

UTAH  
TRANSPORTATION  
CENTER  
2010-11  
ANNUAL REPORT



“INNOVATIVE ENGINEERING AGAINST HAZARDS”



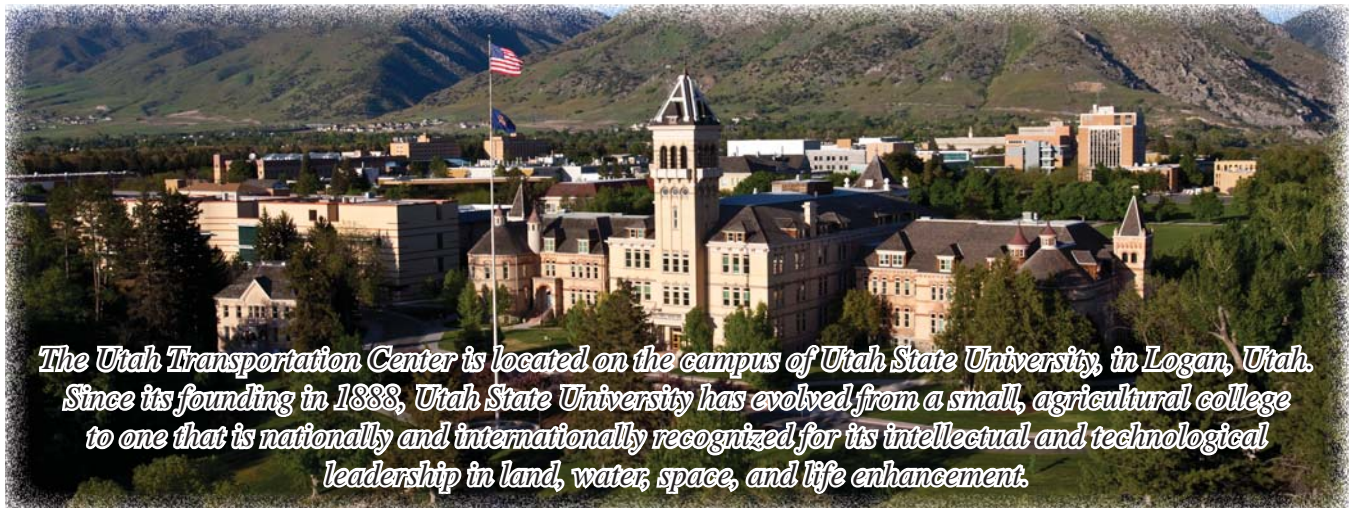
# ABOUT THE UTAH TRANSPORTATION CENTER

The theme for the Utah Transportation Center (UTC) is “Innovative Engineering Against Hazards” and comes from the core expertise of the initial group of colleagues associated with the Center. For more than a decade, the transportation research expertise within the Department of Civil and Environmental Engineering (CEE) at Utah State University has been in areas addressing natural hazards such as earthquakes, landslides, and flooding. It was decided to mold the Center around this expertise and then reach out to other colleagues to provide expertise that can be applied to both hazards and other areas of transportation—congestion and transit being two prime examples.

This approach has been very successful during the first five years of the Center. In particular, the association of colleagues in Utah State University’s Department of Electrical and Computer Engineering (ECE), College of Natural Resources and most recently, the Energy Dynamics Laboratory and the Department of Consumer Sciences, has expanded the Center’s ability to look at transportation issues from a wide variety of perspectives. We anticipate continued expansion of these cross-discipline partnering efforts in the future.

The *educational activities* of the Center continue to be centered primarily around instruction by CEE faculty associated with the Center. These faculty teach an array of transportation-related courses in many disciplines of civil engineering: surveying, structures, hydraulics, operations, transportation design, planning, and engineering economics. Center *research activities* continue to focus on “engineering against hazards,” and also include transit and wildlife transportation corridor users. The Center’s principal research partner continues to be the Utah Department of Transportation (UDOT) and has grown to include the Utah Transit Authority (UTA). Our partnership with the Federal Highway Administration (FHWA) has continued as work on the Long Term Bridge Performance (LTBP) Program moves forward. Work with local agencies has continued through the Utah Local Technical Assistance Program (LTAP). Throughout all of our activities, the underlying emphasis on undergraduate and graduate student development continues to be a focus beyond the classroom. Students learn hands-on as they participate with Center faculty in their real-world research projects, serve local agency needs by providing technical assistance through the Utah LTAP Center, and learn from classroom instruction based on the latest in the ever-changing transportation field.

The *technology transfer activities* of the Center this past year have been three-pronged: (1) the presentation of papers at professional conferences—the annual Transportation Research Board meeting being the principal medium for these presentations; (2) peer reviewed journal publications (see page 8-11 for the list of presentations and publications); and (3) research dissemination to local agencies through the Utah LTAP Center.



*The Utah Transportation Center is located on the campus of Utah State University, in Logan, Utah. Since its founding in 1888, Utah State University has evolved from a small, agricultural college to one that is nationally and internationally recognized for its intellectual and technological leadership in land, water, space, and life enhancement.*

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# ANNUAL REPORT 2010-11

## CONTACT THE UTAH TRANSPORTATION CENTER

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## CENTER STAFF

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Director  
Civil & Environmental Engineering

**Marvin W. Halling, Ph.D, P.E.**  
Associate Director  
Civil & Environmental Engineering

**Julie H. Duersch**  
Publications Editor

## FACULTY COLLEAGUES

*listed alphabetically*

**Paul J. Barr, Ph.D**  
Assistant Professor  
Civil & Environmental Engineering

**James A. Bay, Ph.D**  
Associate Professor  
Civil & Environmental Engineering

**Scott E. Budge, Ph.D**  
Associate Professor  
Electrical & Computer Engineering

**Joseph A. Caliendo, Ph.D**  
Associate Professor  
Civil & Environmental Engineering

**Anthony Chen, Ph.D**  
Associate Professor  
Civil & Environmental Engineering

**Patricia Cramer, Ph.D.**  
Research Assistant Professor  
Wildland Resources

**Kevin P. Heaslip, Ph.D**  
Assistant Professor  
Civil & Environmental Engineering

**Robert T. Pack, Ph.D**  
Associate Professor & Director, Center  
for Advanced Imaging Ladar  
Civil & Environmental Engineering

**Lindsey Shirley, Ph.D**  
Assistant Professor  
Agricultural Systems Technology  
& Education (ASTE) and Family &  
Consumer Sciences Education (FCSE)

**Blake P. Tullis, Ph.D**  
Assistant Professor  
Civil & Environmental Engineering

**Chris Winstead, Ph.D**  
Assistant Professor  
Electrical & Computer Engineering

## FROM THE DIRECTOR

KEVIN C. WOMACK, PH.D, P.E.



It is with some melancholy that I sit and write what will be my last “From the Director” letter for the Utah Transportation Center. As with all major changes in one’s life this one is bittersweet. I am looking forward with great anticipation to my new role as the Associate Administrator for Research, Development and Technology within the Research and Innovative Technology Administration of the USDOT. The great thing about this position is that it covers the University Transportation Centers program, so I will continue to be associated with all of you, my fellow Center directors and colleagues, though in a very different role.

The difficult part of this transition will be to leave my great colleagues here at Utah State University, all of whom are great friends and have done so much to make the past five years of the Utah Transportation Center so successful. It is with pride that I can outline such great achievements for a Tier II university transportation center.

Over the past five years the Utah Transportation Center has developed new external relationships with:

- Rutgers University, the Center for Advanced Infrastructure and Transportation;
- Virginia Tech;
- Utah Transit Authority;
- University of Utah;
- Oak Ridge National Laboratory;
- Cache Metropolitan Planning Organization; and,
- Cache Valley Transit District.

Internally, we have developed new relationships with other departments on campus:

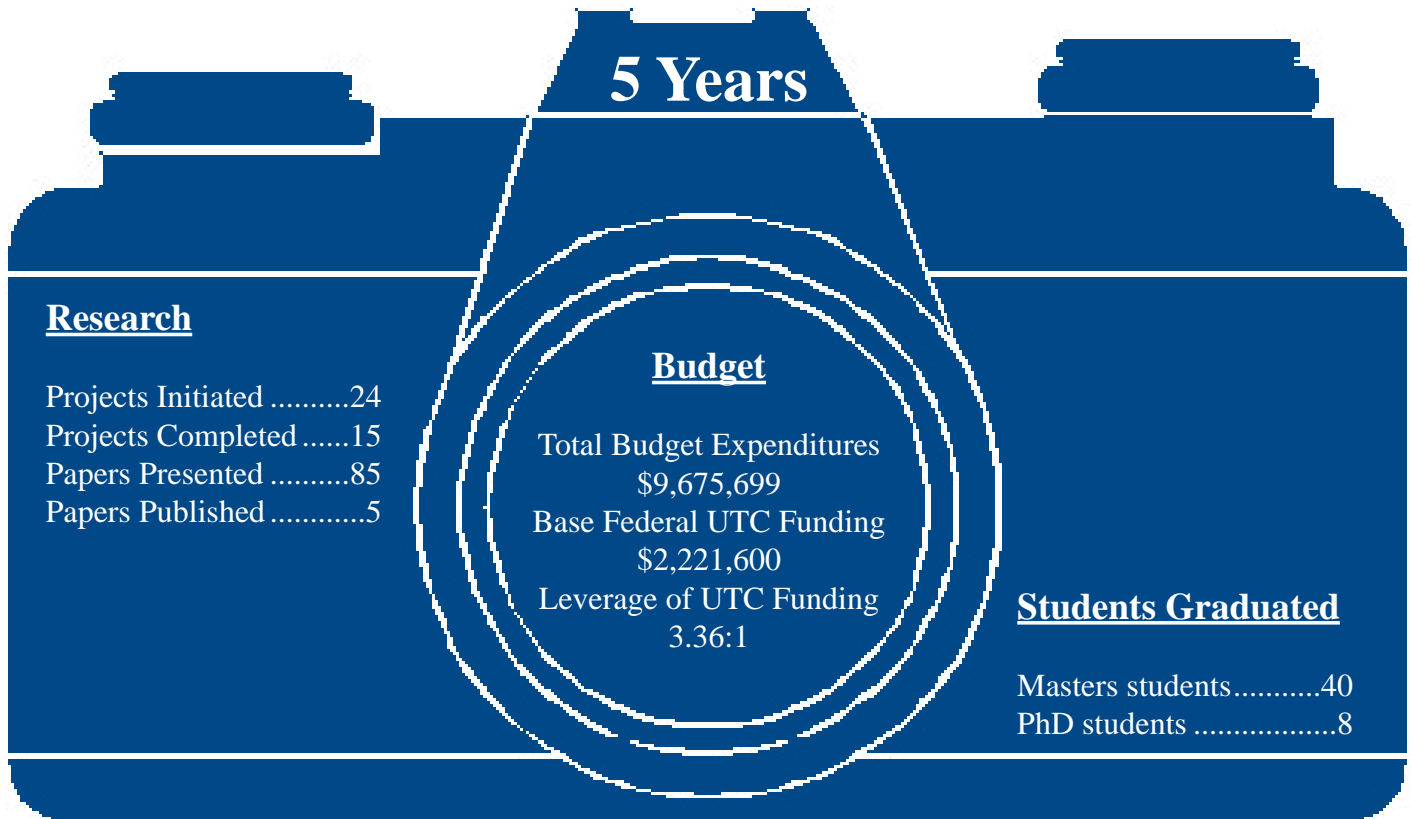
- Electrical and Computer Engineering;
- Wildlife Resources;
- Energy Dynamics Laboratory; and,
- Consumer Sciences;

In concert with the development of these new relationships, some of the major accomplishments of the Center’s colleagues include:

- Receiving a \$1 million special state appropriation for bridge research;



# Utah Transportation Center Snapshot



- Membership in the winning consortium for the Long Term Bridge Performance Program (with CAIT as lead);
- UTA research projects;
- Construction of a new structures testing (SMASH) laboratory;
- Renewal of the Local Technical Assistance Program contract (twice); and,
- New Transportation Infrastructure Management and Engineering Laboratory (TIMELab).

Over the past five years the numbers for the Utah Transportation Center are impressive:

- Total Budgeted Expenditures, \$9,675,699;

- Base federal UTC funding, \$2,221,600;
- Leverage of UTC funding, 3.36:1;
- Research projects initiated, 24;
- Research projects completed, 15;
- Graduate students graduated, Masters–40, Ph.D.–8;
- Papers presented, 85; and,
- Papers published, 50.

Part of this great success has been the effort that Center colleagues have made to branch out into other areas of research which include transit operations, land use planning and the environment, automated and electric transportation systems, and resiliency of transportation systems.

So as I look forward to the next era of my career, I can certainly look back at the past five years, as the Director of the Utah Transportation Center, and say that the successes of my colleagues have been great and that it has been my privilege to have been associated with so many great and hard working people.

I have nothing but the greatest respect for the University Transportation Center community, and I anticipate great things in the future and look forward to working with all of you to continue to make this program a national model for other research and education centers programs.

**The Utah Transportation Center faculty and staff wish Dr. Womack the very best in his new responsibilities.**

# TRANSPORTATION INFRASTRUCTURE MANAGEMENT & ENGINEERING LABORATORY (TIMELAB) COMPLETED

The Utah Transportation Center certainly has cause to celebrate as the Transportation Infrastructure Management and Engineering Laboratory (TIMELab) is finally completed, and well under budget! Those funds will now be used to expand traffic camera installation, enhancing the information available to both UDOT and USU transportation researchers.

This lab, funded by the Utah Department of Transportation (UDOT), allows for expanded real-time research on a variety of transportation issues, and allows UDOT to more quickly update signal timing from the control center in the TIMELab. Support from



UDOT's Matthew Smith, in seeing the need for this lab, and the benefits it will provide now and in the future is greatly appreciated.

Our thanks also goes to Brian Christensen and Carl Sundstrom with Horrocks Engineering and our own Dr. Kevin Heaslip who worked tirelessly to make this happen.

At present, more than 12 students work from the lab, tapping

*The six-screen display panel allows for separate and combined analysis of transportation data by faculty and student researchers (above). The TIMELab is situated in a quiet area of the new David G. Sant Engineering Building at USU where it fits with the buildings purpose of housing cutting-edge engineering research facilities (left). Students Travis Evans, Wes Boggs and Ali Soltani work in the lab (middle).*

into the resources available to complete their transportation research projects under the supervision of Center faculty.

# DR. PATRICIA CRAMER'S ON-GOING WORK ON WILDLIFE-ROADWAY INTERACTIONS RECEIVES WELL-DESERVED RECOGNITION

Center colleague, USU Research Assistant Professor Dr. Patty Cramer was honored this past year by the Denver Zoo with its 2010 Conservation Award. She formally received the award and its accompanying \$5,000 prize in an October 14, 2010 ceremony.

According to the announcement on the Denver Zoo website [<http://www.denverzoo.org/conservation/award.asp>], "Dr. Cramer...has advanced the scientific study of wildlife crossing structures and advocates for landscape connectivity in North America. Wildlife crossings are essential for establishing wildlife corridors between areas of fragmented habitat. For years, Denver Zoo has led and supported conservation projects focused on landscape connectivity; much of this work has been possible through the efforts of scientists like Dr. Cramer."

Dr. Cramer's work was also honored when she received an award for her work as part of a multi-agency committee that worked to plan the



*Bull moose using a wildlife underpass (above) and a Puma using a box culvert (below) were taken as part of Dr. Cramer's on-going work using Reconyx wildlife motion-detection cameras, photos used with permission.*



upgrades to Utah's US 6 along with wildlife mitigation. The committee won a Federal Highways Exemplary Ecosystem Initiative Award for 2010. Ed Woolford of FHWA

gave the representatives of the groups plaques at a February US 6 Wildlife Coordination Committee meeting.

The award was given for "outstanding commitment to environmental stewardship for developing an early partnership to ensure wildlife and wildlife habitat mitigation during a long-term improvement project along US 6 in Utah."

There were 77 applicants for the seven awards given. You can learn more about the award at [<http://www.environment.fhwa.dot.gov/strmlng/newsletters/dec10nl.asp>]. Project details can be found at [<http://www.environment.fhwa.dot.gov/ecosystems/eei/ut10.asp>].

Dr. Cramer's research continues to examine the circumstances and use of wildlife crossing structures by wildlife, including her recent report, "Determining Wildlife Use of Wildlife Crossing Structures Under Different Scenarios," prepared for the Utah Department of Transportation.



# USU TRANSPORTATION ENGINEERING GRADUATE STUDENTS HONORED AT ITE SECTION CONFERENCE

Three USU Transportation Engineering graduate students won awards at the recent Institute of Transportation Engineers (ITE) Intermountain Section Conference in Jackson Hole, Wyoming. Eight schools from the region were eligible for four possible student awards and USU students were awarded three of them.

Derek Freckleton (Masters Student from Bountiful, Utah) won the student paper competition for a pa-

per entitled, “Human Factors and the Challenges Facing AET.” He received a \$600 award and was given the opportunity to present his paper at the conference.

James Fishelson (Masters Student from Long Island, New York)



*Derek Freckleton, Luis Hidalgo & James Fishelson (L-R, above) with their awards, presented during the 2011 ITE Section Conference. Derek Freckleton (left) make his presentation on “Human Factors and the Challenges Facing AET” at the Conference.*

and Luis Hidalgo (Masters Student from the Dominican Republic) won both of the Ellis Mathes Scholarships, worth \$2000 each, sponsored by the members of the Intermountain Section.

In addition, Mr. Fishelson was recently awarded Honorable Mention from the National Science Foundation’s Graduate Research Fellowship program.

All three students are researchers in Utah State University’s Transportation Infrastructure Management and Engineering Laboratory (TIMELab) under the direction of Dr. Kevin Heaslip, Assistant Professor of Civil & Environmental Engineering.



# ADVISORY BOARD MEETS IN LOGAN

On Monday, June 6 the Utah Transportation Center Advisory Board held its annual meeting in the Long Term Bridge Performance Laboratory on the Utah State University campus. Advisory Board members in attendance were William Rahmeyer, USU Civil Engineering Department Head; Clair Fiet, Utah Transit Authority; Cory Pope, Utah Department of Transportation; and James Christian, Federal Highway Administration.

The bulk of the meeting consisted of presentations by Utah Transportation Center (UTC) colleagues, starting off with a discussion of the Utah Local Technical Assistance Program (LTAP) Center activities over the past year led by Nick Jones, LTAP Center Director. This was followed by updates on the Utah Transit Authority passenger count-

ing project by Dr. Scott Budge; the Long Term Bridge Performance (LTBP) Program by Dr. Marvin Halling, the LTBP principal investigator; and current activities in the SMASH (structural testing) laboratory by Dr. Paul Barr. Dr. Kevin Heaslip provided an overview of the activities being conducted by UTC colleagues on the Automated Electric Transportation project being funded by a U.S. Department of Energy grant.

Keith Bartholomew of the University of Utah's College of Architecture and Urban Planning gave a presentation on the Envision Center and the relationship being developed between colleagues in the UTC and the Envision Center, and the critical role of the Utah Transit Authority in the relationship.

The morning ended with a wrap-up discussion led by Dr. Kevin Womack, the UTC Director, on the activities of the UTC over the past five years (see Letter from the Director), and what the future holds for the UTC and the federal university transportation center program. This discussion included the latest news from RITA on the termination of the program as it has existed over the past five years and the new competition for 20 centers at \$4,000,000 per year for the next fiscal year.

This was a lively discussion, focused on how the Center might move forward in this competition and how the best team of research universities can be put together for the competition. As always, the comments and assistance of the Advisory Board members was valuable and greatly appreciated.

## CENTER NAMES STUDENT OF THE YEAR: TOMÁS E. LINDHEIMER

The Utah Transportation Center is pleased to announce the selection of Tomás Lindheimer as the 2011 Student of the Year.

Tomás was born and raised in Buenos Aires, Argentina until he immigrated to Sandy, Utah when he was 13 years old. Tomás attended a private English school, St. Peter's, with the goal of attending an American university.

While still in high school, he decided to pursue an engineering career, and chose to attend Utah State University because of its reputation.

Tomás attended USU for one year, followed by two years in Bulgaria. After his time in Bulgaria, Tomás was tempted to pursue a career in linguistics, but chose to continue pursuing a degree in engineering because it was challenging and interesting.

After a year in Mechanical Engineering, Tomás matriculated into the Civil Engineering program. In the summer following his entrance to the civil engineering program he took an internship with the Utah Department of Transportation (UDOT). The internship with UDOT and Dr.

Heaslip's Introduction to Engineering course piqued his interest in the field of transportation. Upon completion of his bachelors' degree, he pursued a Master's in Transportation studying design and safety considerations in highway work zones. His thesis is titled, "Evaluation of Work Zone Practices in Utah."



# 2010-11 UTAH TRANSPORTATION CENTER PROJECTS

## NEW PROJECTS

- UTC1101 “Parametric Study of the Effects of Seismic Strength Degradation of Fine Grained Soils Beneath Highway Embankments and Bridge Abutments,” Dr. James Bay, PI. *Funded by UTC.*
- UTC 1102 “Integrated Corridor Pricing Structure Modeling and Evaluation,” Dr. Kevin Heaslip, PI. *Funded by UTC.*
- UTC 1103 “Surveying the Transportation Needs of Low Mobility Individuals in Cache Valley,” Dr. Anthony Chen, PI. *Funded by UTC.*
- UTC 1104 “Transportation Network Resiliency Framework Development,” Dr. Kevin Heaslip, PI. *Funded by UTC.*

## ONGOING PROJECTS

- UTC1001 “Work Zone Design Evaluation,” Dr. Kevin Heaslip, PI. *Co-funded by UDOT and UTC.*
- UTC1002 “Forecasting Network Traffic for Small Communities in Utah,” Dr. Anthony Chen, PI. *Funded by UTC.*
- UTC1004 “Investigation of the Use of Texel Cameras for Counting Passengers on Public Transportation, Phase II,” Dr. Scott Budge, PI. *Funded by UTC.*

## COMPLETED PROJECTS

- UTC0803 “ABC Deck Connections, Laboratory Testing and Evaluation,” Dr. Marvin Halling, PI. *Co-funded by UDOT and UTC.*
- UTC1003 “Highway Wildlife Crossing Design Study,” Dr. Patricia Cramer, PI. *Funded by UTC.*
- UTC0702 “UDOT’s Calibration of AASHTO’s New Prestress Loss Design Equations,” Dr. Paul Barr, PI. *Co-funded by UDOT and UTC.*
- UTC0703 “Strong Motion Instrumentation Plan for UDOT Bridges: Array Design, Typical Details, and Specifications,” Dr. Marvin Halling, PI. *Co-funded by UDOT and UTC.*
- UTC0704 “Failure Modes Analysis of UDOT’s MSE Wall Inventory,” Dr. James Bay, PI. *Co-funded by UDOT and UTC.*
- UTC0705 “Logan Bluff Landslide Risk Analysis,” Dr. Robert Pack, PI. *Funded by UDOT.*
- UTC0706 “Wireless Broadband for Commuter Rail: ‘River of RF,’” Dr. Chris Winstead, PI. *Funded by UTC.*
- UTC0801 “Development of a Decision Support Tool for Assessing Vulnerability of Transportation Networks,” Dr. Anthony Chen, PI. *Co-funded by UDOT and UTC.*
- UTC0802 “Synthesis Study and Field Evaluation of In-Situ Culvert Rehabilitation in Utah,” Dr. Blake Tullis, PI. *Co-funded by UDOT and UTC.*

- UTC0804 “Investigation of the Use of Texel Cameras for Counting Passengers on Public Transportation,” Dr. Scott Budge, PI. *Funded by UTA.*
- UTC0805 “Shear Capacity of Pre-stressed Girders,” Dr. Paul Barr, PI. *Co-funded by UDOT and UTC.*
- UTC0901 “Long Term Bridge Performance Program, Supplemental Funding, Year 1,” Dr. Marvin Halling, PI. *Funded by UTC and FHWA.*
- UTC0902 “Cache Valley Transit District (CVTD) Rider Surveys and Analyses,” Dr. Kevin Heaslip, PI. *Funded by the CVTD.*
- UTC0903 “Cache Metropolitan Planning Organization (CMPO) Traveler Preference Study,” Dr. Kevin Heaslip, PI. *Funded by the CMPO.*
- UTC0904 “Quality of Life in Cache Valley Study,” Dr. Kevin Heaslip, PI. *Funded by UTC.*

## 2010-11 PRESENTATIONS & PUBLICATIONS

### PRESENTATIONS

*listed alphabetically by lead author; Utah Transportation Center colleagues in bold*

- Bill, A., Beyerlein, S., **Heaslip, K.**, Hurwitz, D., Sanford Bernhardt, K., Kyte, M., Young, R. (2011) “Development of Knowledge Tables and Learning Outcomes for the Introductory Course in Transportation Engineering,” In the Proceedings of the 90th Transportation Research Board Annual Meeting, Washington, DC, January 2011 (in press).
- Fishelson, J., **Heaslip, K.**, Louisell, W., **Womack, K.** (2011) “An Evaluation Framework for an Automated Electric Transportation Network,” In the Proceedings of the 90th Transportation Research Board Annual Meeting, Washington, DC, January 2011.
- Heaslip, K.**, Brady, B, Thomas, M. (2011) “The Importance of Road Pricing to the Future of Roadway Infrastructure.” In the Proceedings of the 2011 Association of Private Enterprise Education International Conference.
- Manley, M., Kim, Y.S., Christensen, K., **Chen, A.** (2010) An agent-based model for emergency evacuation simulation of heterogeneous populations. Decision Sciences Institute (DSI) 41st Annual Meeting, Nov. 20-23, 2010, San Diego, CA., USA.
- Manley, M., Kim, Y.S., Christensen, K., **Chen, A.** (2011) Modeling emergency evacuation of individuals with disabilities in a densely populated airport. Paper presented for the 90th annual meeting of the Transportation Research Board, Jan. 23-27, 2011, Washington, D.C., USA.
- Petroff, S.M., Halling, M.W., Barr, P.J.** (2011) “Monitoring of Long Term Bridge Performance (LTBP) Program Bridges.” ASCE Structures Congress. Las Vegas, NV April 2011.
- Ryu, S., **Chen, A.**, Kim, Y. (2011) Investigating travel time reliability measures in toll design problem. Proceedings of Eastern Asia Society for Transportation Studies, Vol. 8. Presented at the 9th Eastern Asia Society for Transportation Studies, 20-23 June 2011, Jeju, Korea.



- Sanford Bernhardt, K., Bill, A., Beyerlein, S., **Heaslip, K.**, Hurwitz, D., Kyte, M., Young, R.K. (2011) “A Nationwide Effort to Improve Transportation Engineering Education.” In the Proceedings of the ASEE 2011 Annual Conference & Exposition.
- Shao, H., Lam, W.H.K., Sumalee, A., **Chen, A.** (2010) Network-wide travel time estimation with inconsistent sensor data. Paper presented at the 7th International Conference on Traffic & Transportation Studies (ICTTS 2010), 3-5 August 2010, Kunming, P.R. China.
- Shao, H., Lam, W.H.K., Sumalee, A., **Chen, A.** (2010) Journey time estimator for network travel performance assessment under demand uncertainty. Paper presented at the 4th International Symposium on Transportation Network Reliability (INSTR), 22-23 July 2010, University of Minnesota, USA.
- Shirley, L., **Heaslip, K.** (2011) “The Resilient Family: A Methodology for Bridging Cultures and Disciplines Before and After a Disaster.” In the Proceedings of the American Association of Family & Consumer Sciences 102nd Annual Conference & Exposition.
- Urena Serulle, N., **Heaslip, K.**, Louisell, W., Brady, B., Collura, J. (2011) “Quantifying Transportation Network Resiliency: A Case Study of Santo Domingo, Dominican Republic,” In the Proceedings of the 90th Transportation Research Board Annual Meeting, Washington, DC, January 2011.
- Vasquez, C., **Heaslip, K.**, Langford, M. (2011) “An Alternative Pavement Management System Approach for Local Governments,” In the Proceedings of the 90th Transportation Research Board Annual Meeting, Washington, DC, January 2011.
- Xing, S., **Halling, M.W.**, Meng, Q., **Barr, P.J.** (2011) “Structural Pounding Identification by using Wavelet Scalogram.” Proceedings of the 8th International Conference on Structural Dynamics, EUROODYN. Leuven, Belgium July 2011.
- Xing, S., **Halling, M.W.**, **Barr, P.J.** (2011) “Delamination Detection in Concrete Plates using Output-Only Vibration Measurements.” Proceedings of the International Modal Analysis Conference. Jacksonville, Florida. January 2011.
- Xu, X., **Chen, A.** (2011) Assessing the effects of stochastic perception error in the stochastic mean-excess traffic equilibrium model. Paper presented for the 90th annual meeting of the Transportation Research Board, Jan. 23-27, 2011, Washington, D.C., USA.
- Xu, X., **Chen, A.** (2010) Estimating total travel time distribution in stochastic mean-excess traffic equilibrium model. Paper presented at the 15th Hong Kong Society of Transportation Studies Conference: Transportation and Urban Sustainability, December 11-14, 2010, Hong Kong, P.R. China.
- Xu, X., **Chen, A.** (2011) Solving stochastic multi-objective network design problem: A goal programming approach. Paper presented for the 90th annual meeting of the Transportation Research Board, Jan. 23-27, 2011, Washington, D.C., USA.
- Xu, X., **Chen, A.** (2010) Goal programming approach to solving NDP with multiple objectives and demand uncertainty. Paper presented at the 4th International Symposium on Transportation Network Reliability (INSTR 2010), 22-23 July 2010, Minnesota, USA.
- Xu, X., **Chen, A.**, Zhou, Z., Cheng, L. (2010) Considering late-arrival in multi-class risk-averse traffic assignment model. Paper presented at the 4th International Symposium on Transportation Network Reliability (INSTR 2010), 22-23 July 2010, Minnesota, USA.

- Yang, C., **Chen, A.** (2010) Uncertainty analysis of a combined travel demand model. Paper presented at the 15th Hong Kong Society of Transportation Studies Conference: Transportation and Urban Sustainability, December 11-14, 2010, Hong Kong, P.R. China.
- Yang, C., **Chen, A.** (2011) Sensitivity-based uncertainty analysis of a combined travel demand model. Paper presented for the 90th annual meeting of the Transportation Research Board, Jan. 23-27, 2011, Washington, D.C., USA.
- Zhou, Z., **Chen, A.** (2011) Finding alpha reliable mean-excess path in stochastic networks. Paper presented for the 90th annual meeting of the Transportation Research Board, Jan. 23-27, 2011, Washington, D.C., USA.
- Zhou, Z., **Chen, A.** (2010) The  $\alpha$ -reliable mean-excess path finding model in stochastic networks. Paper presented at the 10th International Chinese Conference of Transportation Professionals (ICCTP 2010), 4-8 August 2010, Beijing, P.R. China.

## PUBLICATIONS

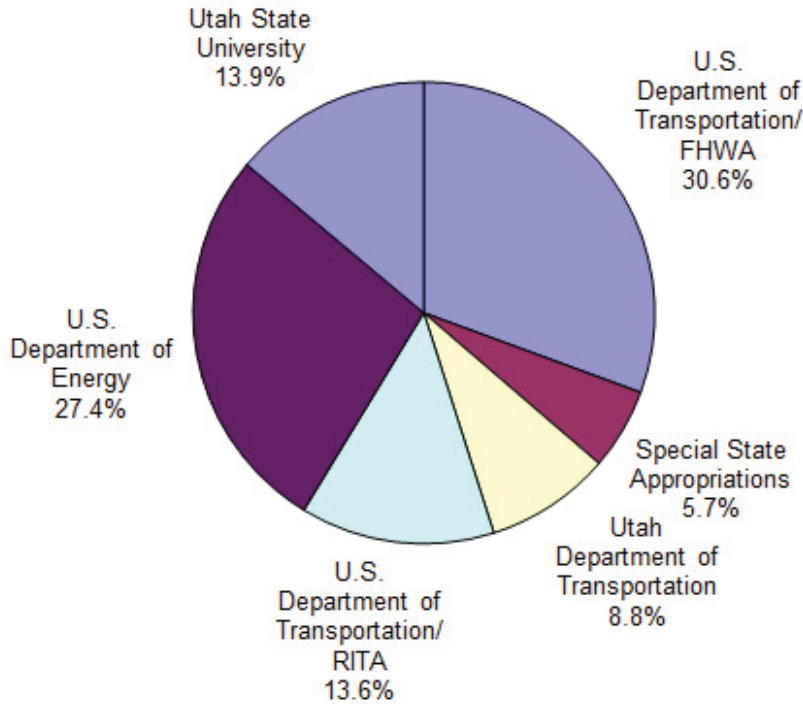
*listed alphabetically by lead author; Utah Transportation Center colleagues in bold*

- Barr, P.J.**, Angomas, F. (2010) Differences Between Calculated and Measured Long-Term Deflections in Prestressed Concrete Bridge Girders. ASCE Journal of Performance of Constructed Facilities. V.24 , No.6 , November/December 2010. Pp. 603-609.
- Chen, A.**, Kasikitwiwat, P. (2011) Modeling network capacity flexibility of transportation networks. Transportation Research Part A 45(2), 105-117. doi:10.1016/j.tra.2010.11.003.
- Chen, A.**, Oh, J., Park, D., Recker, W. (2010) Solving the bicriteria traffic equilibrium problem with variable demand and nonlinear path costs. Applied Mathematics and Computation 217 3020-3031. doi:10.1016/j.amc.2010.08.035.
- Chen, A.**, Zhou, Z., Xu, X. (2012) A self-adaptive gradient projection algorithm for solving the nonadditive traffic equilibrium problem. Computers and Operations Research 39(2), 127-138. doi:10.1016/j.cor.2011.02.018.
- Chen, A.**, Zhou, Z., Ryu, S. (2011) Modeling physical and environmental side constraints in traffic equilibrium problem. International Journal of Sustainable Transportation 5(3), 172-197. DOI: 10.1080/15568318.2010.488277.
- Collura, J., **Heaslip, K.**, Moriarty, K., Wu, F., Khanta, R., Berthaume, A. (2010) Using Simulation Models to Assess the Impacts of Highway Work Zone Strategies: Case Studies along Interstate Highways and State Routes in New England. Transportation Research Record: The Journal of the Transportation Research Board, No. 2169, 62-69.
- Heaslip, K.**, Jain, M., Elefteriadou, L. (2011) Estimation of Arterial Work Zone Capacity Using Simulation. Transportation Letters: The International Journal of Transportation Research, 3(2), 127-138.
- Heaslip, K.**, Collura, J., Knodler, M. (2011) Evaluation of Work Zone Design Features to Aid Older Drivers. ITE Journal, 81(3), 36-40.
- Heaslip, K.**, **Womack, K.**, Muhs, J. (2011) Automated Electric Transportation: A Way to Meet America's Critical Issues. Leadership & Management in Engineering, 11(1), 23-28.

- Heaslip, K.**, Schrock, S., Wang, M., Rescot, R., Bai, Y., Brady, B. (2010) A Closed Course Feasibility Analysis of Temporary Rumble Strips for Use in Short Term Work Zones. *Journal of Transportation Safety & Security*, 2(4), 299-311.
- Heaslip, K.**, Jones, J., Harpst, T., **Bolling, D.** (2010) Implementation of Road Safety Audit Recommendations: Case Study in Salt Lake City, Utah. *Transportation Research Record: The Journal of the Transportation Research Board*, No. 2182, 105-112.
- Ji, Z., Kim, Y., **Chen, A.** (2011) Multi-objective a-reliable path finding in stochastic networks with correlated link costs: A simulation-based multi-objective genetic algorithm approach (SMOGA). *Expert Systems with Applications* 38(3), 1515-1528. doi:10.1016/j.eswa.2010.07.064.
- Ou, Z., Chen, B., Hseih, K., **Halling, M.W.**, **Barr, P.J.** (2011) Experimental and Analytical Investigation of Concrete Filled Steel Tubular Columns. *ASCE Journal of Structural Engineering*. June 2011. Pp. 635-645.
- Porter, S.D., Julander, J.L., **Halling, M.W.**, **Barr, P.J.**, Boyle, H. (2011) Flexural Testing of Precast Bridge Deck Panel Connections. *ASCE Journal of Bridge Engineering*. May/June 2011. Pp. 422-430.
- Schrock, S., **Heaslip, K.**, Wang, M., Jasrotia, R., Rescot, R. (2010) Closed Course Test and Analysis of Vibration and Sound Generated by Temporary Rumble Strips for Short Term Work Zones. *Transportation Research Record: The Journal of the Transportation Research Board*, No. 2169, 21-30.
- Xu, M., **Chen, A.**, Qu, Y., Gao, Z. (2011) A semi-smooth Newton method for traffic equilibrium problem with a general nonadditive route cost. *Applied Mathematical Modeling* 35(6), 3048-3062. doi: 10.1016/j.apm.2010.12.021.
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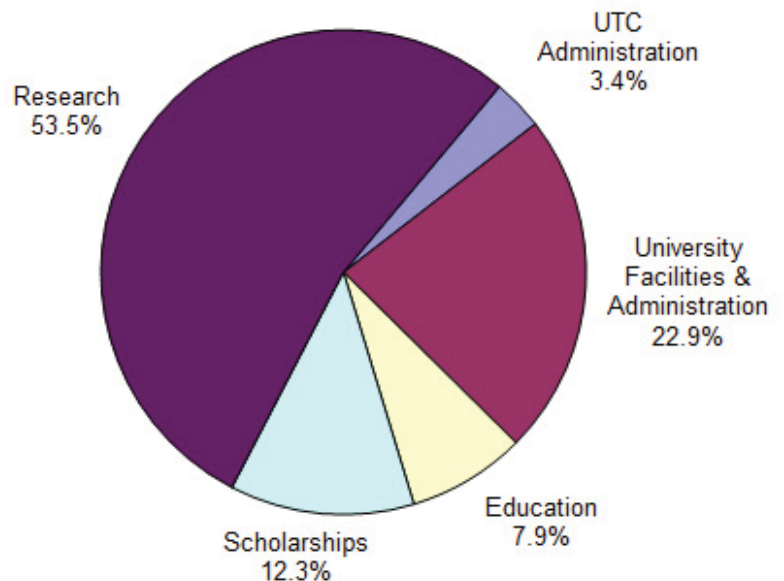
## Funding by Source



**FUNDING BY SOURCE**  
*Total budget for FY2011: \$3,399,892 (includes funds from all sources)*

## Funding by Use

**FUNDING BY USE**  
*includes all funds expended and encumbered during FY2011*



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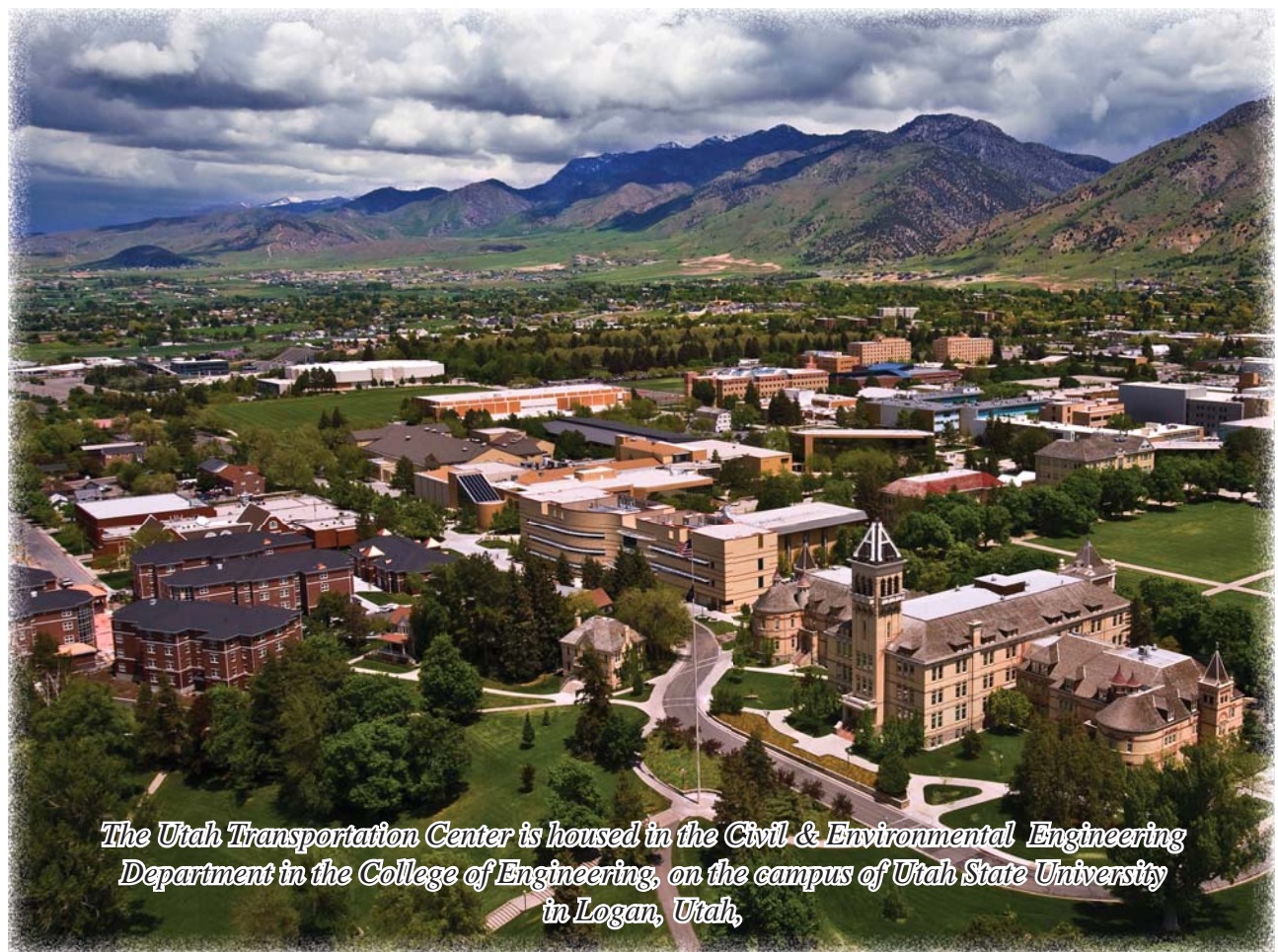
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*The Utah Transportation Center is housed in the Civil & Environmental Engineering Department in the College of Engineering, on the campus of Utah State University in Logan, Utah,*