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Research and Innovative Technology Administration
University Transportation Center Grant Agreement

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1. Accomplishments: What was done? What was learned?

a. What are the major goals of the program?

The overall objectives are to: (1) conduct basic and applied research, the products of which are judged by peers or other experts in the field of transportation to advance the body of knowledge in transportation; (2) offer an education program in transportation that includes multidisciplinary course work and participation in research; (3) conduct workforce development activities and programs to expand the workforce of transportation professionals; (4) provide an ongoing program of technology transfer to make transportation research results available to potential users in a form that can be readily used; and (5) provide planning and technical assistance to Native American tribes, especially those heavily impacted by energy development. Other program goals are to select projects and activities using peer review principles and procedures and client input that: (1) address the Secretary's strategic goals, and (2) leverage UTC funds with matching funds from state and local governments and private industry. The chief operational goals for grant DTRT12-G-UTC08 is to make important contributions to research and technology transfer in key areas related to the Secretary's goals of State of Good Repair, Safety, and Economic Competiveness, while addressing critical issues of the region and stakeholder groups—especially issues in the rapidly growing Bakken oil production region. Under grant DTRT13-G-UTC38, the focus will shift more toward State of Good Repair. However, some safety emphasis is still necessary, given the issues posed by the transportation of Bakken crude oil by rail and truck.

b. What was accomplished under these goals?

i. Project Selection and Peer Review

Under grant DTRT12-G-UTC08, 47 research projects have been selected from federal fiscal year (FY) 2012 funds—which were received in 2013. An additional 36 research projects have been selected from FY 2013 funds—which were received in 2014. All projects have been selected through a peer review process that reflects substantial input and matching resources from state departments of transportation and other transportation agencies in the region. The projects selected under grant DTRT12-G-UTC08 are listed in Tables 1-8, under the primary strategic goal addressed by the project. Please note that many of the projects address several goals simultaneously. In particular, many projects that address State of Good Repair have potential Safety and Economic Competiveness benefits.

Table 1: MPC Research Projects Most Directly Correlated with Sustainability

1. MPC-354: Geotechnical Limit to Scour at Spill-through Abutments (Year 2)
2. MPC-361: Building a Framework for Transportation Resiliency and Evaluating the Resiliency
3. Benefits of Light Rail Transit in Denver, Colorado
4. MPC-364: Do Changing Prices Portend a Shift in Fuel Consumption, Diminished Greenhouse Gas Emissions, and Lower Fuel Tax Revenue?
5. MPC-372: A Novel Methodology for Quantifying the Performance of Constructed Bridges in Cold Regions: Development, Assessment, and Repair
6. MPC-377: Assessing Existing Transportation Sustainability Rating Systems for use in the
7. Mountain-Plains Consortium States
8. MPC-391: Implementation of Low Temperature Test for Asphalt Mixtures to Improve the Longevity of Road Surfaces
9. MPC-392: Evaluation of Spliced Sleeve Connections for Precast Reinforced Concrete Bridge Piers
10. MPC-393: Traffic Modeling of Transit Oriented Development

Table 2: MPC Research Projects Most Directly Correlated with Safety

1. MPC-354: Geotechnical Limit to Scour at Spill-through Abutments (Year 2)
2. MPC-363: A Two-stage Approach for Estimating a Statewide Truck Trip Table
3. MPC-366: Structural Health Monitoring of Highway Bridges Subjected to Overweight Trucks, Phase I

– Instrumentation Development and Validation
4. MPC-367: Developing Statistical Models for Crash Severity Comparing Statewide, County and Indian Reservation Roads
5. MPC-368: Effectiveness of Advisory Letter in Preventing At-Risk Teen Driver Crashes: Pilot Project
6. MPC-369: ND Motor Crash Analysis and Rider Assessment for Improved Conspicuity
7. MPC-371: Decision Support for Strategic Truck Safety and Weight Enforcement Planning
8. MPC-373: Damage Assessment, Characterization, and Modeling for Enhanced Design of Concrete Bridge Decks in Cold Regions
9. MPC-374: An Integrated Real-Time Health Monitoring and Impact/Collision Detection System for Bridges in Cold Remote Regions
10. MPC-375: Small Railroad Capital Investment Needs and Financial Options
11. MPC-378: MEMS Sensors for Transportation Structures
12. MPC-380: Investigation of Interactions between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado
13. MPC-381: Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic
14. MPC-386: Use of Travel Time, Travel Time Reliability, and Winter Condition Index Information for Improved Operation of Rural Interstates
15. MPC-406: Risk- and Reliability-Based Approaches to Analyzing Road Geometric Design Criteria
16. MPC-407: The Effect of Multi-tasking on Self-Assessments of Driving Performance Center for the Prevention of Distracted Driving
17. MPC-408: Exploring Unique Plastic-Reinforced Bridge Decks: Phase I
18. MPC-416: Development and Testing of Crashworthy Ipe Bridge Rails
19. MPC-418: 400 South Corridor Assessment
20. MPC-423: Impact of Energy Sector Growth on Perceived Transportation Safety in the Seventeen County Oil Region of Western North Dakota: A Longitudinal Analysis
21. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
22. MPC-431: Connected Vehicle Weather Data for Operation of Rural Variable Speed Limit Corridors
23. MPC-432: Finding Innovative Solutions to Prevent Wildlife Access to Highways at Wildlife Guards
24. MPC-433: Real-Time Traffic Management to Maximize Throughput of Automated Vehicles
25. MPC-434: A Bicycle Network Analysis Tool for Planning Applications in Small Communities
26. MPC-435: Realization of a Coarse Position Verification System for an Automated Highway System
27. MPC-445: A Sensor Fusion Approach to Assess Pavement Condition and Maintenance Effectiveness

Table 3: MPC Research Projects Most Directly Correlated with State of Good Repair

1. MPC-354: Geotechnical Limit to Scour at Spill-through Abutments (Year 2)
2. MPC-362: Develop Design Guidelines for Integral Abutment Bridges
3. MPC-363: A Two-stage Approach for Estimating a Statewide Truck Trip Table
4. MPC-366: Structural Health Monitoring of Highway Bridges Subjected to Overweight Trucks, Phase I – Instrumentation Development and Validation
5. MPC-371: Decision Support for Strategic Truck Safety and Weight Enforcement Planning
6. MPC-372: A Novel Methodology for Quantifying the Performance of Constructed Bridges in Cold Regions: Development, Assessment, and Repair
7. MPC-373: Damage Assessment, Characterization, and Modeling for Enhanced Design of Concrete Bridge Decks in Cold Regions
8. MPC-374: An Integrated Real-Time Health Monitoring and Impact/Collision Detection System for Bridges in Cold Remote Regions
9. MPC-375: Small Railroad Capital Investment Needs and Financial Options
10. MPC-376: Improved Understanding of Pavement Impacts and Cost-Effective Designs Based on Mechanistic-Empirical Methods
11. MPC-378: MEMS Sensors for Transportation Structures
12. MPC-379: Plastic-Aluminum Composites in Transportation Infrastructure

13. MPC-387: Comprehensive GIS-Based Rural Regional Transportation Planning Models
14. MPC-391: Implementation of Low Temperature Test for Asphalt Mixtures to Improve the Longevity of Road Surfaces
15. MPC -394: Quantifying Uncertainty in Nondestructive Bridge Inspection Methods for use in P B I
16. MPC-404: Seismic Performance of Concrete Filled Steel Tube (CFST) Bridge Columns For Accelerated Bridge Construction
17. MPC-405: Seismic Retrofit of Spliced Sleeve Connections for Precast Bridge Piers
18. MPC-406: Risk- and Reliability-Based Approaches to Analyzing Road Geometric Design Criteria
19. MPC-410: Predicting Fatigue Service Life Extension of RC Bridges with Externally Bonded CFRP Repairs
20. MPC-411: Re-Use of Mine Waste Materials Amended with Fly Ash in Transportation Earthwork Projects
21. MPC-413: A Pilot Case Study to Evaluate the Potential Impact and Benefit of Adopting and Implementing BIM on Bridge and Infrastructure Projects
22. MPC-414: Quantifying Sustainability Metrics for Trunk line Bridges in the Mountain Plains Region
23. MPC-415: Framework of Performance-Based Earthquake Design of Curved and Skewed Bridges
24. MPC-419: Experimental and Numerical Study for the Debonding Interface Between an Existing Pavement and a New Concrete Overlay
25. MPC-421: Seismic Rehabilitation of Skewed and Curved Bridges Using a New Generation of Bulking Restrained Braces
26. MPC-423: Impact of Energy Sector Growth on Perceived Transportation Safety in the Seventeen County Oil Region of Western North Dakota: A Longitudinal Analysis
27. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
28. MPC-427: Fire Performance of Bridge Members Retrofitted with Near-Surface-Mounted Carbon Fiber Reinforced Polymer Composites
29. MPC-428: Using Recycled Concrete Aggregate in New Concrete Construction
30. MPC-429: A Methodology for Developing a Replacement Strategy for County/City Owned Bridges
31. MPC-430: Implementation of Intelligent Compaction Technologies for Road Constructions in Wyoming
32. MPC-432: Finding Innovative Solutions to Prevent Wildlife Access to Highways at Wildlife Guards
33. MPC-434: A Bicycle Network Analysis Tool for Planning Applications in Small Communities
34. MPC-444: Data-Driven Freeway Performance Evaluation Framework for Project Prioritization and Decision Making
35. MPC-445: A Sensor Fusion Approach to Assess Pavement Condition and Maintenance Effectiveness

Table 4: MPC Research Projects Most Directly Correlated with Economic Competitiveness

1. MPC-354: Geotechnical Limit to Scour at Spill-through Abutments (Year 2)
2. MPC-363: A Two-stage Approach for Estimating a Statewide Truck Trip Table
3. MPC-364: Do Changing Prices Portend a Shift in Fuel Consumption, Diminished Greenhouse Gas Emissions, and Lower Fuel Tax Revenue?
4. MPC-366: Structural Health Monitoring of Highway Bridges Subjected to Overweight Trucks, Phase I – Instrumentation Development and Validation
5. MPC-375: Small Railroad Capital Investment Needs and Financial Options
6. MPC-379: Plastic-Aluminum Composites in Transportation Infrastructure
7. MPC-380: Investigation of Interactions Between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado
8. MPC-381: Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic
9. MPC-384: Understanding Public Perceptions of Different Revenue Generation Systems for Highway Construction and Maintenance
10. MPC-387: Comprehensive GIS-Based Rural Regional Transportation Planning Models
11. MPC-408: Exploring Unique Plastic-Reinforced Bridge Decks: Phase I

12. MPC-418: 400 South Corridor Assessment
13. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
14. MPC-426: Does the Livability of a Residential Street Depend on the Characteristics of the Neighboring Street Network?
15. MPC-427: Fire Performance of Bridge Members Retrofitted with Near-Surface-Mounted Carbon Fiber Reinforced Polymer Composites
16. MPC-433: Real-Time Traffic Management to Maximize Throughput of Automated Vehicles
17. MPC-435: Realization of a Coarse Position Verification System for an Automated Highway System
18. MPC-445: A Sensor Fusion Approach to Assess Pavement Condition and Maintenance Effectiveness

Table 5: MPC Research Projects Most Directly Correlated with Livable Communities

1. MPC-361: Building a Framework for Transportation Resiliency and Evaluating the Resiliency Benefits of Light Rail Transit in Denver, Colorado
2. MPC-376: Improved Understanding of Pavements Impacts and Cost-Effective Designs Based on Mechanistic-Empirical Methods
3. MPC-379: Plastic-Aluminum Composites in Transportation Infrastructure
4. MPC-380: Investigation of Interactions between Traffic Law Enforcement and Driving Behavior on Rural Highways in Colorado
5. MPC-381: Performance-based Interaction Analysis of Damage on Bridge Expansion Joints and Heavy Traffic
6. MPC-387: Comprehensive GIS-Based Rural Regional Transportation Planning Models
7. MPC-392: Evaluation of Spliced Sleeve Connections for Precast Reinforced Concrete Bridge Piers
8. MPC-393: Traffic Modeling of Transit Oriented Development
9. MPC-408: Exploring Unique Plastic-Reinforced Bridge Decks: Phase I
10. MPC-417: Evaluation and Development of Livability and Sustainability Programs for Indian Reservations
11. MPC-418: 400 South Corridor Assessment
12. MPC-425: Building a Sustainable GIS Framework for Supporting a Tribal Transportation Program
13. MPC-426: Does the Livability of a Residential Street Depend on the Characteristics of the Neighboring Street Network?
14. MPC-444: Data-driven Freeway Performance Evaluation Framework for Project Prioritization and Decision Making

Table 6: MPC Research Projects Most Directly Correlated with Environmental Sustainability

1. MPC-411: Re-Use of Mine Waste Materials Amended with Fly Ash in Transportation Earthwork Project
2. MPC-414: Quantifying Sustainability Metrics for Trunk line Bridges in the Mountain Plains Region
3. MPC-416: Development and Testing of Crashworthy Ipe Bridge Rails
4. MPC-417: Evaluation and Development of Livability and Sustainability Programs for Indian Reservations
5. MPC-418: 400 South Corridor Assessment
6. MPC-421: Seismic Rehabilitation of Skewed and Curved Bridges Using a New Generation of Bulking Restrained Braces
7. MPC-428: Using Recycled Concrete Aggregate in New Concrete Construction

Table 7: MPC Education Projects

1. MPC-385: Educational and Workforce Development Proposal: STEM Outreach at Colorado State University
2. MPC-403: Web-based Decision Support Tool for Traffic Management and Work Zone Analysis

3. MPC-424: Educational and Workforce Development: Ethics and Academic Conduct

ii. Educational Accomplishments

The transportation and transportation-related courses offered during Fall 2014 are listed in Table 8, organized by major subject area. In some cases, courses with the same titles were offered at more than one MPC university. In these cases, the number of courses offered is shown in parenthesis.

Table 8: Transportation and Transportation-Related Courses Offered This Reporting Period

Major Subject Area	Course Title
Engineering & Design	Adv. Geotechnical Engineering
	Advanced Construction Materials
	Advanced Reinforced Concrete Design
	Advanced Steel Design
	Bridge Design
	Design and Behavior of Steel Structures
	Engineering Applications of GIS and GPS
	Evaluation of Civil Engineering Materials
	Foundation Engineering
	Highway Engineering
	Intermediate Structural Analysis
	Mechanics of Fatigue and Fracture
	Open Channel Flow (Undergraduate)
	Pavement Design
	Pavement Design (Undergraduate)
	Pavement Management System
	Pedestrians and Bicyclists
	Pre-stressed Concrete
	Statistics and Economics (Undergraduate)
	Steel Design
	Structural Dynamics and Seismic Design
	Transportation Engineering
Freight & Logistics	Freight Transportation Systems
	Logistics Systems
	Principles of Supply Chain: Management and Technologies
	Technology Advances/Logistics
Planning & Environment	Disaster/Climate Change Planning
	Intermodal Business Planning Project
	Intermodal Transportation Systems
	Introduction to Sustainable Urban Infrastructure
	Leadership Development Planning Project
	Planning History and Theory
	Planning in the Developing World
Planning & Environment	Planning Methods
	Quantitative Tools for Transportation Management
	Sprawl and Growth Management
	Transportation Management, Leadership, and Values

	Transportation Planning and Environmental Comp
	Transportation Planning/Policy
	Urban and Regional Transportation Planning
Traffic & Operations	Advanced Traffic Control
	Highway Capacity Analysis
	Traffic Engineering
	Transportation Engineering (Undergraduate)
Transportation Safety	Transportation Law and Regulation: Domestic and International
	Cognitive Psychology (Undergraduate)
	Traffic Simulation
Transportation Systems	Freight Transportation Systems
	Intermodal Transportation Systems
	Introduction to Transportation Systems
	Transportation and Land Use
	Transportation System Security
	Transportation Systems Analysis
	Transportation Systems I
	Urban Transportation Systems Analysis
Public Transportation	Passenger Transportation Systems
	Public Transportation
	Public Transportation Systems
	Transit Design

Altogether, 59 transportation and transportation-related courses have been offered during this reporting period. Altogether, 314 transportation courses have been offered during the grant period thus far. In addition to the courses listed in Table 8, foundational courses in engineering materials, mechanics, structural analysis, and geotechnical engineering have been offered at most of the MPC universities.

iii. Workforce Development Accomplishments

Training events provided for transportation professionals during this reporting period are listed below.

1. Access Management Training
2. ATSSA Flagger Certification
3. ATSSA Traffic Control Technician (TCT)
4. Basic of a Good Road
5. Basic Surveying
6. Cement Seminar
7. Communication Skills for Supervisors
8. Concrete Pavements
9. Heavy Equipment Operations
10. Integrated Roadside Vegetation Management
11. Registered Storm water Inspector
12. Roadway Drainage
13. Transportation Safety
14. Tree Trimming
15. Trenching and Shoring
16. Winter Road Maintenance
17. Women in Transportation
18. Work Zones

iv. Research accomplishments

The following peer reviewed research reports/presentations were published during the period of July-December 2014 from grant DTRT12-G-UTC08 or previous grants.

Project #	Title	Date	Report No.
393	Traffic Modeling of Transit Oriented Development	Sep 2014	MPC 14-270
423	Impact of Energy Sector Growth on Perceived Transportation Safety in the Seventeen County Oil Region of Western North Dakota: A Longitudinal Analysis	Oct 2014	MPC 14-271
413	A Pilot Case Study to Evaluate the Potential Impact and Benefit of Adopting and Implementing BIM on Bridge and Infrastructure Projects	Nov 2014	MPC 14-272
277	Safety Factor Increase to Fatigue Limit States Through Shear Spiking for Timber Railroad Bridge Rehabilitation	Nov 2014	MPC 14-273
376	Improved Understanding of Pavement s Impacts and Cost-Effective Designs Based on Mechanistic-Empirical Methods		MPC 14-274
398	Selection of Discount Rates for Infrastructure Investment	Dec 2014	MPC 14-275
457	Tribal Emergency Preparedness Planning	Dec 2014	MPC 14-276
370	Anticipatory Guidance for Older Drivers	Dec 2014	MPC 14-277

c. How have the results been disseminated?

The results are being disseminated in a variety of ways, including: (1) workshops and conferences, (2) videoconferences, (3) online modules, (4) presentations at conferences, (5) publications, (6) webpage postings and displays, and (7) Internet-based dissemination media, including broadcast emails and webinars. These accomplishments are summarized under the products section of this report.

d. What do you plan to do during the next reporting period to accomplish the goals/objectives?

(1) Continue to offer the multidisciplinary multimodal catalogue of courses described in the prospectus and teach those courses scheduled during the academic year (2) Continue to deliver extensive programs of technical training, similar to the programs illustrated in b.iii. (3) With the guidance of the recently established North Dakota Transportation Safety Advisory Group, identify a two-year work plan to conduct safety research and technical training that addresses key Bakken-related issues, including motor carrier, railway, and pipeline safety. (4) In conjunction with tribal partners, develop a two-year plan for tribal transportation research and technical assistance to include: a) the development of an emergency management/response guidebook, b) GIS modeling and technical assistance in traffic forecasting; and c) help in implementing road safety procedures and countermeasures on tribal roads. (5) Continue the strong MPC research programs, which will result in many new publications and journal papers. (6) Participate in 4 or more conferences and workshops on transportation and energy development. (7) Collaborate with other UTCs to promote greater exchange of information and explore

partnering possibilities in railway and waterway transportation. (9) Continue to involve graduate students in MPC research projects.

2. Products: What has the program produced?

a. Publications, conference papers, presentations

i. Participation in key conferences and workshops

- 2014 ASCE T&DI Congress, June 8-11 2014, Orlando, Florida
- 2014 Rocky Mountain Geo-Conference, Denver, Colorado
- 2014 Tailings and Mine Waste Conference, Keystone, Colorado
- ABC Bridge Conference. Miami, FL
- ACI Fall Convention. Washington, D.C.
- Annual Fuel Cycle Technologies Meeting, Idaho Falls, ID
- Annual Meeting of the American Psychological Science Association, San Francisco, CA
- ASCE Global Conference. Panama City, Panama
- Association of Collegiate Schools of Planning (ASCP), Philadelphia, PA, November 2014
- Australian and South East Asia Conference in Structural Engineering and Construction Conference (ASEA-SEC-2) in Bangkok, Thailand. November 2014
- ESCAR Embedded Security in Cars Conference, June 18-19, Hamburg, Germany
- International Rail Safety Conference, Berlin, Germany
- ITE Joint Western/Midwestern District Annual Meeting, Rapid City, SD
- Ninth International Conference on Structural Dynamics - EURODYN, June 30 - July 2, Univ. of Porto, Porto, Portugal
- North Dakota Conference on Injury Prevention and Control, Bismarck, ND
- Probabilistic Safety Assessment and Management (PSAM 12), Honolulu, HI
- Tenth U.S. National Conference on Earthquake Engineering
  Frontiers of Earthquake Engineering (10NCEE), July 21-25, 2014, Anchorage, Alaska
- TRB Alternative Intersections and Interchanges Symposium and Midyear Meetings of TRB Operational Effects of Geometrics Committee (AHB65), TRB Geometric Design Committee (AFB10), and AASHTO Technical Committee on Geometric Design, Salt Lake City, UT
- TRB/AUVSI “Envisioning Automated Vehicles within the Built Environment: 2020, 2035, 2050." San Francisco, CA July 19, 2014
- U.S. Department of Transportation ITS Joint Program Office Workshop on Incorporating ITS Education into University Curriculum and Learning Programs, Washington, D.C.
- Utah Department of Transportation 2014 Annual Conference, Sandy, UT
- Wasatch Choice for 2040 Consortium Meeting, Salt Lake City, UT
- World Congress of Health and Safety, Frankfurt, Germany, August 24-27, 2014

ii. Key Journal Articles or Conference Publications

- Ahmari, S., Yang, M.J., “Impact Event Identification through Real-time Strain Measurements”, Submitted to Journal of Engineering Mechanics.
- Ahmari, S., Yang, M.J., “Impact load identification through measurement with uncertainty’, Smart Materials and Structures, 2013, (22) 085024
- Bordelon, Amanda, C., Jeffery R. Roesler. “Spatial Distribution of Synthetic Fibers in Concrete with X-Ray Computed Tomography,” Cement and Concrete Composites, Vol. 53, October 2014, pp. 35-43.
- Bridgelall, R., “Inertial Sensor Sample Rate Selection for Ride Quality Measures,” Journal of Infrastructure Systems, American Society of Civil Engineering, DOI: 10.1061/(ASCE)IS.1943-555X.0000225, July 7, 2014.
- Bridgelall, R., “Precision bounds of pavement distress localization with connected vehicle sensors,” Journal of Infrastructure Systems, American Society of Civil Engineering, DOI:

10.1061/(ASCE)IS.1943-555X.0000234, September 2, 2014.
- Bronson, R. and Marshall, W. Alternative and adaptive transportation: What household and neighborhood factors support recovery from a drastic increase in gas price? International Journal of Environmental Science and Technology, (doi: 10.1007/s13762-014-0583-2), Vol. 11, Issue 8: 2245-2258, 2014.
- Choi, Jaesung, Lee, EunSu, and Roberts, David. Reshaping Tribal Road Network Using Public Information. Journal of Geographic Information System 6(6), 594-604.
- D. Desiraju, T. Chantem, and K. Heaslip, "Minimizing the Disruption of Traffic Flow of Automated Vehicles During Lane Changes", IEEE Transactions on Intelligent Transportation Systems (IEEE ITS), volume PP, number 99, pages 1–10, September 2014.
- Fanning, B., Clevenger, C., Ozbek, M., and Mahmoud, H. (2014). "Implementing BIM on Infrastructure: Comparison of Two Bridge Construction Projects." Pract. Period. Struct. Des. Constr. , 10.1061/(ASCE)SC.1943-5576.0000239 , 04014044.
- Feng Chen, Xiaoxiang Ma and Chen, Suren (2014). "Refined-scale panel data crash rate analysis using random-effects tobit model", Accident Analysis and Prevention, 2014 Sep 27;73C:323-332.
- Hesse, A.A., Atadero, R.A. and Ozbek, M.E. "Uncertainty in Common NDE Techniques for Use in Risk-Based Bridge Inspection Planning: Existing Data." ASCE Journal of Bridge Engineering, Accepted October 2014.
- Huffaker, C., Barr, P.J., Halling, M.W. and Boyle, H. "Behavior and Analysis of an Integral Abutment Bridge." UDOT Annual Conference, Sandy, Utah, November 5th-7th, 2013.
- Jehring, M.J. and Bareither, C.A. Effect of tailings composition on shear strength behavior of co-mixed mine waste rock and tailings, Canadian Geotechnical Journal, Submitted 24 Nov. 2014, In Review.
- Kam Ng, Robert Ettema, Edward Kempema, Ram Chakradhar and Joshua Fuller. Geotechnical Limit to Scour at Spill-through Bridge Abutments: Laboratory Investigation Findings. MPC Report No. 14-354. North Dakota State University - Upper Great Plains Transportation Institute, Fargo: Mountain-Plains Consortium, 2014.
- Kim, Y.J. Moment-shear interaction mechanism for CFRP-strengthened RC beams in flexure, ACI Structural Journal, American Concrete Institute (ACI) , 111(4), 967-975, 2014.
- Kubas, Andrew and Kimberly Vachal. Impact of Energy Sector Growth on Perceived Transportation Safety in the Seventeen-County Oil Region of Western North Dakota: A Follow-Up Study. MPC-14-271, North Dakota State University - Upper Great Plains Transportation Institute, Fargo: Mountain-Plains Consortium, 2014.
- Namrou, A.R. and Kim, Y.J. An experimental investigation into the behavior of concrete elements retrofitted with NSM composite strips at elevated temperatures, American Concrete Institute (ACI) Special Publication on Advanced Materials and Sensors toward Smart Concrete Bridges: Concept, Performance, Evaluation, and Repair, 225-239, 2014.
- Pantelides, C.P., Ameli, M.J., and Reaveley, L.D. (2014). "Evaluation of Grouted Splice Sleeve Connections for Precast Reinforced Concrete Bridge Piers." Draft Final Report for Mountain Plains Consortium Report Project No. MPC 392. (submitted for peer review).
- Pantelides, C.P., Ameli, M.J., Parks, J.E., and Brown, D.N. (2014). "Seismic Evaluation of Grouted Splice Sleeve Connections for Precast RC Bridge Piers." UDOT Report No. UT-14.09, Utah Department of Transportation, Salt Lake City, Utah.
- Pantelides, C.P., Brown, D.N., Parks, J.E., and Ameli, M.J. (2014). "Seismic Retrofit of Spliced Sleeve Connections for Precast Bridge Piers Health Monitoring of Precast Bridge Deck Panels Reinforced with Glass Fiber Reinforced Polymer (GFRP) Bars." Draft Final Report for Mountain Plains Consortium Report Project No. MPC 405. (submitted for peer review)
- Ray, B.L., Ferguson, E.M., Knudsen, J.K., Porter, R.J., and Mason, J. "Performance-Based Analysis of Geometric Design of Highways and Streets," NCHRP Report 785, National Cooperative Highway Research Program, Transportation Research Board, Washington, D.C., 2014.

(no federal support)

- Saboori, A., Yazdani, S., and Tolliver D. (2014). “Anisotropic Damage Mechanics Modeling of Concrete under Biaxial Fatigue Loading”. Submitted to the Open Journal of Civil Engineering.
- Saboori, A., Yazdani, S., Reberg, A., and Tolliver, D. (2014, August). “Anisotropic Damage Modeling of Concrete Subjected to Freeze-Thaw Process”. International Journal of Civil and Structural Engineering, 5(1), 42-51.
- Sanbonmatsu, David, David Strayer, Arwen Behrends, Nate Medeiros-Ward, and Jason Watson. Why drivers use cell phones and why they support legislation to restrict this practice. Draft Final Report for MPC-407. (submitted for review)
- Sanbonmatsu, David, David Strayer, Francesco Biondi, Arwen Behrends, and Shannon Moore. Cell phone use diminishes awareness of the adverse effects of cell phone use. Draft Final Report for MPC-407. (submitted for review)
- Savan, C. (2014). Intelligent Compaction for Roadway Soil and Asphalt Pavement. MS Thesis, Department of Civil and Architectural Engineering, University of Wyoming, Laramie, WY.
- Shea, M.S., Le, T.Q., and Porter, R.J. “A Combined Crash Frequency-Crash Severity Evaluation of Geometric Design Decisions: Entrance-Exit Ramp Spacing and Auxiliary Lane Presence,” Transportation Research Record: Journal of the Transportation Research Board, submitted. (federal support)
- Sobiek, T., Atadero, R.A., and Mahmoud, H.M. Fatigue Crack Propagation of Notched Steel Rebar in RC Beams Repaired with Externally Bonded CFRP, Journal of Composites for Construction, Accepted October 2014. doi: 10.1061/(ASCE)CC.1943-5614.0000541
- Tasic, I., Zlatkovic, M., Martin, P.T., and Porter, R.J. “Street Connectivity Versus Street Widening: Enhanced Street Connectivity on Traffic Operations in Transit-Supportive Environments,” Transportation Research Record: Journal of the Transportation Research Board, submitted. (federal support)
- Tasic, Ivana, Xuesong Zhou, and Milan Zlatkovic. “Using Spatio-Temporal Constraints to Quantify Transit Accessibility: Case Study of a Potential Transit Oriented Development Location in West Valley, Utah.” Transportation Research Record, Journal of the Transportation Research Board, No. 2417 (2014) 130-138.
- Taylor, J., Zhou, X., Rouphail, N.M., and Porter, R.J. “Method for Investigating Intradriver Heterogeneity using Vehicle Trajectory Data: A Dynamic Time Warping Approach,” Transportation Research Part B, accepted. (no federal support).
- Telste, M. and Yang, M.J., “A Deformation Distribution Based Bridge Health Monitoring Methodology”, ACI-Congress Special Publication, 2013.
- Wesley Werbelow and Khaled Ksaibati. "Developing a Methodology to Assess and Prioritize Culvert Conditions on County Roads". International Low Volume Roads Conference, July, 2015.
- Wood, J.S., Donnell, E.T., and Porter, R.J. “Comparison of Safety Effect Estimates Obtained from Empirical Bayes, Before-After Study, Propensity Scores-Potential Outcomes Framework, and Regression Model with Cross-Sectional Data,” Accident Analysis and Prevention, submitted. (no federal support)
- Yang, M.J. and Lutfur Akand, “Small hidden object identification through weigh-in-motion data for security purposes”, Journal of Advances in Civil and Environmental Engineering, 2014, 1: 16-26
- Yang, M.J., “Dynamic load factors for progressive failure of elastic and inelastic structures”, International Journal of Engineering Research & Innovation, 2014, 6: 23-28
- Yang, M.J., Ahmari, S., “Dynamic Behavior of Deck-Girder System of Bridges Subjected to Settlement through Finite Strain Plate Theory”, Engineering Structures (Accepted).
- Z. Zhang, Y. Huang, L. Palek, and R. Strommen, “Glass fiber reinforced polymer packaged fiber Bragg grating sensors for ultra-thin unbonded concrete overlay monitoring”, Structural Health Monitoring, October 13, 2014, 1475921714554143, [Impact factor: 3.2].
- Zhou, Xuesong, Peter T. Martin, Milan Zlatkovic and Ivana Tasic. Traffic Modeling of Transit

Oriented Development: Evaluation of Transit Friendly Strategies and Innovative Intersection Designs in West Valley City, UT. MPC-14-270, North Dakota State University - Upper Great Plains Transportation Institute, Fargo: Mountain-Plains Consortium, 2014.

- Zlatkovic, M., and X. Zhou "Integration of Signal Timing Estimation Model and Dynamic Traffic Assignment in Feedback Loops: System Design and Case Study." Journal of Advanced Transportation, John Wiley & Sons, Inc., Wiley Online Library (wileyonlinelibrary.com). DOI: 10.1002/atr.1295, 2014
- Zlatkovic, M., Porter, R.J., and Kergaye, C. "Performance-Based Pavement Marking Warranty Contracts: Experience and Lessons Learned in the State of Utah," Transportation Research Record: Journal of the Transportation Research Board, submitted. (no federal support)

iii. Key Conference Papers

- Ameli, M.J., Parks, J.E., Brown, D.N., and Pantelides, C.P. (2014). "Grouted splice sleeve connection alternatives for precast reinforced concrete bridge piers in moderate-to-high seismic regions." 10th US Nation. Conf. in Earth. Eng.: Frontiers of Earthquake Engineering, EERI, DOI: 10.4231/D3D50FZ10, Anchorage, AK.
- Ameli, M.J., Parks, J.E., Brown, D.N., Pantelides, C.P., and Reaveley, L.D. (2014). "Evaluation and repair of precast RC bridge column connections utilizing grouted splice sleeves." Proc. 9th Int. Conf. on Structural Dynamics-EURODYN 2014, Eds. Cunha, A., Caetano, E., Ribeiro, P., Müller, G., Univ. of Porto, Porto, Portugal, 275-282.
- Ameli, M.J., Parks, J.E., Brown, D.N., Pantelides, C.P., and Reaveley, L.D. (2014). "Evaluation and repair of precast RC bridge column connections utilizing grouted splice sleeves." Proc. 9th Int. Conf. on Structural Dynamics-EURODYN 2014, Eds. Cunha, A., Caetano, E., Ribeiro, P., Müller, G., Univ. of Porto, Porto, Portugal, 275-282.
- Gorakhki, M.R.H. and Bareither, C.A. (2014). Salinity effects on the geotechnical characterization of mine tailings, Proc. Tailings and Mine Waste 2014, Information Technology, Creative Media, University of British Columbia, Vancouver, BC, 117-126.
- Jehring, M.M. and Bareither, C.A. (2014). Effect of tailings composition on the shear behavior of co-mixed mine waste, Proc. Tailings and Mine Waste 2014, Information Technology, Creative Media, University of British Columbia, Vancouver, BC, 391-401.
- Kam Ng, Robert Ettema, Edward Kempema, Ram Chakradhar. Geotechnical Challenges in Laboratory Investigation of Bridge Abutment Scour. The 65st Highway Geology Symposium, Laramie WY, July, 2014.
- Kim, Y.J., Hyun, S.W., Yoshitake, I., Kang, J.-Y, and Seo, J. A composite-bonded steel substrate with silyl-modified polymer exposed to thermal distress, Probabilistic Safety Assessment and Management (PSAM 12), Honolulu, HI, 2014.
- Parks, J.E., Brown, D.N., Ameli, M.J., Pantelides, C.P., and Reaveley, L.D. (2014). "Repair of damaged precast RC bridge columns with grouted splice sleeve connections using CFRP shells and plastic hinge relocation." 10th US Nation. Conf. in Earth. Eng.: Frontiers of Earthquake Engineering, EERI, DOI: 10.4231/D38C9R473, Anchorage, AK.
- R. Chauhan, R. M. Gerdes and K. Heaslip, "Demonstration of a False-data Injection Attack Against an FMCW Radar," In Proceedings of Embedded Security in Cars Conference (ESCAR 2014), 2014 (to appear).
- Saboori, A., Yazdani, S., Reberg, A., Yang, M., Tolliver, D., and Mamani, S. (2014). "Modeling of Concrete Behavior under Biaxial Fatigue Loading with Various Mean Stresses". ASEA-SEC-2 Proceedings (pp. 51-56). ISEC Press.
- Saboori, A., Yazdani, S., Reberg, A., Yang, M., Tolliver, D., and Mamani, S. (2014). "Modeling Freeze and Thaw Damage in Concrete Decks using Damage Mechanics". ASEA-SEC-2 Proceedings (pp. 251-256). ISEC Press.
- Sanjay Pokharel, Debbie Sue Shinstine, Khaled Ksaibati. "Developing a Livability Program for Indian

Reservations: A Methodology and Case Study". 2015 Transportation Research Board Meeting, Washington DC, January 11-15, 2015.

- Savan, C., Ng, K.W., and Ksaibati, K. (2014). “Intelligent Compaction for roadway Construction and Quality Assurance.” Proceedings of the 65th Annual Highway Geology Symposium, Laramie, WY.
- Tucker C, and L Ibarra (2014). "Seismic performance of circular concrete filled tube columns for accelerated bridge construction." 10th NCEE. Anchorage Alaska.
- Y. Huang, L. Palek, and R. Strommen, and B. Worel, “Pavement condition monitoring of ultra-thin unbonded concrete overlay using fiber reinforced polymer fiber Bragg grating sensors”, Proceeding of T&DI Congress 2014: pp. 564-573.
- Yang, M.J., Bond Strength of PCC Pavement Repairs Using Metakaolin-Based Geopolymer Concrete, EMI2015HK
- Yang, M.J., Bridge Settlement Criteria Based on Reliability Analysis of Close-to-Reality Modeling Results, EMI2015HK
- Yang, M.J., Progressive failure of fiber reinforced pervious concrete with inclusion of cohesive interface modeling, EMI2015HK

iv. Key Presentations

- Ameli, M.J., Parks, J.E., Brown, D.N., and Pantelides, C.P. (2014). “Grouted splice sleeve connection alternatives for precast reinforced concrete bridge piers in moderate-to-high seismic regions.” 10th US Nation. Conf. in Earth. Eng.: Frontiers of Earthquake Engineering, EERI, DOI: 10.4231/D3D50FZ10, Anchorage, AK.
- Ameli, M.J., Parks, J.E., Brown, D.N., Pantelides, C.P., and Reaveley, L.D. (2014). “Evaluation and repair of precast RC bridge column connections utilizing grouted splice sleeves.” Proc. 9th Int. Conf. on Structural Dynamics-EURODYN 2014, Eds. Cunha, A., Caetano, E., Ribeiro, P., Müller, G., Univ. of Porto, Porto, Portugal, 275-282.
- Ameli, M.J., Parks, J.E., Brown, D.N., Pantelides, C.P., and Reaveley, L.D. (2014). “Evaluation and repair of precast RC bridge column connections utilizing grouted splice sleeves.” Proc. 9th Int. Conf. on Structural Dynamics-EURODYN 2014, Eds. Cunha, A., Caetano, E., Ribeiro, P., Müller, G., Univ. of Porto, Porto, Portugal, 275-282.
- Gorakhki, M.R.H. and Bareither, C.A. (2014). Salinity effects on the geotechnical characterization of mine tailings, Proc. Tailings and Mine Waste 2014, Information Technology, Keystone, Colorado, Oct. 2014.
- Huffaker, C., Barr, P.J., Halling, M.W. and Boyle, H. "Behavior and Analysis of an Integral Abutment Bridge." UDOT Bridge Office, July 2013.
- Jehring, M.M. and Bareither, C.A. (2014). Effect of tailings composition on the shear behavior of co-mixed mine waste, Proc. Tailings and Mine Waste 2014, Keystone, Colorado, Oct. 2014.
- Kim, Y.J., Hyun, S.W., Yoshitake, I., Kang, J.-Y, and Seo, J. A composite-bonded steel substrate with silyl-modified polymer exposed to thermal distress, Probabilistic Safety Assessment and Management (PSAM 12), Honolulu, HI. 2014.
- Konrad, M. and N. Wehbe. "Long-Term Performance of Current and Proposed Longitudinal Joints between Double Tee Bridge Girders." National Accelerated Bridge Construction Conference, Miami, FL, December 5, 2014.
- Kubas, A. "A Follow-Up Study of Oil County Traffic Safety: Perspectives from Western North Dakota Residents." Annual meeting of the Great Plains Sociological Association, Sioux Falls, SD, October 23-24.
- Kubas, A. "Oil County Traffic Safety: A Perspective of Western North Dakota Residents." 4th Annual North Dakota Conference on Injury Prevention and Control, Bismarck, ND, October.
- McAndrews, C. and Marshall, W. Livable Streets, Livable Arterials? Association of Collegiate Schools of Planning (ASCP), Philadelphia, PA, November 2014.
- Mulholland, R. & Sherry, P. (2014). “Being Female in the Traditionally Male Industries:

Exploring the Characteristics of Women in Transportation and Engineering." A paper presented at the Rocky Mountain Psychological Association Annual Convention. Salt Lake City, Utah. April 26, 2014.

- Ostojic, M., A. Stevanovic, M. Zlatkovic, M., and I. Tasic. “Evaluation of the Impacts of Light Rail Transit Predictive Priority on Multimodal Operations in Salt Lake City Downtown.” 15th Annual North America PTV Vision Traffic User Group Meeting, Orlando, FL, October 2014.
- Parks, J.E., Brown, D.N., Ameli, M.J., Pantelides, C.P., and Reaveley, L.D. (2014). “Repair of damaged precast RC bridge columns with grouted splice sleeve connections using CFRP shells and plastic hinge relocation.” 10th US Nation. Conf. in Earth. Eng.: Frontiers of Earthquake Engineering, EERI, DOI: 10.4231/D38C9R473, Anchorage, AK.
- Pei, S., N. Wehbe, and B. Kelley. "Ice Load Monitoring for Bridge Substructure in South Dakota Rivers," ACI Fall Convention, Washington, D.C., October 27, 2014.
- Pokharel, S., Shinstine, D., Ksaibati, K., "Developing a Livability Program for Indian Reservations: A Methodology and Case Study". 2015 Transportation Research Board Meeting, Washington DC, January 11-15, 2015.
- R. Chauhan, R. M. Gerdes and K. Heaslip, “Demonstration of a False-data Injection Attack Against an FMCW Radar,” In Proceedings of Embedded Security in Cars Conference (ESCAR 2014), 2014 (to appear).
- Savan, C., Ng, K.W., and Ksaibati, K. (2014). “Intelligent Compaction for roadway Construction and Quality Assurance.” Proceedings of the 65th Annual Highway Geology Symposium, Laramie, WY.
- Sherry, P. & Zucker, K. (2014) “Promoting Pedestrian Safety through Community and Employee Intervention in the Rail Industry” World Congress of Health and Safety, Frankfurt, Germany, August 24-27, 2014.
- Sherry, P. & Zucker, K. (2014). "Effects of Suicide Prevention Training on Rail Transit Workers Knowledge and Attitudes.” A paper presented at the Annual Meeting of the American Association of Suicidology, Los Angeles, CA. April 10, 2014.
- Sherry, P. (2014). "Fatigue Countermeasures for Shortline Railroad Operations." A paper presented to the Annual Meeting of the ASLRRA in San Diego CA. April 23, 2014.
- Sherry, P. (2014). "The Impact of Suicide by Train on the Community, First Responders and Rail Workers." A paper presented at the Annual Meeting of the Public Rail Safety Conference, Anaheim, CA. April 10, 2014.
- Sherry, P. (2014). “Psychological Consequences of Transit Operator Assault. A presentation at the Transit Operator Assault Roundtable. A Paper presented at the US DOT FTA Operator Roundtable, Washington, DC on July 11, 2014
- Sherry, P., & Zucker, K. (2014) “The Efficacy of Pedestrian Suicide Prevention and Safety Promotion Interventions in the Public Transit Industry" A paper presented at the Rocky Mountain Psychological Association Annual Convention. Salt Lake City, Utah. April 25, 2014.
- Sherry, P., Hedman, B., Garriott, P., & Mulholland, R. (2014). “Workforce Development: Recruitment, Retention & Turnover.” A paper presented at the 55th Annual Transportation Research Forum, San Jose, CA, March 13, 2014.
- Sherry, P., Zucker, K., Bondanza, A., Trujillo, L., & Colarossi, D. (2014) “Safety Culture and Employee Health in the Transit Industry.” A paper presented at the 55th Annual Transportation Research Forum, San Jose, CA, March 13, 2014
- Tucker C, and L Ibarra (2010)"Seismic performance of circular concrete filled tube columns for accelerated bridge construction." 10th NCEE. Anchorage Alaska.
- Wehbe, N., B. Tigges, and A. Boudaqa. "Low Flexural and Shear Capacity Bridge Columns under Truck Collision Loads." ACI Fall Convention, Washington, D.C., October 27, 2014
- Werbelow, W. and Ksaibati, K. "Developing a Methodology to Assess and Prioritize Culvert Conditions on County Roads". International Low Volume Roads Conference, July, 2015.

- Y. Huang “Pavement condition monitoring of ultra-thin unbonded concrete overlay using fiber reinforced polymer fiber Bragg grating sensors”, 2014 ASCE T&DI Congress, June 8-11 2014.
- Yang, M.J., Bond Strength of PCC Pavement Repairs Using Metakaolin-Based Geopolymer Concrete, EMI2015HK
- Yang, M.J., Bridge Settlement Criteria Based on Reliability Analysis of Close-to-Reality Modeling Results, EMI2015HK
- Yang, M.J., Progressive failure of fiber reinforced pervious concrete with inclusion of cohesive interface modeling, EMI2015HK
- Zucker, K., Bondanza, A., & Sherry, P. (2014). “"The Effects of Shift Work on Women’s Health." A paper presented at the Annual Meeting of the Amalgamated Transportation Workers Union, Orlando, FL. May 23rd, 2014.
- Zucker, K., Sherry, P. & Mulholland, R.A. (2014). "Women in Transportation: A Model for Job Seeking & Acceptance in the Transportation Industry." A paper presented to the Annual Southeastern Transportation Research, Innovation, Development and Education Center (STRIDE) Conference, Atlanta, GA. March 24, 2014.

b. Books or other non-periodical, one-time publications

- University of Wyoming will have two journal articles appear in journals during spring 2015.

c. Website(s) or other internet site(s)

- Hosted a week-long Summer Transportation Institute camp for junior high students and produced a video documenting the experience: http://youtu.be/UDT4OgHS6Us
- Website that contains a backend simulation engine for Web-based Decision Support Tool for Traffic Management and Work Zone Analysis, http://code.google.com/p/nexta/
- Website that describes in details the backend simulation engine with all of its components for Web-based Decision Support Tool for Traffic Management and Work Zone Analysis, www.learning-transportation.org
- The PI facilitated a student Capstone project that utilized a model produced by this research to implement an iOS app (Apple iPhone) that logs inertial and geospatial data to measure ride-quality. The PI is collaborating with two other UGPTI departments (DOTSC, TLN) and the NDSU Computer Science department to facilitate another Capstone project that will implement a web-service that will use the models produced by this project to monitor pavement ride-quality for North Dakota counties. Website: http://www.ugpti.org/research/projects.php?view=226&program=smartse

d. Technologies or Techniques

- QEM spreadsheet; an excel-based application for signal timing parameters estimation integrated with the DTA tool
- Relational Database linking incidents, weather and the traffic sensor data at each station along I-15 corridor to support Data-Driven Freeway Performance Evaluation Framework for Project Prioritization and Decision Making.

e. Inventions, patent applications, and/or licenses?

Nothing to report at this time.

f. Other

Nothing to report at this time.

3. Participants and Other Collaborating Organizations: Who has been involved?

a. What individuals have worked on the program?

The principal investigators, faculty, and administrators participating in MPC project:

Nine principal investigators, faculty, and administrators participating in MPC projects at **Utah State University** are: Kevin Heaslip, University Program Coordinator and PI; Anthony Chen, PI; Ryan Bosworth, Co-PI; Michael Thomas, Investigator; Patricia Cramer, PI; Paul Barr, PI; Marv Halling, Co-PI; Ryan Gerdes, PI; and Thidapat (Tam) Chantem, PI. In addition, twelve students are participating in MPC research projects at **Utah State University**: Doctorate Students – Sarawut Jansuwan, Seunkyu Ryu, Ali Soltani Sobh, Donghyung Yook, Ryan Barnes; Masters Students – Conner Huffaker, Joseph Flower, Divya Desiraju, Niranjan Chandrappa; Undergraduate Students – Eric Meissner, Jaque Johansen, and Jacqueline Su.

Nine principal investigators, faculty, and administrators participating in MPC projects at the **University of Wyoming** are: Khaled Ksaibati, University Program Coordinator and PI; Robert Ettema, PI; Rhonda Young, PI; Richard J. Schmidt, PI; Kam Ng, PI; Jennifer Tanner, PI; Debbie Shinstine, Post Doctorate; Ed Kempema, Lab Director; and James Branscomb, Engineer. Fourteen students participating in MPC research projects at the **University of Wyoming**: Doctorate Students: Edward Offei, Vijay Sabawat, Promoths Saha; Masters Students - Ram Chakradha, Mike Jung, McKenzie Danforth, Darby Hacker, Nicholas Owen, Rebecca Franke, Sanjay Pokharel, Christopher Savan; Undergraduate Students - Chris Leclerc, Bryce Fiore, and Britton Hammit. Others who participated in the projects at the **University of Wyoming**: Wendy Perkins, Administrator; Shaun Wulff, Statistics Professor; David Reynaud, NCHRP; Bart Bergendahl, FHWA; Larry Arneson, FHWA.

Seventeen principal investigators, faculty, and administrators participating in MPC projects at the **University of Utah**: Richard Porter, University Program Coordinator and PI; David Sanbonmatsu, Co-PI; Peter Martin, PI; Chris Pantelides, PI; Lawrence Reaveley, Co-PI; Pedro Romero, PI; Xuesong Zhou, PI; David Strayer, PI; Luis Ibara, PI; Evert Lawton, PI; Ivana Tasic, PI; Cathy Liu, PI; Milan Zlatkovic, PI; Muhammad Farhan, PI; Amanda Bordelon, PI; Jinjin Tang, Researcher, Visiting Professor; and Francesco Biondi, Researcher, Vising Scholar. Eighteen graduate and undergraduate students are working on MPC research projects at the **University of Utah**: Doctorate Students – M.J. Ameli, Ivana Tasic, Tie Shi, Jeffrey Taylor, Min Ook Kim, M. Scott Shea, Yuandong Wang, and Zhuo Chen; Masters Students - Joel Parks, Dylan Brown, Catherine Tucker, Daniel Sudbury, Dillon Lee, Anusha Musunuru, Arwen Behrends, Shannon Moore, and Anurag Upadhay; Undergraduate Students- Crystal Orantes.

Six principal investigators, faculty, and administrators are participating in MPC projects at **South Dakota State University**: Nadim Wehbe, University Program Coordinator and PI; Allen Jones, PI; Xiao Qin, PI; Guanghui Hua, PI; Haifa Samra, PI; and Aaron Breyfogle, Project Manager, SDDOT. In addition, seven graduate and undergraduate students are working on MPC research projects at **South Dakota State University**: Masters Students - Zhao Shen, Zhaoxiang He, Jacob Humburg, Micah Underberg, Michael Konrad, Walker Olson, and Abdullah Boudaqa.

Nine principal investigators, faculty, and administrators are participating in selected projects from **Colorado State University**: Rebecca Atadero, University Program Coordinator and PI; Paul Heyliger, PI; Suren Chen, PI; Hussam Mahmoud, PI; Mehmet Ozbek, PI; Caroline Clevenger, PI; John van de Lindt, PI; Christopher Bareither, PI; and Bolivar A. Senior, PI. In addition, fifteen graduate and undergraduate students are working on MPC research projects at **Colorado State University**: Doctorate Students- Xiaoxiang Ma, Kristen Peterson, Luke Chen; Masters Students –Patrick Sanders, Chris Bright, Mohammad Reza Hassanzadeh Gorakhki, Sultan Abdulaziz Alhomair, Sherona Simpson, Tyler Sobieck, Vaishak Gopi, Nasser Alberuti, Blaine Fanning, Thomas Wilson, and Robert Lankford.

Altogether, sixteen principal investigators, faculty, and administrators are participating in selected projects at

North Dakota State University: Kimberly Vachal, University Program Coordinator and PI; Andrew Bratlien, Co-PI; Brenda Lantz, PI; Frank Yazdani, PI ; Mijia Yang, PI; Doug Benson, PI; EunSu Lee, PI; Pan Lu, PI; Alan Dybing, Co-PI; Raj Bridgelall, PI; Ying Huang, Co-PI; Denver Tolliver, Director; Donald Malchose, Project Researcher; Laurel Benson, Research Specialist; Mike Telste, Graduate Assistant; and Saeed Ahmari, Postdoctoral Researcher. In addition, fifteen graduate and undergraduate students are working on MPC projects at **North Dakota State University**: Doctorate Students- Oz Khan, Poyraz Kayabas, Anne Campbell, Elvis Ndembe, Chijioke Ifepe, Hai Zhong, Andrew Kubas, and Zhiming Zhang; Masters Students- Mike Telste, Ashkan Saboori, Sara Mamani, Liuqing Hu, Leonard Chia, and Xiao Liang; Undergraduate Student- Nathan Todd.

Two principal investigators, faculty, and administrators participating in MPC projects at the **University of Denver** include Patrick Sherry, University Program Coordinator and PI and Briana Hedman, Assistant Director. Four graduate and undergraduate students working on MPC projects at **University of Denver** include: Doctoral Students - Keaton Zucker; Masters Students Rachel Mulholland, Allison Bondanza, and Yifan Shi.

Four principal investigators, faculty, and administrators participating in MPC projects at the **University of Colorado Denver** include: Wesley Marshall, University Program Coordinator and PI; Jimmy Kim, PI; Carolyn McAndrews, PI; and Bruce Janson, PI. Seventeen graduate and undergraduate students working on MPC projects at **University of Colorado Denver** include: Masters Students - Alejandro Henao, Rachael Bronson, Mahdi Alavizadeh, Greg Colucci, Zachary Heinry, Mayam Karimi, Jenny McGinnis, Sarah Rosenberg, Tong Wen, Shile Dong, Kenny Qian, Kun Jiang, Thushara Siriwardanage, Laia Mitchell, and Craig Fisher; Undergraduate Students- Ben Johnk and Mat Tostle.

b. What other organizations have been involved as partners?

The timing of match funding and the commitments of collaborators vary widely throughout the life of the grant. During this period, we have the following committed collaborators.

1. AAR John Gray, Frank Hardesty, Shannon Stare
2. Ajou University, Korea
3. ASLRRA Scott Sullivan, Elizabeth Petty, Richard Timmons
4. Boyle Engineering
5. City and County of Denver
6. City of Salt Lake Transportation Division
7. Colorado DOT
8. Denver Regional Council of Governments
9. Federal Highway Administration (FHWA)
10. Florida Atlantic University
11. Fort Berthold Reservation
12. FRA Administrators
13. Kittelson & Associates, Inc.
14. Minnesota Department of Transportation (MnDOT), MnROAD research facility
15. National Cooperative Highway Research Program
16. National Institute of Standards and Technology, Boulder
17. NCAR
18. NCHRP, in developing the project's ideas for a possible national-level project
19. ND Department of Transportation
20. NDDOT is providing crash data
21. NDHP is providing officer log and CAD data
22. Northern Plain TTAP Center
23. Northern Plain TTAP Center
24. Regional Transportation District
25. Sean Vonfeldt, Triunity (contractor of Regional Transportation District (RTD)). RTD has provided

matching funding for the project. In addition, Sean is co-authored the conference proceeding currently under review.
26. South Dakota DOT
27. South Dakota DOT
28. Tailings and Mine Waste (TMW) Conference Committee, which is a consortium of consulting companies and industry partners that support research related to tailings and mine waste at CSU. Tailings and fly ash materials were obtained through three different consulting companies that are a part of the TMW consortium.
29. Tegracore, Industrial partner
30. The AAA Foundation for Traffic Safety
31. Tom Streicher, American Short Line Railroad Association
32. University of Utah (faculty start-up funds)
33. Utah Department of Transportation
34. Utah Department of Transportation
35. Utah Division of Wildlife Resources
36. Utah DOT
37. Utah Transit Authority
38. Ward Johnson, NIST, collaborator
39. Wasatch Front Regional Council
40. Wind River Indian Reservation
41. Working on access to the FMSCA portal data
42. WSDOT
43. WYDOT
44. Wyoming Division of FHWA
45. Wyoming DOT

c. Have other collaborators or contacts been involved?

The list of collaborating organizations in 3(b) is complete, as of this grant period.

4. Impact

The impacts of the program will become clearer in future years. The implementation of research findings often lags project selection and completion. However, certain impacts are emerging. The benefits of the program are already being felt in many respects.

1. **Graduate Education**. Collectively, the MPC universities offer one of the most diverse and comprehensive multimodal multidisciplinary graduate education programs in the nation. As shown earlier, 59 courses were offered in the fall 2014 and 314 courses have been offered since the inception of the program. The impact of the educational program will increase in future years, as the MPC universities expand the number of courses offered through their existing exchange program, in which students from any MPC university can take courses from other universities. These courses must be placed online for the collaborative exchange to work most effectively. Considerable progress has been made, thus far, in converting classroom courses to online courses and increasing the reach of the program. The Master of Transportation and Urban Systems degree is offered fully online at NDSU as is the Master of Managerial Logistics.
2. **Workforce Development.** MPC's technical training program is having a major impact in the region. Online modules, short courses, webinars, and on site/videoconferencing events are reaching state and local transportation department employees and tribal transportation planners. By harnessing the capabilities of the four LTAP centers located at the MPC universities and the multimedia capabilities of the Transportation Learning Network (which was founded and is partly funded by MPC) more than 18

technical training events were offered in the second half of 2014. These training modules and short courses are critical to transportation agencies that need to improve or renew the skills of engineering technicians and other frontline workers. Many MPC courses or training events result in the certification of workers. Even when certification is not required, TLN's online learning management systems allow employees and employers to set learning goals and monitor progress towards these goals.

MPC is making another major impact in workforce development. Altogether, 92 graduate students are working on MPC research projects under the tutelage of faculty researchers. These graduate students represent the researchers and technical analysts of tomorrow. Without the MPC program and the stipend funds that it provides, these students may not be specializing in transportation; but, instead would be seeking career opportunities in other fields. The MPC research program allows faculty to mentor graduate students while allowing the students to work on projects for federal and state transportation agencies—thereby, gaining valuable practical experience.

3. **Tribal Transportation Technical Assistance.** The program is already having a major impact in terms of providing tools and assistance for Native American tribes in the region, especially those impacted by energy development in Wyoming and North Dakota. To better coordinate and plan tribal-related activities, NDSU has designated a tribal transportation program coordinator to help the director identify critical needs and leverage resources to meet those needs. Technical assistance is already being provided in road safety, GIS transportation model building, forecasting heavy truck traffic attributable to energy development, and facilities planning. An emergency response planning guidebook (to help tribes plan for and respond to natural disasters that impact the transportation system and the delivery of life-saving services) is currently under development and will be disseminated within the region and the western United States when completed.

4. **Research.** During this rating period eight research projects have been completed and final reports published that address critical regional and national issues. Multiple journal articles and conference papers have been derived from each project, increasing their reach and impact. MPC's strategy of requiring journal articles and presentations at national conferences (such as TRB and the Transportation Research Forum) is greatly magnifying the impacts of the research projects and MPC reports.

5. **Leadership.** MPC researchers and program administrators are having a major impact through participation in TRB, TRF, ITE, and other national organizations and conferences. Moreover, MPC is a leader in responding to the dynamic and sometimes unprecedented transportation demands and issues posed by shale energy development. MPC research projects in Wyoming and North Dakota are helping impacted states and local/tribal governments develop long-term road and bridge investment strategies. The newly formed North Dakota Transportation Safety Advisory Group (which includes representation from NDDOT, North Dakota Highway Patrol, FRA, PHMSA, and FMCSA) is identifying critical research projects for 2015-2016 and leveraging technical assistance and training for transportation operators, emergency responders, and state and local planners. Even though MPC's primary focus is State of Good Repair, MPC has responded quickly to urgent requests for safety training and research in light of the unprecedented issues associated with the transportation of Bakken crude oil via rail, pipeline, and truck.

5. **Changes/Problems -** Nothing to report at this time.

5a. Additional Information Regarding Products and Impacts -Nothing to report at this time.

PROGRAM OUTPUTS: Nothing to report at this time.

PROGRAM OUTCOMES: Nothing to report at this time.

PROGRAM IMPACTS: Nothing to report at this time.

6. SPECIAL REPORTING REQUIREMENTS: None