Yinhai Wang will visit NPRA in May 2017 to continue the discussion.

Another event of note is that PacTrans PI, Dr. Don MacKenzie (UW), was invited to the White House for a roundtable on vehicle automation and energy demand. Participants included (of which there were 30 in total) officials from the Department of Transportation, Department of Energy, the EPA, and the Executive Office of the President, as well as representatives from industry, academia, and the non-profit sector. Dr. MacKenzie had the opportunity to share about the work he's doing with electric vehicle fleets and alternative fuels.

Education

Each year, concurrent with the annual Regional Transportation Conference**, the PacTrans Student Leadership Council organizes its own student conference**. This year, on Saturday, October 15, 2016, 35 students from across our five consortium partner institutions gathered in the Husky Union Building on the University of Washington campus for this one-day event. This event included a government agency presentation by the Washington State Department of Transportation (WSDOT), a private industry presentation by Inrix, and a recent graduate panel so that students could ask young working professional about their experiences. The day was concluded by a student poster competition where conference sponsors offered prizes to the winners. Students voted on a total of 18 peer posters and the top three winners were identified. WSDOT co-sponsored this Region 10 Student Conference.

A second very impressive accomplishment of this six month reporting period was that **PacTrans aided in**

the funding of over fifty students to the Transportation Research Board (TRB) annual meeting in Washington D.C. in January. Of those students, about three-quarters were there to present papers that had been accepted. We had two students, Eric Howard (UW) and Jason Anderson (OSU), who received CUTC Outstanding Student of the Year Awards, and one student, Masoud Ghodrat Abadi (OSU), who received the PacTrans Michael Kyte Outstanding Student of the Year Award.

PacTrans has extended fellow offers to seven of the graduate level students that have been admitted to the UW transportation engineering program. This program offers a handful of students each year the opportunity to complete a master's degree in transportation engineering and graduate with internship experience to boot. This program has been very successful over the past years in training industry and agency leaders. PacTrans is hopeful to attract five fellows for the 2017-2018 academic school year.

There were many other notable achievements in education at PacTrans consortium universities during this reporting period. Several key examples include:

PacTrans sponsored a UW student hyperloop team and they did very well during this reporting period. This January, the 35-member UW Hyperloop team competed against other Hyperloop teams from across the country and the world in Hawthorne, California. Last January, at the first of a series of competitions, the UW team was identified as one of twenty-six teams to advance to the building phase of the competition. In this competition each team's "pod" was tested on safety, design, and scalability (ease with which the design could be constructed at full size**). The UW team placed 4th in the nation and 6th in the world under these criteria**. For the next competition, which will be held this summer, the focus will be on speed.

This past November 2016, the Oregon State University Institute of Transportation Engineers (ITE) student chapter won first place in the 25th annual Oregon ITE Traffic Bowl in Portland, Oregon.

Workforce Development

PacTrans had a number activities geared at workforce development during this reporting period. Notably, PacTrans BOD decided to develop the PacTrans Workforce Development Institute at its meeting in Alaska in March. Also, PacTrans hosted six seminars to help workforce development. Below are representative examples of such activities.

Over the course of the last several PPPRs PacTrans has been reporting on ongoing talks about developing a continuing education, workforce development, and training platform for state and local agencies. During the past six months, PacTrans has worked with WSDOT to identify a handful of the most urgently needed courses, identified funding for those courses, and established a timeline for implementation. Once these courses are solidified, it is the express desire of PacTrans to move operations to an online platform and begin expanding the course offerings for more diversity of subjects from a broader audience.

On October 19, 2016, Dr. James Tsai, professor of Civil and Environmental Engineering at Georgia Tech, gave the Fall Regional Transportation Seminar on the University of Washington campus in front of about one hundred attendees. He delivered a presentation titled, Smart City Transportation Asset Management and Safety Analysis Using Emerging 3D and GPS/GIS Methodologies. Consistent among the

projects discussed, Dr. Tsai talked about how much less expensive many currently expensive technologies will soon become due to the emergence of the autonomous vehicle. LiDAR was one of the examples used. Foreseeing this significant drop in cost for fairly advanced sensing technology, he and his students have been working to develop new methodologies that implement such hardware. More specifically they have been using it for collecting roadway characteristics data and developing methodologies for identifying conditions and predicting dangerous roadway sections for roadway safety improvement.

On October 26, 2016, Wayne Kittleson, Owner and Principal of Kittelson and Associate, gave the Michael Kyte Lecture on the University of Idaho campus. Mr. Kittelson gave a talk that he calls *15,000 days,* where he elaborate on how to be effective over the course of a forty year career.

On March 7, 2017, Dr. Terry Friez, Harold and Inge Marcus Chaired Professor of Industrial Engineering at Penn State University, gave the Winter Regional Transportation Seminar on the University of Washington campus in front of about seventy-five attendees. He spoke about his long tenure exploring dynamic traffic assignment models, and more broadly about the future of model-based transportation planning.

On March 8, 3027, Dr. Shinji Tanaka, Associate Professor at Yokohama National University in Japan, gave a UW seminar where he explored a number of practices including highway operations and control, parking management, and others.

Outreach

During this reporting period PacTrans made great use of the ample opportunities to participate in both internal and external functions that make the center more visible, show off our research, add expertise and influence, advertise to potential student, advocate for STEM learning and build strong partnerships within the industry. The following is a sample list of these functions:

1. In November 2016, Director Jianwei HE from Tianjin Traffic Management Bureau and his delegation, along with Professor Meng Li from Tsinghua University, Beijing, visited University of Washington to speak with PacTrans researchers on their ongoing work.
2. In November 2016, PacTrans director, Dr. Yinhai Wang, traveled to Taipei, Taiwan to give a keynote address at the Global Spatial Data Infrastructure Association (GDSI) 15 World Conference.
3. In November 2016, PacTrans associate director, Dr. David Hurwitz, sat on a Future-of-Portland Panel that explored the city's most pressing challenges. Dr. Hurwitz was the only participant representing the transportation industry.
4. In October 2016, PacTrans director, Dr. Yinhai Wang, delivered a talk on PacTrans data science research at the 2016 World Internet of Things Wuxi Summit.
5. Two PacTrans PIs, Katherine Hunter-Zaworski and David Hurwitz, participated in an OSU college of engineering blog where each was given an opportunity to discuss the arena in which they do research.
6. PacTrans Director, Dr. Yinhai Wang presented PacTrans research on video-based collision avoidance technology and the connected vehicles testbed at the 2017 ITS Washington Annual Meeting on Dec. 6, 2016.

7. The second phase of PacTrans' Outreach Project wrapped up. This phase included a student lead public service announcement competition that received some impressive submissions. This will be elaborated on in the impacts section.

Additionally, the Video Analytics Partnership originally founded by the City of Bellevue, Microsoft, PacTrans has generated significant impact to both academia and practitioners. ITS America sponsored a luncheon on Jan. 9, 2017. ITE also publicized its participation in the partnership. There are 24 entities joined this partnership to date. PacTrans director, Dr. Yinhai Wang is invited to talk about this partnership at the TRB Innovations in Freight Data Workshop on May 18, 2017.

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:

Each year at the TRB annual meeting in Washington D.C., PacTrans hosts a Region 10 reception attracts hundreds of academic researchers, students, private industry professional, and government agency representatives. This year, on the evening of Monday, January 9, 2017, at the Walter E. Washington Convention Center, the PacTrans Region 10 Reception offered friends and colleagues an opportunity to interact and discuss future collaboration opportunities.

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.

The second large component of our dissemination efforts surround facilitating and attending various seminars, workshops and conferences. During this reporting period, PacTrans hosted the annual Regional Transportation Conference, with over two hundred participants getting exposure to our ongoing research projects. PacTrans was also 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 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 finishing up with external reviews and technical report finalization of year 3 (2015-2016) and year 4 (2016) funding-cycle projects. These will then be promptly disseminated to the proper repositories. Ongoing year 5 (2016-2017) funding-cycle projects will be closely monitored.

Technology Transfer

The first and second round of research funding projects (also referred to as Year 3 and Year 4 projects) under this grant are currently being submitted by PacTrans PIs. Subsequently, this next reporting period will be an exciting time for technology transfer activities.

PacTrans will encourage and cultivate the importance of technology transfer among PIs in the following ways:

1. PacTrans will solicit submissions for "success stories." Once selected, a handful of projects will receive additional funding to engage in innovative technology transfer techniques.
2. PacTrans will continue supporting PIs and student researchers to conferences, seminars, and workshops where these findings can be presented to a broader audience.

Further, during this next reporting period PacTrans will host its annual workshop where research is shared and new research subjects are identified.

Education

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

1. PacTrans will welcome its newest fellows to the program.
2. PacTrans will continue sponsoring two extra transportation courses to broaden knowledge of transportation students.

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.
2. PacTrans will continue to host the quarterly regional transportation seminar, including Konstantinos Triantis (John Lawrence Professor of Industrial Engineering and Operations Research in the Grado Department of Industrial and Systems Engineering (ISE) at Virginia Tech's Northern Virginia Center) for this spring edition. We also currently have a leadership seminar scheduled with Lenor M. Bromberg (City Engineer in the Community Development Department of the City of Roswell, Georgia.), and a UW seminar scheduled with Valerie Karplus (assistant professor of Global Economics and Management at the MIT Sloan School of Management).

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.

Dr. Yinhai Wang will serve as a general co-chair of the IEEE International Smart Cities Conference to be held in Wuxi, China in September 2017. He will take the opportunity to outreach to professionals from the world. Also, Dr. Wang will visit Norway to discuss research collaborations between the UW, WSDOT, NPRA, and Norwegian University of Science and Technology in May. On the same trip, Dr. Wang will deliver a keynote speech on PacTrans research at the ITS Borealis Conference to be held in Tromso, Norway on May 11, 2017.

The UW will host the ASCE International Workshop on Computing in Civil Engineering in June 2017. PacTrans director, Dr. Yinhai Wang will deliver a keynote at this workshop to introduce PacTrans research in data science.

PacTrans will also be doing outreach to elementary-, middle-, and high-school aged students to continue promoting STEM, as well as transportation engineering. For example, the University of Washington hosts its annual Engineering Discovery Days each April where thousands of local primary and middle school students, as well as teachers and parents, are invited to campus to learn about engineering programs. PacTrans and several labs associated with PacTrans will host interactive demonstrations for students.

Similarly, the Oregon State University Undergraduate Engineering Expo provides an excellent opportunity each spring for young students to get exposure to the world of engineering.

Finally, our steel bridge, concrete canoe, big beam, and clean snowmobile teams are all gearing up for spring competition.

Collaboration

PacTrans and the University of Idaho will be hosting the PacTrans Mobility workshop this coming April where representatives from private industry and government agencies will join researchers and center directors to explore and identify regional mobility needs. These workshops are a key component to our steadfast commitment to support the needs of the Pacific Northwest.

Products (reporting period: October 1, 2016 – March 31, 2017)

	Total	UW	WSU	UI	OSU	UAF
Publications: peer reviewed journal articles	**130**	46	10	20	35	19
Publications: Book chapters and other edited manuscripts	**23**	3	0	4	4	12
Conference papers	**92**	35	4	17	19	17
Conference presentations	**129**	55	10	14	29	21
Lectures/Seminars /Workshops/ Invited Talks	**97**	52	3	11	22	9
Technologies or Techniques	**15**	3	0	4	3	5
Inventions, patent applications, and/or licenses	**1**	0	0	0	0	1
Websites or Other Internet Sites	**4**	1	0	2	1	0
Other products: data or databases, physical collections, audio or video products, software or NetWare, models, educational aids or curricula, instruments, or equipment	**8**	3	1	1	2	1

Examples of peer reviewed journal articles

Allison, L., Kaminsky, J. (in press). Safety Communication Networks: Females in Small Work Crews. Journal of Construction Engineering and Management.

Dunham, L., Wartman, J., Olsen, M.J., O'Banion, M.S, & Cunningham, K. (In Press). Rockfall Activity Index (RAI): A Lidar-derived, morphology-based hazard assessment system, Engineering Geology.

Scott, M.H. and Mason, H.B. Constant-ductility response spectra for sequential earthquake and tsunami loading. Earthquake Engineering and Structural Dynamics, Accepted December 2016.

Mehrabipour, M. and A. Hajbabaie. A Cell Based Distributed-Coordinated Approach for Network Level Signal Timing Optimization. Computer-Aided Civil and Infrastructural Engineering, Accepted, 2017.

Islam S. and A. Hajbabaie. Distributed – Coordinated Signal Timing Optimization in Connected Transportation Networks. Transportation Research Part C: Emerging Technologies, Accepted, 2017.

Tajalli M. and A. Hajbabaie. On the Relationships between Commuting Mode Choice and Public Health. Journal of Transport and Health, In Press, 2017.

Wygonik, E.1 and A. Goodchild (in press) Urban Form and Goods Movement: Factors affecting delivery supply chain structure congestion and emissions impacts, Transportation Research Part D

Wygonik, E. and A. Goodchild (in press). Evaluating the Impacts of Density on Urban Goods Movement Externalities, Urbanism.

Al-Bdairi, N., Hernandez, S. 2017. An Empirical Analysis of Run-Off-Road Injury Severity Crashes involving Large Trucks. Accident Analysis and Prevention, 102, pp. 93-100.

Anderson, J., Hernandez, S., 2016. Heavy Vehicle Crash Rate Analysis: A Comparison of Heterogeneity Methods Using Idaho Crash Data. Accepted to Transportation Research Record: Journal of the Transportation Research Board [In Press]

Dunham, L., Wartman, J., Olsen, M., O'Banion, M., and Cunningham, K. (2017) Rockfall Activity Index (RAI): A lidarderived, morphology-based method for hazard assessment, Engineering Geology, doi: 10.1016/j.enggeo.2017.03.009

Wang, H., M. Palm, C. Chen, R. Vogt, and Y. Wang. Does bicycle network level of traffic stress (LTS) explain bicycle travel behavior? Mixed results from an Oregon case study, Journal of Transport Geography Volume 57, December 2016, Pages 8–18. http://doi.org/10.1016/j.jtrangeo.2016.08.016

Wartman, J., Olsen, M., Dunham, L., O'Banion, M., & Cunningham, K. Rockfall Activity Index (RAI): A Lidar-Derived, Morphology-Based Method for Hazard Assessment. Engineering Geology

Zeng, Z. W. Zhu, R. Ke, J. Ash, Y. Wang, J. Xu, and X. Xu. A Generalized Nonlinear Model-based Mixed Multinomial Logit Approach for Crash Data Analysis. Accident Analysis & Prevention. Vol. 99: 51-65. 2017. http://dx.doi.org/10.1016/j.aap.2016.11.008

Example of book chapters and other edited manuscripts

He, B., Van Gerpen, J.H., Morra, M., McDonald, A.G., Lipid-Based Biorefinery. In: Bioenergy: Principles and Applications. Eds. Li, Y., Khanal, S.K., Wiley-Blackwell, IW, USA, Chapter 26.

Posted in "BEACON Researchers at Work", https://www3.beacon-center.org/blog/2017/02/05/evolving-evacuationplans-for-urban-areas/, Title: Evolving Evacuation Plans for Urban Areas, author Keith Drew, in the on-line news for the BEACON NSF Center for Evolution in Action.

Examples of conference papers and presentations

Gillins, D.T., Gillins, M.N., Cain, E., and Parrish, C. (2017). Emerging Technology: Unmanned Aircraft Systems (UAS) for Bridge Inspection, 2017 Bridge & Tunnel Inspector's Conference, Portland, OR.

Gillins, M.N., Gillins, D.T., and Parrish, C. (2016). Bridge and Communication Tower Inspections with small Unmanned Aircraft Systems (sUAS), UAS Mapping 2016 Conference, ASPRS, Palm Springs, CA.

Minturn, J., B. Hafele, and G. H. Bham, Preliminary Crash Causality Study of Divided Highways with Depressed Medians in Alaska, 5th International Conference on RSS, Orlando, Oct. 2015.

Allison, L. and Kaminsky, J. Safety Communication Networks: Women in Small Work Crews. 2017 New Frontiers in Construction Conference, Seattle, WA, March 16, 2017. [poster presentation]

Chen, P. and Q. Shen. 2016. Bicyclist Injury Risks in Different Built Environments. Paper presented at the 56th Annual Conference of Association of Collegiate Schools of Planning, Portland, Oregon.

Chan, K. and J. Louis (2017). Leveraging Telematics and Real-time Sensor Data to Increase Safety of Equipment- Intensive Construction Operations. To be published in Proceedings of CSCE Construction Research Congress 2017, Vancouver Canada

Keynote Speaker, "Safe Pedestrians, Healthy Cities," talk at the 'INTERNATIONAL SEMINAR ON PEDESTRIAN SAFETY' organized by Architecture & Urban Research Institute (AURI) in Seoul, South Korea. October 21, 2016

Bhattacharjee, P.S. and McGann, C.R. (2017). Parameter study to examine role of 3D geometric effects on bridge foundation loads resulting from demands of liquefaction-induced lateral spreading. New Zealand Society for Earthquake Engineering (NZSEE) Annual Conference, April 27-29, Wellington, New Zealand.

Olsen, M. and C. Parrish, 2017. Surveying with Drones, Lasers, and Explosions. Professional Land Surveyors of Oregon (PLSO) 2017 Conference, 18-20 January, Portland, Oregon. [Note: my portion of this conference presentation covered work funded both by PacTrans and ODOT on bridge inspections with unmanned aerial vehicles.]

Olsen, M.J., Hurwitz, D., Kashani, A., & Buker, K. (2016). 3D sight distance analyses with lidar (poster). PacTrans Annual Regional Transportation Conference. Seattle, WA, October 2016.

Hajbabaie, A. Variable Speed Limit Optimization In Urban Street Networks, Mehrdad Tajalli, Sattar Sattarov, INFORMS 2016, Nashville.

Sankarakumaraswamy, McCormack, Goodchild, Hallenbeck "Evaluating Global Positioning System Data Usability for Freight Performance Measures" TRB Annual Meeting, Washington, DC (January 2017)

Machado, Goodchild "Review of Transportation Performance Metrics for Community-Based Planning of Resilience", Annual Meeting of the Transportation Research Board, Washington, DC (January 2017)

Hernandez, S., Jessup, E., Anderson, J., North, E., (2017). Uncovering Confounding Factors of Large Trucks Crashes and Safety Critical Events: An Exploratory Analysis of a Northwest Truck Driver survey. Transportation Research Forum, Chicago, Illinois.

Drew, Keith J. and Heckendorn, Robert B and Abdel-Rahim, Ahmed and Marisetty, Homaja Pydi Kumar and Stalick, Anton, "Evolving a Real-time Evacuation for Urban Disaster Management". GECCO 2017: Proceedings of the Genetic and Evolutionary Computation Conference Accepted, ACM, 2017

Hegazy, M. and A. Abdel-Rahim, "The Effect of Physical Maturation on ATV Head-On Collision Outcome: A Simulation Study", Transportation Research Board 96th Annual Meeting, Paper 17-06116.

Barnes, D.L. and B. Connor. 2017. Dust Management. Presented at Alaska Forum on the Environment, Anchorage, AK, February 6-10.

Barnes, D.L. and B.G Connor. 2016. Dust Management. Presented at the Alaska Tribal Conference on Environmental Management, Anchorage, AK, October 24-28.

Ke, R., Y. Wang, J. Spears, and J. Lutin. Automated Vehicle-Pedestrian Near-Miss Detection through Onboard Monocular Vision. Poster presentation by Ruimin Ke at UTC Safety Summit, April 6, 2017.

Example of lectures/seminars/workshops/invited talks

Parrish, C., 2017. Webinar: Drones in Education: Research Perspective, 21 March, Oregon State University: http://www.oregon.gov/ode/learningoptions/CTE/resources/Documents/Drones%20in%20Education%20Research%20Perspective%20Webinar%20Presentation%20--%20March%2021,%202017.pdf [Note: this webinar covered work funded both by PacTrans and ODOT on bridge inspections with unmanned aerial vehicles.]

Seattle Department of Transportation, Seattle Bike Advisory Board, October 21, 2016

Chang, K., Patel, K., Dyre, B., & Abdel-Rahim, A. (2016). "Modeling Passing Behavior on Two-Lane Rural Highways: Evaluating Crash Risk Under Different Geometric Conditions," Pacific Northwest Transportation Consortium; Seattle, WA.

Belz, N., Chang, K., Schlotthauer, N., & Sorensen, C. (2016). "Mixed-Use Safety on Rural Roads," Pacific Northwest Transportation Consortium; Seattle, WA.

Chang, K., Brown, S., Castro, E., Bautista, E., Perkins, R., Chen, C., Chen, P. & Hajbabaie, A. (2016). "Safety Data Management and Analysis: Addressing the Continuous Education Needs for the Pacific Northwest," Pacific Northwest Transportation Consortium; Seattle, WA.

Arizona State University Transportation Seminar. Delivering Sustainability: Transporting Goods in Urban Spaces, Phoenix, AZ (March 2017)

The Matt Townsend Show. More online shopping means more delivery trucks. Are cities ready? BYU Radio (January 2017)

City Smarts: Engineering Resilient Communities. UW College of Engineering Lecture Series Delivering Sustainability: Transporting Goods in Urban Spaces, Seattle WA (November 2016)

O. Burkan Isgor (2016; upcoming). Formation factor of fresh cementitious pastes, Materials Seminar Series. University of Illinois Urbana Champagne.

The 71st Taoyaka Seminar, the 322nd IDEC Seminar, and the ASMO Seminar. "Toward Smart and Connected Communities: Challenges and Opportunities in Transportation." Hiroshima, Japan, July 15, 2016.

Gigabit City Summit. "Challenges and Opportunities in Smart Transportation Research under the Smart Cities Context." Kansas City, Missouri, May 17, 2016.

Examples of technologies or techniques

Development of new low cost RWIS equipment

Rockfall Activity Index (RAI): A Lidar-Derived, Morphology-Based Method

Development of a laboratory procedure to predict the effectiveness of dust control palliatives

Development of a field and laboratory procedure to measure the effectiveness of dust control palliatives

Development of a mobile monitor to measure the effectiveness of dust control palliatives

Mobile Unit for Sensing Traffic -1 (MUST-1), funded by PacTrans and WSDOT, March 2017.

Mobile App for Communication with Connected Vehicles, funded by PacTrans and WSDOT, March 2017.

Examples of Websites

http://www.uidaho.edu/engr/research/itd-competition

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

- WSU is developing a freight data warehouse and some PacTrans funding has supported that activity.
- Invented low cost Road Weather Information System (RWIS) using low cost, low power off the shelf sensors
- Congestion analysis module for DRIVE Net, funded by PacTrans, WSDOT, and SHRP 2.
- MUST-1 based Roadway Network Performance Monitoring Module, funded by PacTrans
- 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 50 percent of his time directing PacTrans. Dr. Wang has overall responsibility for program management, oversight of PacTrans operations, including the Research Committee, the Education and Workforce Development Committee, and the Outreach and Technology Transfer Committee, and Student Leadership Council. He is the regional and national leadership for PacTrans, and the contact person for management relationships with USDOT Research and Innovative Administration (RITA) and other USDOT organizations.
- PacTrans Associate Director in Research, **Jeff Ban**, Ph.D., Associate Professor of Transportation

Engineering in Civil and Environmental Engineering at the UW spends 5 percent of her time managing the research program for PacTrans and coordinates the research collaboration across the five partner institutions.

- PacTrans Associate Director in Education and Workforce Development, **Anne Vernez-Moudon**, Dr. es SC, Professor of Architecture, Landscape Architecture, and Urban Design and Planning, Adjunct Professor of Epidemiology and in Civil and Environmental Engineering, devotes 5 percent of her time leading the Education and Workforce Development Committee. She is involved in curriculum changes, training program development, and educational enhancements among the partner institutions.
- PacTrans Associate Director in Oregon State University (OSU), **David Hurwitz**, Ph.D., Professor of Civil and Construction Engineering at OSU, devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within OSU. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in the University of Alaska Fairbanks (UAF), **Billy Connor**, Director of the Alaska University Transportation Center (AUTC), devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within UAF. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in University of Idaho (UI), **Ahmed Abdel-Rahim**, Ph.D., Associate Professor of Civil Engineering at UI, devotes 5 percent of his time to managing and organizing the education, outreach, and research activities within UI. He coordinates all results and outcomes with the UW on a regular basis.
- PacTrans Associate Director in Washington State University (WSU), **Ken Casavant**, Ph.D., Professor and Transportation Economist 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 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.
- **Weibin Zhang**, 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?

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	
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?

The program at PacTrans is to explore transportation safety through the lens of technology and data. This had been, and will continue to be, done in many capacities.

One such example is a project currently in the works with Haizhong Wang (OSU), Yinhai Wang (UW), and Michael Lowry (UI), where they are using the emergence of "big bike data" from sources like STRAVA, to enhance a GIS Tool that explores cyclists' exposure levels, to then generate safety performance functions (SPF) in the Pacific Northwest. Currently the Highway Safety Manual (HSM) provides an evidence-based approach to SPF to evaluate the safety of common traffic but not for bicycles.

Another such project comes from Michael Olsen (OSU) and explores site distance at unsignalized intersections. The aim is to develop a workflow that takes 3D dense point clouds and compares the modeling that can be conducted in a virtual environment to define things like intersection sight distance and stopping site distance, and benchmark those measurements against current practice. Current practice involves people standing out in the middle of the roadway and measuring linear distances by hand or by sight distance triangle. This obviously exposes workers to risk and ultimately gives you only

one measurement. This new method generates full three dimensional representations on the intersection, which allows the user to explore the sight distance from a variety of perspectives as oppose to just the one. The truly innovative piece of this work is that in all cases in current practice, the canopy of a tree is projected all the way to the ground, which underrepresents actual view sheds. This method creates a realistic representation of a tree from all perspective, making sight distances much more realistic.

What is the impact on other disciplines?

Transportation is a very active innovation area, which has drawn interests and participations from car manufacturers, information technology companies, and sensing technology companies. PacTrans center theme centers on developing data-driven solutions and decision making for safe transport. Its research and educational activities focus on identifying safety solutions. Findings of PacTrans research help researchers in relevant domains to target the right issues. For example, the Video Analytics Partnership involves top researchers from PacTrans and Microsoft to work together on detecting near-misses at signalized intersections using video image processing technologies. Microsoft researchers developed artificial intelligence methods for automated detection of automobiles, bicyclists and pedestrians. Also, PacTrans projects brought researchers from structure engineering, environmental engineering, electrical engineering, computer science and engineering, public health, public policy, and mathematics to work together to develop safety solutions. The interdisciplinary University of Washington Hyperloop student team is another great example. There are approximately 70 students from engineering, computer science, economics, and business to collaborate to address the top challenges in developing a Hyperloop prototype with a target speed of 700 mph.

What is the impact on transportation workforce development?

PacTrans associate director Billy Connor (UAF), and another PacTrans PI, David Barnes (UAF), are at the forefront of exploration into dust mitigation from roadway activities. This is in part because, living in Alaska, they exist in proximity to some of the most rural communities in the world. “When you go to a village, the first thing they ask you is if you can fix their dust problem, they don’t ask you to fix their schools or their roads, they want the dust gone,” says Connor. After about a decade of research, including several PacTrans funded projects, they have developed an apparatus and new test method, mimicking those developed by the coal industry that allows DOTs to test the effectiveness of palliatives before they are applied to the dust. Connor goes on, “Current industry practice is to walk out there and kick the dirt and say what you think.” This new instrument (which costs $12,000) and method, allows DOTs to also identify optimal application rates as well.

You might be wondering what dust has to do with transportation safety. The two most obvious connects include: (1) dust content in the air effects sight distance, so if an intersection in designed assuming certain sight and it has been reduced do to dust, that is a serious safety hazard; and (2) vehicles on rural, non-paved roads, are actually a huge contributor to dust which is a public health concern, so it is also about mitigation negative externalities of the use of our transportation system. Dust problems are such a serious condition in certain parts of the country it is changing peoples’ travel behavior; when they travel and how they travel.

The workforce development component comes into play because these researchers needed to produce a test method for DOT employees. This was an iterative process where first, the researchers ran the test while DOT employees wrote the test method. Then those DOT employees had an opportunity to refine their own method by attempting to repeat the test, and finally they gave the manual to someone who had never seen the test or apparatus and they observed problem areas. This collaboration between PacTrans and DOT resulted in a very strong method that has given Alaska's DOT the confidence to purchase this equipment for use.

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

PacTrans research and educational activities focus on data-driven solutions. Datasets and the corresponding tools produced by PacTrans research greatly enhances resources for research and education at all consortium universities. For example, Professor Wang's research team added several new datasets and analytical modules on the Digital Roadway Interactive Visualization and Evaluation Network (DRIVE Net). In addition to serving the practical needs of WSDOT, these new data resources and analytical functions can be used for both education and research efforts. The PacTrans educational research project entitled "Safety Data Management and Analysis: Addressing the Continuing Education Needs for the Pacific Northwest" will develop datasets, course modules, and tools for educational needs in transportation safety.

What is the impact on technology transfer?

In previous PPPRs PacTrans has elaborated on ongoing projects involving the utility of UAVs in data collection. One such project, utilizing LIDAR and newly developed algorithm index, seeks to identify critical slopes that dangerous to roadway infrastructure below in a safe, reliable, and time/cost effective way. Historically agencies send technical out into the field with a clipboard, in some cases, up onto the slopes, to make somewhat subjective observations about their stability. A big part of this work is to use technology to increase the accuracy of those measurements and improve the safety of the individuals making these observations in the field.

The team, which includes Joe Wartman (UW), Michael Olsen (OSU), and Keith Cunningham (UAF), have devised the Rockfall Activity Index (RAI): A Lidar-Derived, Morphology-Based Method. Currently, this research team is working with the Oregon Department of Transportation (ODOT) to implement these new and improved technologies and methods for analyzing the potential for rock fall and slope stability over roadway infrastructure in the Pacific Northwest.

Also, the mobile sensing technology developed by the PacTrans STAR Lab will be tested in Norway. If successful, Mobile Unit for Sensing Traffic version 1 (MUST-1) will be used to monitor travel time of the busy freight corridors in Norway.

What is the impact on society beyond science and technology?

As discussed previously, each research cycle PacTrans funds an outreach multi-institution project. This is unique because the board decides the main focal area, and then identifies an institution representative from each consortium partner. This team then narrows the project to a specific subject. This past year,

the outreach team, led by David Hurwitz at OSU, worked on a project titled *Mitigation of Lane Departure Crashes in the Pacific Northwest through Coordinated Outreach*, the premise was to find ways of effective public outreach to educate people of the dangers of lane departure crashes.

One of our board members had made the comment that it would be great if we could get student involvement in that process, because they will have an easier time making materials that are relatable to their peers. Thus, the public service announcement student competition was born. PacTrans built a portal on our website that had rules and resources, and a submission page. High school and college age students could work individually or in teams to prepare a series products (a video, a poster, and series of SM posts) that creatively educated their peers on the dangers of lane departure crashes. Ultimately PacTrans received dozens of extremely creative and thoughtful submissions from across the four state region.

In all, this outreach project has reached thousands of high school and college age students and the focus of the project for this year is to explore ways of achieving the same outreach with elementary- and middle-school aged kids.

Changes/Problems

NONE.

Special Reporting Requirements

NONE.