



## Program Progress Performance Report

**Submitted to:** U.S. Department of Transportation  
Office of the Assistant Secretary for Transportation and Research (OST-R)

**Federal Grant:** #DTRT12-G-UTC06

**Project Title:** Southwest Region University Transportation Center (SWUTC)

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**Recipient Organization:** Texas A&M Transportation Institute  
Texas A&M University System  
3135 TAMU  
College Station, TX 77843-3135

**Recipient Identifying Number:** 600451

**Grant Period:** January 1, 2012 – January 31, 2016

**Reporting Period End Date:** December 31, 2014

**Report Term:** Semi-annual – July 1, 2014 – December 31, 2014

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Melissa Tooley - Director

## 1. Accomplishments:

SWUTC Goals as stated in *SWUTC Prospectus* – to produce research, education and workforce development and technology transfer initiatives that serve the needs of Region 6 and support the five strategic goals of USDOT.

### **SWUTC Goal #1: Research Program**

With this grant, SWUTC's research program will build on historical accomplishments, and make fundamental strides in basic and advanced research that will be implementable by operating agencies responsible for improving accessibility and mobility while reducing congestion in our urban transportation systems; provide infrastructure renewal; harmonize freight movements between Canada, U.S. and Mexico; reduce the bottlenecks while improving the technology and linkages among the freight and passenger modes in the intermodal transportation network; improve the livability of our rural and urban neighborhoods; and contribute to improvements in the overall safety of the transportation enterprise in our region and nation.

### **Completed Research Project Accomplishments/Dissemination of Results for this Reporting Period:**

◆ SWUTC Project #161303: Next Generation Safety Performance Monitoring at Signalized Intersections Using Connected Vehicle Technology - The advent of connected vehicle technology allows vehicles to talk to each other and to infrastructure wirelessly. Through this platform, vehicle movements and signal status at the facilities can be automatically and continually monitored in real time. This project developed and evaluated a safety performance monitoring framework for signalized intersections using data exchange within vehicle-to-infrastructure platforms. The evaluation results revealed that at least 40% market penetration rate is required for a reliable detection of safety deficiency under light to moderate traffic volume condition. In case of lower market penetration rates, the observation period can be extended to compensate for smaller sample size.

Research results disseminated through:

- Final Technical Report: Next Generation Safety Performance Monitoring at Signalized Intersections Using Connected Vehicle Technology, Liteng Zha, Praprut Songchitruksa, and Kevin Balke, Texas A&M University (TAMU), August 2014
- Software Scripts Developed: Researchers developed a simulation test bed in VISSIM that enables vehicle-to-infrastructure (V2I) communications. Related algorithms for extracting safety measures in the V2I communications environment were also developed using Python scripts.
- Technique Developed: The project developed a framework to monitor the safety performance of signalized intersections using data exchange within connected vehicle environment. This framework can potentially be incorporated into facilities instrumented with connected vehicle capability. A connected vehicle application can be developed based on the proposed framework to automatically collect and evaluate the safety performance of signalized intersection operation.
- Presentations: 1 (citation in Products Section of previous PPPR)
- Publication: 1 (citation in Products Section of previous PPPR)
- Future Presentation: Impacts of Market Penetration and Observation Period on Safety Performance Monitoring at Signalized Intersections Using Connected Vehicle Data, P. Songchitruksa, to be presented to the Transportation Research Board (TRB) Annual Meeting, January 2015.

◆ SWUTC Project #161341: Hot Spot Analysis of Teen Drivers in Houston, Texas – Today, states have enacted laws to ensure that teen drivers are more skilled and drive safely. The result is fewer accidents. However, in previous research, when teen crashes were mapped, certain streets and areas appeared to have more accidents than other areas. The goal of this research was to investigate the “hot spot” locations where teens have accidents and to determine important factors contributing to the concentration of accidents.

Research results disseminated through:

- Final Technical Report: A Hot spot Analysis of Teenage Crashes: As Assessment of Crashes in Houston, Texas, Gwendolyn C Goodwin, Jamaal Schoby, and Walter Council, Texas Southern University (TSU), September, 2014
- Future Presentation: Hot Spot Analysis of Teen Drivers in Houston, Texas, Gwendolyn Goodwin, Jamaal Schoby and Walter Council, to be presented to the TRB Annual Meeting, January 2015.

◆ SWUTC Project #600451-00025: Controlling Electrical Conductivity of Asphalt Concrete for Multifunctional Applications - The key finding of this research is a method of controlling electrical conductivity of asphalt concrete, which is the most common paving material that is inherently non-conductive. The traditional function of the asphalt concrete is the mechanical performance to resist traffic loads and environmental degradation. Conductivity control enables asphalt pavements to have various non-structural and non-traditional functions such as self-healing, self-sensing, deicing, and tele-communication. In addition, conductive pavement can be utilized for some developing technologies such as a guide for autonomous (driverless) vehicles and connected vehicles. Conductive pavement is a new, but actively investigated concept in transportation engineering, and the results of this research provide a technical basis to the development of multifunctional pavement technology.

Research results disseminated through:

- Final Technical Report: Controlling Conductivity of Asphalt Concrete with Graphite, Philip Park, Younho Rew, and Aishwarya Baranidumar, TAMU, August 2014
- Technique Developed: Method of controlling electrical conductivity of asphalt concrete using graphite including the effect of graphite types (electrical impedance curves for nine conductive additives), aggregate gradation, and binder types.
- Presentations: 2 (citations in Products Section of previous PPPR)
- Master’s Thesis: 1 (citation in Products Section of previous PPPR)
- Journal Articles Submitted: 2 (citations in Products Section of this PPPR)
- Future Presentation: Controlling Electrical Conductivity and Mechanical Performance of Asphalt Concrete with Conductive Additives, Y. Rew and P. Park, TAMU, to be presented to the TRB Annual Meeting, January 2015.

◆ SWUTC Project #600451-00026: Zone/Fleet Sizing for MAST (Mobility Allowance Shuttle Transit) Services - The mobility allowance shuttle transit (MAST) system is an innovative concept that allows transit vehicles to deviate from a fixed route consisting of a few mandatory checkpoints to serve on-demand customers within a predetermined service area, and thus can be both affordable and convenient enough to attract the general public. Through this effort, researchers developed analytical results for the waiting time probability distribution and its expected value as well as the expected ride

time for different types of customers in terms of the system parameters for both 1-MAST systems and multi-vehicle MAST (m-MAST) systems.

The results of this project provides the basis for evaluating the performance of MAST transit systems, to better plan for resource allocation (such as fleet sizing) and deployment arrangements (such as zoning).

Research results disseminated through:

- Final Technical Report: Performance Measures for Multi-vehicle Allowance Shuttle Transit (MAST) System, Luca Quadrifoglio, Kai Yin, and Wei Lu, TAMU, September 2014
- New Technique Developed: For evaluating the performance of MULTI-MAST transit systems.

◆ SWUTC Project #600451-00045: Safety Performance of Different Types of Freeway Weaving Segments - The intensive lane change maneuvers at freeway weaving sections often result in safety and operational problems. Various factors, including the design of ramp roadways, use of auxiliary lanes, and continuity of lanes will have significant effects on the level of service and safety performance of the weaving sections. This study investigated the safety performance of freeway weaving sections and developed a quantitative model for predicting the safety impacts of different types of geometric treatments for freeway weaving sections.

Research results disseminated through:

- Final Technical Report: Safety Performance for Freeway Weaving Segments, Yi Qi, Jie Liu and Yubain Wang, TSU, September 2014
- Model Developed: This study produced a new model for predicting the crash frequencies of freeway weaving segments. This is a unique model that can take account of the impacts of various factors, including the length of weaving section and the minimum required lane changes for merging or diverging vehicle. The impacts of these factors cannot be found in the current Highway Safety Manual.
- Presentations: 1 (citation in Products Section of this PPPR)
- Future Presentation: Safety Performance of Freeway Weaving Sections, Qi, Y., X. Chen and J. Liu, TSU, to be presented to the TRB Annual Meeting, January 2015.

◆ SWUTC Project #600451-00047: The Effect of the City of Houston Transit Corridor Ordinance on Development Along METRO's Light Rail Corridors - In 2009 the City of Houston added a Transit Corridor Ordinance, a code in Chapter 42 to encourage an urban environment that improves pedestrian mobility, supports METRO's light rail investment, and helps accommodate the City's anticipated growth. This research examined developer response to the Transit Corridor Ordinance and determined which parcels owners have chosen to undertake design of elements within this code. Other agency TOD efforts, various developer rail station projects and best practices of public and private joint developments were also explored.

This study identified and mapped the locations of all parcels where developers applied the TOD ordinance. This information was provided to the City of Houston Planning and Development Department. Prior to the conduct of this study, the City did not have this information available in this format.

Research results disseminated through:

- Final Technical Report: The Effect of the City of Houston Transit Corridor Ordinance on Development along METRO's Light Rail Corridors, Walter Hassell, Carol Abel Lewis , and Jennifer Auzenne, TSU, October 2014
  - Presentation: 1 (citation in Products Section of this PPPR)
- ♦ SWUTC Project #600451-00076: Micro-crack Growth in Aged Asphalt Mixtures - The use of reclaimed asphalt pavement (RAP) in asphalt mixes has significantly increased over the last few years. However, the long-term impact of using high percentages of RAP is not clear. Also, mixes with RAP are often regarded as prone to fatigue cracking. The results from this study indicate that it is possible to carefully design mixes with high RAP content without compromising on durability.

Research results disseminated through:

- Final Technical Report: Fatigue and Fracture Properties of Aged Binders in the Context of Reclaimed Asphalt Mixes, Arash Motamed, Solomon Nyanhongo, Pravat Karki, and Amit Bhasin, University of Texas at Austin (UT-Austin), August 2014
  - Test Method Developed: This research study has led to the development of a test method to evaluate fatigue cracking resistance of asphalt binders in a more realistic manner. The information has been shared with other Universities and personnel from the TxDOT. Future work using this test method is anticipated.
  - Journal Articles Submitted: 1 (citation in Products Section of this PPPR)
- ♦ SWUTC Project #600451-00078: Examining the Market Potential for Natural Gas Powered Trucks: Barriers and Opportunities for Promoting Environmental Sustainability and Economic Prosperity - This research, through a detailed analysis of natural gas trucks, fueling infrastructure, and case studies, reaches conclusions over the role natural gas vehicles (NGVs) should play in the future U.S. transportation system.

Research results disseminated through:

- Final Technical Report: Examining the Market Potential for Natural-Gas-Powered Trucks: Barriers and Opportunities for Promoting Environmental Sustainability and Economic Prosperity, Ryan Hazlett and Lauren Cresswell, UT-Austin, August 2014
- ♦ SWUTC Project #600451-00081: Anticipating Long-Term Energy and GHG Emissions Impacts of Autonomous Vehicles - This work pursued two major lines of investigation. The first conducted an assessment of the potential implications of fully autonomous vehicles, at varying levels of market penetration, in terms of safety, mobility, parking, social and travel behavioral changes, and economic impact. Additionally, it examined the potential barriers to a successful rollout, and recommended policy actions to be undertaken at the national level.

The second line of investigation explored in detail the concept of a shared fully autonomous vehicle (SAV), which would essentially act as a demand-responsive transit vehicle. This new transportation mode was explored using micro-simulation of thousands of SAVs and tens or hundreds of thousands of daily travelers who could use them. Additionally, dynamic ride sharing was also explored in this investigation, where two or more travelers with similar (though not necessarily identical) origins, destinations and departure times could share an SAV ride at the same time.

Research results disseminated through:

- Final Technical Report: The Future of Fully Automated Vehicles: Opportunities for Vehicle- and Ride-Sharing, with Cot and Emissions Savings, Daniel Fagnant and Kara Kockelman, UT-Austin, August 2014
  - Model Developed: This work resulted in the creation of two substantive pieces of computer code, approximately 6000 lines each, in length. This code simulates how shared fully automated vehicles can serve a population of travelers, similar to what Google and other autonomous vehicle technology providers are hoping to introduce within the next five to six years. The code is flexible and may be adapted to fit the needs of any city or region, for deployment evaluation.
  - Presentations: 14 (citations in Products Section or previous and current PPPR)
- ◆ SWUTC Project #600451-00082: Real Time Optimization of Passenger Collection for Commuter Rail Systems - Commuter rail systems are being introduced into many urban areas as an alternative mode to automobiles for commuting trips. The shift from the auto mode to rail mode is anticipated to greatly help alleviate traffic congestion in urban road networks. However, the right-of-way of many existing commuter rail systems is usually not ideally located. Since the locations of rail systems were typically chosen long ago to serve the needs of freight customers, the majority of current commuter rail passengers have to take a non-walkable connecting trip to reach their final destinations after departing even the most conveniently located rail stations. To make rail a more viable, competitive commuting option, a bus feeder or circulator system is proposed for seamlessly transporting passengers from their departing rail stations to final work destinations. The primary research challenge in modeling such a bus circulator system is to optimally determine a bus route and stop sequence for each circulating tour using the real-time demand information. In this research, we termed this joint routing and stop optimization problem the circulator service network design problem, the objective of which is to minimize the total tour cost incurred by bus passengers and operators while minimizing the walk time of each individual bus passenger.

Research results disseminated through:

- Final Technical Report: Real-Time Optimization of Passenger Collection for Commuter Rail Systems, Yao Yu, Randy Machemehl, and Shadi Hakimi, UT-Austin, September 2014
  - Model and Method Developed: A bi-level nonlinear mixed integer programming model was constructed and a tabu search method with different local search strategies and neighborhood evaluation methods was then developed to tackle the circulator service network design problem.
  - Presentations: 1 (citation in Products Section of this PPPR)
  - Journal Articles under Review: 2 (citations in the Products Section of this PPPR)
- ◆ SWUTC Project #600451-00086: Financial Arrangements for Alternative Delivery Techniques of Transportation Programs and Projects - This study explored whether the private sector's life-cycle approach to design and construction of transportation infrastructure results in operational cost efficiencies. The results of a case study showed cost-efficiency differences between public and private sectors, but additional research is recommended to empirically test the hypothesis of the private sector's greater efficiency. This is important because understanding the differences in cost-efficiency between publicly and privately managed roads will help decision-makers to minimize the life-cycle cost of their investments.

Research results disseminated through:

- Final Technical Report: Cost-Efficiency of Highway Operations and Maintenance of Public-Private Partnerships, Sergio E. Martinez and C. Michael Walton, UT-Austin, August 2014
- Future Presentation: The Efficiency Claim of Public-Private Partnerships: A Look into Project Operations and Maintenance Costs, Sergio Martinez and C. Michael Walton, UT-Austin, to be presented to the TRB Annual Meeting, January 2015.

♦ SWUTC Project #600451-00087: Policy Implications of Emerging Vehicle and Infrastructure Technology - This research considered a broad range of emerging transportation technologies that have potential for enhancing travel on and operations of the Texas transportation system. The final report provides an overview of technology classifications and assesses the policy implications of emerging vehicle and infrastructure technology classifications—namely, connected, autonomous, and electric vehicle technologies—as well as cloud computing and crowdsourcing in the context of transportation systems and services. The researchers assessed these technologies in terms of their ability to further state and national transportation goals. Also assessed were barriers to adoption and promotion at various development stages. Research is presented on new policies and institutional changes that are being implemented outside of Texas. Finally, policy implications for Texas are discussed.

Research results disseminated through:

- Final Technical Report: Policy Implications of Emerging Vehicle and Infrastructure Technology, Peter J. Jin, Dan Fagnant, Andrea Hall, and C. Michael Walton, UT-Austin, August 2014
- Presentation: 1 (citation in Products Section of this PPR)

♦ SWUTC Project #600451-00089: An Integrated Approach to Managing the Transportation System - Asset valuation has become a key component in asset management because it links the performance of infrastructure and deterioration process with the value of the infrastructure and its depreciation, providing critical information for decision makers at various levels to make more informed decisions. This research presents a utility-based methodological framework for the valuation of transportation infrastructure along with a case study to demonstrate its applicability. The proposed framework can assist state and local transportation agencies in the optimization of resource allocation procedures for better coordination of asset investments, facilitating benefit-cost analyses to quantify the impact of infrastructure investments.

Research results disseminated through:

- Final Technical Report: Productivity-based Approach to Valuation of Transportation Infrastructure, Zhanmin Zhang and Diniece D. Peters, UT-Austin, October 2014
- New Method Developed: A new method for transportation asset valuation.
- Presentation: 1 (citation in Products Section of this PPR)
- Future Presentation: A Novel Utility-based Methodological Framework for the Valuation of Road Infrastructure, Zhanmin Zhang, UT-Austin, to be presented to the TRB Annual Meeting, January 2015.

♦ SWUTC Project #600451-00105: Use of Containers to Carry Bulk and Break Bulk Commodities and Its Impact on Gulf Region Ports and International Trade - This research expanded the focus of another Louisiana Transportation Research Center research effort, which reviewed the role of the Panama Canal Expansion (PCE) on the container trade along the Gulf Coast and on Lower Mississippi

River (LMR) ports, to include the probable impacts of the PCE on the ports and industries along the Lower Mississippi River as well as along the Gulf Coast and its ports, particularly the Port of Houston Authority. For Louisiana, traditional bulk cargoes in agriculture, energy and chemical will see the greatest increase in tonnage. Currently, largely due to the influence of liquid natural gas (LNG) as a chemical feedstock and an energy source, over \$90 billion is being expended in either industrial development or new plant development along the LMR and in the Lake Charles region. Equally important, this research confirmed the rationale for new LNG export terminals currently being built in southwest LA and new facilities within the Port of New Orleans to accommodate growth in the shipping of plastic resins and related products.

Research results disseminated through:

- Final Technical Report: Use of Containers to Carry Bulk and Break Bulk Commodities and Its Impact on Gulf Region Ports and International Trade, James R. Amdal, and Marc Howlett, University of New Orleans (UNO), August 2014
  - Presentation: 1 (citation in Products Section of previous PPPR)
  - Results Presented: Study results presented to the Project Advisory Committee, representing both public and private sector leaders of the maritime industry in New Orleans and along the Lower Mississippi River and members of the Louisiana Transportation Research Center.
- ♦ SWUTC Project #600451-00106: Cooperation and Competition – Regional Transportation Planning and Competitive Federal Awards - Transportation benefits and economic stimulus were behind the creation of the Transportation Investment Generating Economic Recovery (TIGER) program in 2009. New transportation funding programs exist in a landscape of other programs, and in addition extensive federal rules require that state-designated metropolitan planning organizations (MPOs) lead regional transportation planning and produce near and long-range plans. This project examined the potential for the TIGER program to conflict with these mandated planning processes.

Research results disseminated through:

- Final Technical Report: Regional Decision-Making and Competitive Funding: Metropolitan Planning Organization and the Transportation Investments Generating Economic Recovery Program, Kate Lowe, UNO, August 2014
- Presentation: 1 (citation in Products Section of previous PPPR)
- Journal Articles Published: 2 (citations in Products Section of this PPPR)

#### **Plans for Next Reporting Period to Accomplish Research Goal:**

- Provide support, guidance and assistance to project Principal Investigators to facilitate the achievement of individual research project objectives in compliance with approved work plans.



## **SWUTC Goal #2: Education and Workforce Development Programs**

With this grant, SWUTC will promote excellence and the preeminent status of the education programs at each of the consortium member universities. This consortium nurtures world-class innovators in the education and preparation of transportation leaders for the emerging information-rich economy, through a continuing process of improvement in curriculum, courses and teaching methods.

### **Efforts Active July 1, 2014 – December 31, 2014:**

♦ **SWUTC graduate scholarship programs** have the ultimate goal to prepare a highly qualified cadre of new professionals into transportation science. These programs provide financial support to students to participate in classroom and sponsored research activities. In addition, the program provides increased communications skills as students make presentations, participate in debates, and write proposals and reports. Students also participate in technical tours and professional meetings throughout the year. Students in these programs receive tuition, fees and/or stipend support.

#### **Current Status:**

Transportation Scholars Program at TAMU - Number of students currently in program: 5

Advanced Institute at the UT-Austin – Number of students currently in program: 14

Graduate Stipend Program at Texas Southern University (TSU) – Number of students currently in program: 7

#### ♦ **Summer Undergraduate Fellows Programs**

The SWUTC Summer Undergraduate Transportation Scholars (UGTSP) at TAMU continues to be an extremely successful recruiting endeavor, attracting a diverse group of students into the graduate programs in transportation. Each year, the UGTSP recruits juniors and seniors from other universities and from diverse academic backgrounds into a summer-long program in transportation research and education as a first step towards graduate study in transportation. While at TAMU, the students have the opportunity to work with graduate students, faculty members, and researchers and are also exposed to research through meetings with project sponsors and weekly research seminars. Students make field trips to various transportation agencies and attend professional meetings such as the summer meeting of TexITE. At the end of the summer term, the students make presentations on their research and produce a paper for publication. These papers are published annually as a *Compendium of Student Papers* and posted on the SWUTC website.

#### **Current Status:**

Undergraduate Transportation Scholars Program (UGTSP) at TAMU. 2014 program completed. Number of students participating: 4.

Publication of 2014 Student Papers: Compendium of Student Papers: 2014 Undergraduate Transportation Engineering Fellows Program, is currently being edited and will be published during the next reporting period. Complete summary of the 2014 program available at <http://swutc.tamu.edu/2014/08/10/tamu-undergraduate-scholars-program-completes-24th-successful-year/>

#### ♦ **Ph.D. Candidate Assistantship Program** at TAMU:

This competitive program selects Ph.D. candidates for a maximum of 12 months of salary support while their dissertation is being completed. No tuition or fees are paid. Candidates are chosen based

on the quality and value of the proposed research. The goal of this program is to expedite the progress of students to complete doctoral requirements and begin their careers as transportation leaders.

Current Status:

2012 PhDCA Program:

Of the six proposals selected for funding in FY12, five are now complete. (Citations in previous PPRs) The remaining effort is in the final stages of editing.

2013 PhDCA Program

Of the six proposals selected for FY13 funding – two are now complete (Citations in Products section of this report). The remaining four are in progress.

2014 PhDCA Program

One proposal selected for FY14 funding – initiated September 1, 2014 and is currently in progress.

**FY 14 Effort Selected**

<b>Study Title</b>	<b>Student Name</b>
Marine Transportation System Maintenance Optimization	Adel Khodakarami

**Plans for Next Reporting Period to Accomplish Education and Workforce Development Goal:**

- Continue support of graduate scholarship programs at TAMU, UT-Austin and TSU, and the Ph.D. Candidate Assistantship Program at TAMU.
- Publish the 2014 Undergraduate Transportation Scholars Program at TAMU Compendium of Student Papers.
- Support and conduct the 2015 Summer Undergraduate Transportation Scholars Program at TAMU.

**SWUTC Goal #3: Technology Transfer**

Timely information, delivered to the right people is the desired outcome for SWUTC’s technology transfer program. SWUTC supports a varied menu of techniques to transfer SWUTC derived results. These include: continually updating the SWUTC website at <http://swutc.tamu.edu/> with center news and downloadable publications; publishing and distributing research final technical reports to 20 state and national libraries; and support for SWUTC researchers as they present their research results through peer-reviewed publications and professional presentations.

**See complete listing of publications and presentations produced during this reporting period in the following Products Section.**

**Plans for Next Reporting Period to Accomplish Technology Transfer Goal:**

- Continue to update website with recent center activities and accomplishments.
- Publish final technical reports as individual research projects are completed.
- Continue to support researchers as they present their research results through peer-reviewed publications and professional presentations.

## 2. Products:

SWUTC Publications/papers/presentations for this reporting period:

### **Publications Submitted for Review:**

Controlling Electrical Conductivity of Asphalt Binder Using Graphite, P. Park, A. Baranikumar, A. V. Tamashauskyy and S. El-Tawil, TAMU, under review for publication in *Construction and Building Materials*, 2014 (Product of SWUTC Project #600451-00025)

Controlling Electrical Conductivity and Mechanical Performance of Asphalt Concrete with Conductive Additives, Y. Rew, A. Baranikumar and P. Park, TAMU, under review for publication in the *Journal of the Transportation Research Board*, 2014 (Product of SWUTC Project #600451-00025)

Influence of Aging in Asphalt Binders on its Fatigue Cracking Resistance in the Context of RAP Mixes, Amit Bhasin, UT-Austin, under review for publication in the *ASCE Journal of Materials in Civil Engineering*, 2014. (Product of SWUTC Project #600451-00076)

Demand-responsive Transit Circulator Service Network Design, Randy Machemehl, UT-Austin, under review for publication in *Transportation Research Part E: Logistics and Transportation Review*, 2014. (Product of SWUTC Project #600451-00082)

Optimizing Transit Circulator Service Networks for Commuter Rails, Yao Yu, Randy B. Machemehl, and Chi Xie, UT-Austin, under review for publication in the *Journal of American Society of Civil Engineers*, (Products of SWUTC project #600451-00082)

Highway Safety Manual Calibration and the Quantitative Effects of Data Availability and Assumption-Making, Brian Wolshon, LSU, under review for publication in *Journal of the Transportation Research Board*, August, 2014. (Product of SWUTC Project #600451-00102)

### **Book/Journal Submissions Published (citations not captured in previous PPPRs):**

The Environmental Implications of Shared Autonomous Vehicles, Using Agent-Based Model Simulation, Dan Fagnant and Kara Kockelman, UT-austin, published in *Transportation Research Part C* 40: 1-13, 2014 (Product of SWUTC Project #600451-00081)

Rethinking Competition in TIGER: Lessons for Federal and Public Administration, Kate Lowe, UNO, published in *Public Works Management & Policy*, 2014. (Product of SWUTC Project #600451-00106)

Capacity and Federal Program Design: Competing for TIGER Funds, K. Lowe, UNO, published in *Public Works Management and Policy*. (Product of SWUTC Project #600451-00106)

Capacity or Equity?: Federal Funding Competition between and within Regions, K. Lowe, S. Reckhow and J. Gainsborough, UNO, published in the *Journal of Urban Affairs*. (Product of SWUTC Project #600451-00106)

**Products of SWUTC Ph.D. Candidate Assistantship Program at TAMU:**

Optimization and Mechanism Design for Ridesharing Services, Wei Lu, December 2014, 80 pp. (Product of SWUTC Project #600451-00034)

Incorporating Risk and Uncertainty into Pavement Network Maintenance and Rehabilitation Budget Allocation Decisions, Jose Rafael Menendez Acurio, August 2014, 76 pp. (Product of SWUTC Project #600451-00037)

**Presentations (citations not captured in previous PPPRs):**

Safety Performance of Different Types of Freeway Weaving Segments, J. Liu and Y. Qi, TSU, presented at the TSU Research Week, April 3, 2014. (Product of SWUTC Project #600451-00045)

Doing Business with Transit-Oriented Development, Carol Lewis, TSU, presented to the Old Spanish Trail Community Partnership, Houston, TX, December 9, 2014. (Product of SWUTC Project #600451-00047)

On Incorporating Spatial Dependence in a Multiple Discrete-Continuous Choice Model, C. R. Bhat and S.K. Dubey, UT-Austin, presented at the 93<sup>rd</sup> TRB Annual Meeting, Washington, DC, January 2014. (Product of SWUTC Project #600451-00063)

Learning in Network Equilibrium Models, Stephen Boyles and Tarun Rambha, UT-Austin, presented to the 2014 Annual Informs Conference, San Francisco, CA, November 8-12, 2014. (Product of SWUTC Project #600451-00079)

A Convergence in Shared Mobility: Demand-Responsive Fully Automated Vehicles, for Car-Sharing and Ride-Sharing across Austin, Texas, Kara Kockelman, UT-Austin, presented at the 2014 Transportation Research Board Conference on Innovations in Travel Modeling, Baltimore, MD, April 27-30, 2014 (Product of SWUTC Project #600451-00081)

A Convergence in Shared Mobility: Demand-Responsive Fully Automated Vehicles, for Car-Sharing and Ride-Sharing Across Austin, Texas, Kara Kockelman, UT-Austin, presented at the 2014 Automated Vehicles Symposium, San Francisco, CA, July 15-17, 2014. (Product of SWUTC Project #600451-00081)

Real-Time Optimization of Passenger Collection for Commuter Rail Systems, Yao Yu and Randy Machemehl, UT-Austin, presented at and published in the Proceedings of the Canadian Society of Civil Engineers 10<sup>th</sup> International Specialty Conference on Transportation, Halifax, Nova Scotia, May 28, 2014. (Product of SWUTC Project #600451-00082)

Strategic Assessment on Emerging Innovative Transportation Technologies for Future Transportation in Texas, Peter Jin, Dan Fagnant, Andrea Hall, and C. Michael Walton, UT-Austin, presented at the meeting of ITS World Congress in Detroit, MI, September 16, 2014. (Product of SWUTC Project #600451-00087)

An Integrated Approach to Managing the Transportation System: Study Results, Zhanmin Zhang, UT-Austin, presented to the ASCE T&DI 2nd Congress, Orlando, FL, June 8-11, 2014. (Product of SWUTC Project #600451-00089)

Development of Louisiana-Specific Highway Safety Crash Calibration Factors, Brian Wolshon, LSU, presented to the Deep South Section Meeting of the Institute of Transportation Engineers, Baton Rouge, LA, February 2014. (Product of SWUTC Project #600451-00102)

Calibration of the Highway Safety Manual for Louisiana, Brian Wolshon, LSU, presented at the 2014 Louisiana Transportation Safety Summit, Baton Rouge, LA, March 2014. (Product of SWUTC Project #600451-00102)

Modeling and Analysis of Manual Intersection Traffic Control for Application in Evacuation Time Estimate Studies, S. Parr and Brian Wolshon, LSU, presented at the 2014 ANS Winter Meeting and Nuclear Technology Expo, Anaheim, CA, November 2014. Also published in the *Conference Proceedings*. (Product of SWUTC Project #600451-00113)

Modeling Large-Scale and Regional Evacuations, Bryan Wolshon, LSU, presented at the 2014 National Hurricane Conference, Orlando, FL, April 2014. (Product of SWUTC Project #600451-00114)

Simulation and Analysis of Evacuations in Megaregion Scale Networks, Brian Wolshon, LSU, presented at the 39<sup>th</sup> Annual natural Hazards Research and Applications Workshop, Broomfield, CO, June 2014. (Product of SWUTC Project #600451-00114)

The Conceptual Mismatch: Rethinking Transportation Accessibility, Kate Lowe, UNO, presented to the Association of Collegiate Schools of Planning Annual Conference, Philadelphia, PA, October 20, 2014. (Product of SWUTC Project #600451-00115)

Websites (other than SWUTC website) and other social media utilized for this reporting period:

Project 161302: <http://mobility.tamu.edu/ums/>

Project 600451-00081: <http://www.caee.utexas.edu/prof/kockelman>

Project 600451-00111: <http://rip.trb.org/view/2013/P/1251601>

Project 600451-00117: <http://Rideneworleans.org>

Project 600451-00119: <http://www.transpotation.uno.edu>

Project 600451-00119: <http://pbriLA.org>

Technologies or techniques for this reporting period:

♦ **New Techniques Developed:**

- SWUTC Project #161303 – Next Generation Safety Performance Monitoring at Signalized Intersections Using Connected Vehicle Technology developed a framework to monitor the safety performance of signalized intersections using data exchange within the connected vehicle environment. This framework can potentially be incorporated into facilities instrumented with connected vehicle capability. A connected vehicle application can be developed based on the proposed framework to automatically collect and evaluate the safety performance of signalized intersection operations.
- SWUTC Project #600451-00025: Controlling Electrical Conductivity of Asphalt Concrete for Multifunctional Applications developed a new method of controlling electrical conductivity of asphalt concrete using graphite. Included, was the effect of graphite types (electrical impedance curves for nine conductive additives), aggregate gradation, and binder types on conductivity.
- SWUTC Project #600451-00026: Zone/Fleet Sizing for MAST (Mobility Allowance Shuttle Transit) Services developed a new technique for evaluating the performance of MULTI-MAST transit systems.
- SWUTC Project #600451-00076: Micro-crack Growth in Aged Asphalt Mixtures developed a specimen fabrication procedure that can make the current test procedure more repeatable and

less time consuming. Additionally, the project developed a test method to evaluate fatigue cracking resistance of asphalt binders in a more realistic manner.

- SWUTC Project #600451-00082: Real Time Optimization of Passenger Collection for Commuter Rail Systems constructed a new tabu search method with different local search strategies and neighborhood evaluation methods to tackle the circulator service network design problem.
- SWUTC Project #600451-00089: An Integrated Approach to Managing the Transportation System developed a new method for transportation asset valuation.

Inventions/patent applications/licenses for this reporting period: Nothing to report at this time.

Other Products for this reporting period:

♦ **New Software Scripts Developed:**

- SWUTC Project #600451-00009 – Sustainability of Transportation Structures Using Composite Materials to Support Growth and Trade developed a simulation test bed in VISSIM that enables vehicle-to-infrastructure (V2I) communications. Related algorithms for extracting safety measures in the V2I communications environment were also developed using Python scripts.

♦ **Models Developed:**

- SWUTC Project #600451-00045: Safety Performance of Different Types of Freeway Weaving Segments produced a new model for predicting the crash frequencies of freeway weaving segments. This is a unique model that can take account the impacts of various factors, including the length of weaving section and the minimum required lane changes for merging or diverging vehicle.
- SWUTC Project #600451-00081: Anticipating Long-Term Energy and GHG Emissions Impacts of Autonomous Vehicles created two substantive pieces of computer code, approximately 6000 lines each, in length. This code simulates how shared fully automated vehicles can serve a population of travelers, similar to what Google and other autonomous vehicle technology providers are hoping to introduce within the next five to six years. The code is flexible and may be adapted to fit the needs of any city or region, for deployment evaluation.
- SWUTC Project #600451-00082: Real Time Optimization of Passenger Collection for Commuter Rail Systems constructed a bi-level nonlinear mixed integer programming model to tackle the circulator service network design problem.

### 3. Participants & Other Collaborating Organizations

#### Organizations as SWUTC Partners:

See previous PPPRs for extensive list of organizations providing in-kind support in the form of personnel who serve as project monitors for active SWUTC research projects.

#### **New Project Monitors for this reporting period:**

Sam Lott, Kimley Horn & Associates – In-kind support for SWUTC Project #600451-00049  
Pres Kabacoff, CEO HRI Properties, New Orleans – In-kind support for SWUTC Project #600451-00116

Jeff Schwartz, Executive Director, Broad Community Connections, and Board Member, New Orleans Regional Planning Commission – In-kind support for SWUTC Project #600451-00117

#### **Partnerships/collaborations for this reporting period:**

Rick Schuman, INRIX – Contribution: In-kind support – provided national speed dataset to be used in the production of the Urban Mobility Report for SWUTC Project #161302.

City of Houston – Public Works Department – Contribution: In-kind support – provided information on traffic signals, signalization and maintenance for SWUTC Project #161341.

City of Austin – Contribution: In-kind support – providing data to help in modeling work for SWUTC Project #600451-00088

Dr. Helmut Scheider, Chair of Information Systems and Decision Sciences Department, LSU – Contribution: In-kind support – support for the statistical analysis for SWUTC Project #600451-00102.

Louisiana Department of Transportation and Development – Contribution: In-kind support - provided roadway data files and historical crash data from 2009 to 2011 to support the analysis and calibration efforts of SWUTC Project #600451-00102.

City of Baton Rouge – Contribution: In-kind support – assisted in locating suitable field project and facilitating access to the site during road construction – SWUTC Project #600451-00111

Barrier Construction - Contribution: In-kind support – assisted in locating suitable field project and facilitating access to the site during road construction – SWUTC Project #600451-00111

University of New South Wales, Sydney Australia – Dr. Vinayak Dixit – Contribution: In-kind support – assisted in the development of some components of the research methodology for SWUTC Project #600451-00113.

Lafayette Habitat for Humanity – Contribution: In-kind support – disseminated materials and arranged use of space at the Rosa Parks Transportation Center in support of SWUTC Project 600451-00115.

Neighborhood Services Coordinator for Department of Community Development of Lafayette Consolidated Government - Contribution: In-kind support – disseminated information for recruitment to community centers and development organizations in support of SWUTC Project 600451-00115.

Rutgers University – David Listokin – Contribution: In-kind support – assisted with data collection, data analysis, and writing and editing of case studies and final report for SWUTC Project #600451-00116.

HRI Properties – Hal Fairbanks, and Pres Kabacoff – Contribution: In-kind support – assistance with data collection for case studies and assistance with strategic understanding of the research issues for SWUTC Project #600451-00116.

Ride New Orleans – Rachel Heiligman and Alexandra Miller – Contribution: In-kind support – provided expertise for SWUTC Project #600451-00117.

National Complete Streets Coalition - Contribution: In-kind support - review of draft survey instrument and provided feedback prior to its release for SWUTC Project #600451-00119.

State Smart Transportation Initiative - Contribution: In-kind support - review of draft survey instrument and provided feedback prior to its release for SWUTC Project #600451-00119.

Center for Planning Excellence – Contribution: Facilities – provided a meeting space for the Complete Streets event at no cost for SWUTC Project #600451-00119.



## 4. Impact

*Impact on the development of the principal disciplines of the program for this reporting period:*

◆ **Civil Engineering/Pavements:**

- Results from SWUTC Project #600451-00025: Controlling Electrical Conductivity of Asphalt Concrete for Multifunctional Applications provided the basis for new multifunctional electrical applications of pavements. This, in turn, can improve transportation safety and service life, and reduce user and agency costs for construction and maintenance of transportation systems.
- One of the findings from SWUTC Project #600451-00076: Micro-crack Growth in Aged Asphalt Mixtures is that the use of reclaimed asphalt pavement in new mixes does not necessarily negatively impact the fatigue cracking resistance of an asphalt mixture. To this end, this research is a small but critical step to educate pavement engineers on the appropriate design and use of materials.

◆ **Civil Engineering/Design:**

- Results from SWUTC Project #600451-00045: Safety Performance of Different Types of Freeway Weaving Segments provide guidelines to transportation engineers in the design of freeway weaving segments and assessing the safety impacts of various influencing factors.

*Impact on other disciplines for this reporting period:*

◆ **Impacts on Service Industry.** SWUTC Project #600451-00026: Zone/Fleet Sizing for MAST (Mobility Allowance Shuttle Transit) Services provided more in depth and accurate assumptions in determining random customer demand which provides for better planning. This can be used in other systems dealing with similar random demand, such as in the service industry other than transit.

◆ **Applicable to Multiple Disciplines.** The model and method developed by SWUTC Project #600451-00082: Real Time Optimization of Passenger Collection for Commuter Rail Systems is also applicable to anyone dealing with solution methods for optimization problems. This multidisciplinary community would include mechanical engineers, electrical engineers and business managers.

*Impact on the transportation workforce development for this reporting period:*

◆ **Provide Opportunities for Students to Participate in SWUTC Research.** SWUTC requires that students be involved in a meaningful way in the conduct of all SWUTC research efforts. During this reporting period, 42 graduate students and 7 undergraduate students were involved in the SWUTC research activities.

◆ **Graduate Scholarships Provided.** The SWUTC graduate scholarship programs provide stipends to students to participate in classroom and sponsored research activities. Graduate students supported this reporting period: 26

◆ **Undergraduate Summer Fellowships Provided.** This program recruits juniors and seniors from other universities and from diverse academic backgrounds into a summer-long program in transportation research and education as a first step towards graduate study in transportation. Undergraduate students supported this reporting period: 4

Impact on physical, institutional, and information resources at the university or other partner institutions for this reporting period:

Nothing to report.

Impact of technology transfer for this reporting period:

◆ **Informing the Public and Decision Makers:**

- SWUTC Project #161303: Next Generation Safety Performance Monitoring at Signalized Intersections Using Connected Vehicle Technology introduced a novel and efficient approach for collecting critical safety data and expediting safety evaluation using emerging connected vehicle technology. As the technology adoption is expected to progress at a faster pace in the near future, it is envisioned that the proposed application can have immediate impact on detecting safety concerns, devising safety countermeasures, and allocating budgets for safety improvements.
- SWUTC Project #161341: Hot Spot Analysis of Teen Drivers in Houston, Texas demonstrated the benefits of red light cameras, traffic calming/management, and signalization programs in decreasing accidents for teens and young drivers. This could be used positively by city officials (public works and planning departments) to lobby for additional changes on streets with a high volume of accidents.
- The new performance evaluation technique developed by SWUTC Project #600451-00026: Zone/Fleet Sizing for MAST (Mobility Allowance Shuttle Transit) Services will impact and improve current practice in decision making in the transportation industry, specifically for planning and design of transit systems. This could lead to cost saving and performance improvement of such systems, improving livability and quality of life.
- Results from SWUTC Project #600451-00047: The Effect of the City of Houston Transit Corridor Ordinance on Development along METRO's Light Rail Corridors help change behavior, practices, decision making and policies by increasing the knowledge about the options available to developers applying for the TOD ordinance. The City's representative stated that developers often indicate interest in the program, but learned of it when their project already had blueprints done. The outcome of this work will present the options to land owners proximate to the rail lines earlier in their development processes. Ultimately, better development of properties proximate to rail lines has been shown to increase the number of transit trips and improve economic return to taxpayers.
- Findings from SWUTC Project #600451-00078: Examining the Market Potential for Natural Gas Powered Trucks: Barriers and Opportunities for Promoting Environmental Sustainability and Economic Prosperity contribute to our understanding of available public policy tools that can be adopted to promote the future use of natural-gas-powered trucks. These findings have important implications for research on energy efficiency and environmental policies which aim to reduce negative externalities associated with conventional vehicles.
- The code developed by SWUTC Project #600451-00081: Anticipating Long-Term Energy and GHG Emissions Impacts of Autonomous Vehicles simulates how shared fully automated vehicles can serve a population of travelers, similar to what Google and other autonomous vehicle technology providers are hoping to introduce within the next five to six years. The code is flexible and may be adapted to fit the needs of any city or region, for deployment evaluation. These results have been presented to representatives of automotive manufacturer industry who are entering the automated vehicle space and were a featured presentation to MPO planners at the

2014 Automated Vehicles Symposium in July. This work has been reported on by *The Atlantic Cities*, *Bloomberg News*, *The Washington Post*, CBS News, and the AP, among other national media. In addition, it has been presented at press releases, and directly to persons in the U.S. House of representatives, FHWA, FTA, numerous persons employed in AV-related technology, and insurance industries. Such efforts have created much discussion and excitement among the public, regarding both the great potential and the potential pitfalls that SAVs (and AVs in general) present. Assuming that SAVs are eventually deployed, this research has demonstrated how they should create substantial environmental benefits, while also reducing parking requirements for cities and ultimately changing the built environment. The results of this work should help inform such persons attempting to plan and prepare for SAV's pending arrival on U.S. city streets.

- Results from SWUTC Project #600451-00082: Real Time Optimization of Passenger Collection for Commuter Rail Systems will benefit public transportation agencies that seek supporting materials for developing plans for new technology adoption and implementation.
- Results from SWUTC Project #600451-00086: Financial Arrangements for Alternative Delivery Techniques of Transportation Programs and Projects will increase understanding of the life-cycle cost-efficiency differences between publicly and privately developed projects, and therefore change practices in the way such projects are procured and managed for the benefit of the sponsor agency and the project's users.
- SWUTC Project #600451-00087: Policy Implications of Emerging Vehicle and Infrastructure Technology is one of the first studies that has taken a comprehensive analysis of new and emerging transportation technologies and their combined and individual ability to further state and national transportation goals. In addition, the study analyzed barriers to transportation technology adoption and promotion. Findings of this research will serve to improve public knowledge and attitudes, as well as change behavior, practices, decision-making and/or policies towards emerging transportation technologies.
- The methodology for transportation asset valuation developed by SWUTC Project #600451-00089: An Integrated Approach to Managing the Transportation System will allow a value tag to be attached to any segment of a highway for communicating the information to the general public and supporting decision makings by the highway agencies.
- The results of SWUTC Project #600451-00105: Use of Containers to Carry Bulk and Break Bulk Commodities and Its Impact on Gulf Region Ports and International Trade reinforced decisions made in both the public and private sector regarding strategic investments at the Port of New Orleans, the Port of Baton Rouge as well as long-term development decisions by the newly formed Port of Plaquemines Parish. The study results may reinforce or contribute to the findings of pending projects that will analyze the economic impact of deepening the Mississippi River to 50' from Head of Passes to Baton Rouge.
- The findings of SWUTC Project #600451-00106: Cooperation and Competition – Regional Transportation Planning and Competitive Federal Awards raise important questions for debate on how to best allocate federal funds, especially for transportation. Additionally, the related publication for *Public Works Management and Policy* will reach public administration scholars and practitioners with implications for the design and implementation of federal programs.

*Impact on society beyond science and technology for this reporting period:*

◆ **Improved Safety and Reduced Costs.** SWUTC Project #600451-00025: Controlling Electrical Conductivity of Asphalt Concrete for Multifunctional Applications - Conductivity control of asphalt pavements enables various non-structural and non-traditional functions such as self-healing, self-sensing, deicing, and tele-communication. In addition, conductive pavement can be utilized for some developing technologies such as a guide for autonomous (driverless) vehicles and connected vehicles. Results from this research will improve transportation safety and service life, and reduce user and agency costs for construction and maintenance of transportation systems.

◆ **Reduced Crash Rates.** The developed methods, tables, and models of SWUTC Project #600451-00045: Safety Performance of Different Types of Freeway Weaving Segments can be incorporated into state or Federal roadway design manuals and the Highway Safety Manual. This implementation will result in reduced crash rates at freeway weaving segments. It will also reduce social and environmental cost associated with the traffic accidents.

## 5. Changes/Problems

Nothing to report.