U.S. Department of Transportation
Research and Innovative Technology Administration
University Transportation Center Grant Agreement

Grant No. DTRT13-G-UTC38
Mountain-Plains Consortium, North Dakota State University
Denver Tolliver, Director
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(701)231-7190

April 30, 2014

DUNS: 803882299 and EIN: 45-6002439

North Dakota State University
Upper Great Plains Transportation Institute
NDSU Dept. 2880, P.O. Box 6050, Fargo, ND 58108-6050

Grant period: October 1, 2013 – September 30, 2017

Reporting Period End Date: March 30, 2014
Semi-Annual PPPR#1

Denver D. Tolliver
Director, Mountain-Plains Consortium
North Dakota State University
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; and (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. Other program goals are to select projects and activities using peer review principles and procedures and client input that: (1) address the Secretary’s five strategic goals, and (2) leverage UTC funds with matching funds from state and local governments and private industry. The chief operational goals are 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 Competitiveness, while addressing critical issues of the region and stakeholder groups.

b. What was accomplished under these goals?

i. Project Selection

More than 30 research projects for the 2013-2014 contract year are undergoing a peer review process for possible selection. The projects reflect substantial input and matching resources from state departments of transportation and MPOs in the region. Collectively, this set of projects addresses all five of the Secretary’s strategic goals and several of USDOT’s requested emphasis areas under State of Good Repair—e.g., (1) bridge condition monitoring, (2) locating critical infrastructure defects, (3) identifying tools to prevent and detect corrosion in transportation infrastructure, (4) analytical tools for infrastructure performance management, and (5) methods and criteria to measure performance of new materials and methods. Other research projects are related to the Secretary’s strategic goals of Safety, Economic Competitiveness, Livable Communities, and Environmental Sustainability.

ii. Programmatic Milestones

In addition to the programmatic milestones described below, several milestones embedded within individual projects have been achieved. Most of the research projects call for literature reviews. The literature reviews for those projects with the earliest starts are substantially complete. Interim reports are not required after the literature review stage. So, no publications have been produced at this time. At this time, all projects are on schedule to be completed as planned during the program period.

The accomplishments to date are summarized in Table 1 by reference to milestones.
Table 1: Program Milestones

<table>
<thead>
<tr>
<th>Milestone Event</th>
<th>Description</th>
<th>Start Date</th>
<th>End Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Development of Proposal</td>
<td>Proposal guidelines were developed by the director, in consultation with other consortium members, to ensure a consistent solicitation and project selection process that facilitates peer review and links program activities to the Secretary’s strategic goals. The research proposals guidelines are shown in Table 2. Similar but different guidelines were developed for education, workforce development, and technology transfer projects, to reflect the differences in tasks and outcomes associated with these projects. The proposal guidelines and related information have been posted on the Center’s webpage.</td>
<td>09/1/2013</td>
<td>09/15/2013</td>
</tr>
<tr>
<td>Guidelines</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Call for Proposals</td>
<td>The solicitation of proposals occurred on each university campus, using proposal guidelines developed by the director.</td>
<td>09/15/2013</td>
<td>11/15/2013</td>
</tr>
<tr>
<td>Execution of Grant Agreement</td>
<td>The grant was received from RITA and executed by NDSU’s Sponsored Programs office. All of the necessary internal accounting and financial procedures were established, including subcontract agreements with consortium universities.</td>
<td>11/08/2013</td>
<td>11/08/2013</td>
</tr>
<tr>
<td>Center Directory</td>
<td>A directory of key center personnel was completed and published on the center’s web page.</td>
<td>12/15/2013</td>
<td>12/15/2013</td>
</tr>
<tr>
<td>Center Webpage</td>
<td>The MPC webpage was updated and is fully functional for the current grant period.</td>
<td>12/15/2013</td>
<td>12/15/2013</td>
</tr>
<tr>
<td>UTC/CUTC Meeting</td>
<td>The director and administrative staff attended the UTC/CUTC meeting at TRB and received guidance from RITA regarding the forthcoming grant.</td>
<td>01/11/2014</td>
<td>01/16/2014</td>
</tr>
<tr>
<td>Peer Review of Proposals</td>
<td>All project proposals were subjected to external and internal peer review.</td>
<td>01/15/2014</td>
<td>03/15/2014</td>
</tr>
</tbody>
</table>
Primary Focus

MPC’s proposal targets the following MAP-21 research and technology deployment objectives under the goal of Improving Infrastructure Integrity: A) increase the reliability of life-cycle performance predictions used in infrastructure design, construction, and management; B) improve the ability of transportation agencies to deliver projects that meet expectations for timeliness, quality, and cost; C) reduce user delay attributable to infrastructure system performance, maintenance, rehabilitation, and construction; D) improve highway condition and performance through increased use of design, materials, construction, and maintenance innovations; and E) study vulnerabilities of the transportation system to seismic activities and extreme events and methods to reduce those vulnerabilities.

03/15/2014 12/31/2014

Selection of Projects

Projects were selected from the proposals received and awards were made to principal investigators, based on the peer reviews of proposals, stakeholder commitments, and the overall availability of funds.

03/15/2014 06/15/2014

Posting of Projects

The selected projects were posted on the MPC webpage and added to the Research in Progress database.

05/15/2014 08/15/2014

Site Visit

A site visit to all MPC Universities.

06/01/2014 06/01/2015

UTC/CUTC Summer Meeting

The center director and other key staff attended the 2014 summer UTC/CUTC meeting in Nebraska.

06/02/2014 06/05/2014

Table 2: MPC Research Proposal Guidelines for Faculty

<table>
<thead>
<tr>
<th>Title</th>
</tr>
</thead>
<tbody>
<tr>
<td>Provide a title that is descriptive of the project and includes key terms that will facilitate internet and library searches for the project.</td>
</tr>
<tr>
<td>Universities</td>
</tr>
<tr>
<td>If the project is a multi-university proposal, list each university involved.</td>
</tr>
<tr>
<td>Principal Investigators</td>
</tr>
<tr>
<td>If the project is a multi-university proposal, list a principal investigator from each university, with the university affiliations denoted in parentheses.</td>
</tr>
<tr>
<td><strong>Research Needs</strong></td>
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<tr>
<td>-------------------</td>
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<tr>
<td><strong>Research Objectives</strong></td>
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<td><strong>Research Methods</strong></td>
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<td><strong>Expected Outcomes</strong></td>
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<tr>
<td><strong>Relevance to Strategic Goals</strong></td>
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<td><strong>Educational Benefits</strong></td>
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<tr>
<td><strong>Work Plan</strong></td>
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</tbody>
</table>
Project Cost

List the amount of MPC funds requested, the amount of the expected matching contributions, and the sources of the matching resources, including all agencies expected to contribute funds or in-kind resources to the project. MPC research projects require at least a dollar-for-dollar match. However, other federal funds (e.g., federal funds other than UTC funds) cannot be used as match, except for state planning and research funds and LTAP funds, which are eligible under exclusionary provisions of the authorizing legislation. The definition of “nonfederal funds” is based on the original source of funds.

Potential Peer Reviewers

Provide the complete contact information of at least three persons who are qualified to review and critically assess the proposal, including the person’s name, position title and organization, street address, city, state, zip code, and email address. Keep in mind that peer reviewers cannot have conflicts of interests, such as those that may arise if someone stands to personally or professionally benefit from the proposed project. Peer reviewers may include professionals at federal, state, metropolitan, or local agencies, as well as university and private-sector researchers. Given that at least three completed reviews are required for a proposal to move forward in the assessment process, the submission of more than three names may expedite the time frame for approval, in the event of one or more nonresponsive reviewers.

TRB Keywords

Provide a complete list of applicable TRB keywords

References

List the major references cited in the proposal and other seminal work in the field.

iii. Educational Accomplishments

The transportation and transportation-related courses offered during Fall 2013 & Spring 2014 are listed in Table 3, 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 3: Transportation and Transportation-Related Courses Offered This Period

<table>
<thead>
<tr>
<th>Major Subject Area</th>
<th>Course Title</th>
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</thead>
<tbody>
<tr>
<td>Engineering &amp; Design</td>
<td>CE 3500 Transportation Engineering</td>
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<tr>
<td></td>
<td>CE 5585 Pavement Transportation System</td>
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<tr>
<td></td>
<td>CE444-Steel Design</td>
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<tr>
<td></td>
<td>CE446/646-Structural Dynamics</td>
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<tr>
<td></td>
<td>CE447/647-Structural Stability</td>
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<tr>
<td></td>
<td>CEE 3210 Introduction to Transportation Engineering</td>
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<td></td>
<td>CEVN 5602 Advanced Highway &amp; Street Design</td>
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<td></td>
<td>CIVE 467 Design of Reinforced Concrete Structures</td>
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<td></td>
<td>CIVE 561 Advanced Steel Behavior and Design</td>
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<td></td>
<td>CIVE 562 Fundamentals of Vibrations</td>
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<td></td>
<td>CIVE 565 Finite Element Method</td>
</tr>
<tr>
<td>Major Subject Area</td>
<td>Course Title</td>
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</tr>
<tr>
<td>Engineering &amp; Design</td>
<td>CIVE 567 Advanced Concrete Design</td>
</tr>
<tr>
<td></td>
<td>CON 370 Asphalt Pavement Materials and Construction</td>
</tr>
<tr>
<td>Engineering &amp; Design</td>
<td>CvEEN 3510 Civil Engineering Materials</td>
</tr>
<tr>
<td></td>
<td>CvEEN 5510 Highway Design</td>
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<td></td>
<td>CvEEN 5570 Pavement Design</td>
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<tr>
<td></td>
<td>CvEEN 6225 Concrete Science</td>
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<td>CvEEN 7225 Prestressed Concrete</td>
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<tr>
<td>Engineering &amp; Design</td>
<td>CvEEN 7250 Structural Earthquake Engineering</td>
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<td></td>
<td>CvEEN 7920 001 Advanced Materials Testing</td>
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<td></td>
<td>CVEN 3602 Introduction to Transportation Engineering</td>
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<td></td>
<td>CVEN 4602 Highway Engineering</td>
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<td>CVEN 5621 Highway Capacity Analysis</td>
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<tr>
<td>Planning &amp; Environment</td>
<td>CVEN 5800 Case Studies in Sustainable Transportation</td>
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<tr>
<td></td>
<td>CVEN 5800 Prestressed Concrete (includes a major design project for a highway bridge using prestressed concrete girders and a literature review project as to the application of fiber reinforced polymer composites for transportation structures)</td>
</tr>
<tr>
<td></td>
<td>CVEN5800 (Prestressed concrete in Spring 2014) includes a major design project for a highway bridge using prestressed concrete girders and a literature review project as to the application of fiber reinforced polymer composites for transportation structures.</td>
</tr>
<tr>
<td>Freight &amp; Logistics</td>
<td>None</td>
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<tr>
<td>Planning &amp; Environment</td>
<td>CEE 5240/6220 Urban and Regional Transportation Planning</td>
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<td>CvEEN 5560 Transportation Planning</td>
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<td>CvEEN 5920 Material Sustainability</td>
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<td>CVEN 5631 Transportation Planning and Methods</td>
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<td>CVEN 5640 Introduction to Sustainable Urban Infrastructure</td>
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<td>TL 752 Transportation Planning and Environmental Compliance</td>
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<td>URPL 5040 Natural and Built Environments</td>
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<td>URPL 5050 Urban Development</td>
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<td>URPL 6200 Land Development Regulations</td>
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<td>URPL 6300 Planning for Healthy Communities</td>
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<td>URPL 6350 Form and Function of Cities</td>
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<td>URPL 6355 Urban Redevelopment Strategies</td>
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<td>URPL 6370 Sprawl and Growth Management</td>
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<td></td>
<td>URPL 6400 Community Development</td>
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<td>URPL 6405 Urban Housing</td>
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</tbody>
</table>
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<table>
<thead>
<tr>
<th>Major Subject Area</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>URPL 6550 Transportation Planning/Policy</td>
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<tr>
<td></td>
<td>URPL 6555 Transportation and Land Use</td>
</tr>
<tr>
<td>Planning &amp; Environment</td>
<td>URPL 6645 Disaster/Climate Change Planning</td>
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<tr>
<td></td>
<td>URPL 6650 Planning in the Dev. World</td>
</tr>
<tr>
<td>Public Transportation</td>
<td>None</td>
</tr>
<tr>
<td>Traffic &amp; Operations</td>
<td>CE 5535 Traffic Operation</td>
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<td>CE 5575 Intelligent Transportation System</td>
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<tr>
<td>Traffic &amp; Operations</td>
<td>CEE 5220/6220 Traffic Engineering</td>
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<tr>
<td></td>
<td>CvEEN 3520 Transportation Engineering</td>
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<td>CvEEN 7920 Traffic Flow Theory</td>
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<tr>
<td></td>
<td>CVEN 5622 Traffic Operations and Controls</td>
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<td>TL753 Transportation System Modeling</td>
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<td></td>
<td>TL755 Context Sensitive Solution</td>
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<td>TL785 Spatial Analysis in Transportation</td>
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<tr>
<td>Transportation Safety</td>
<td>CvEEN 7520 Transportation Safety</td>
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<td></td>
<td>CVEN 5611 Traffic and Safety Data Analysis</td>
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<td></td>
<td>PSY 3120 Cognitive Psychology</td>
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<td>PSY 3172 Human Performance and Engineering</td>
</tr>
<tr>
<td>Transportation Systems</td>
<td>CIVE 303 Infrastructure and Transportation Systems</td>
</tr>
<tr>
<td></td>
<td>CvEEN 7920 003 Statistical and Econometric Analysis</td>
</tr>
</tbody>
</table>

Altogether, 60 transportation and transportation-related courses have been offered this reporting period, for a total of 60 total transportation courses offered this grant period. In addition to the courses listed in Table 3, foundational courses in engineering materials, mechanics, structural analysis, and geotechnical engineering were offered at most MPC universities.

**iv. Workforce Development Accomplishments**

**Training:** A list of training events provided for transportation professionals since the start of the grant is presented below.

1. Asphalt Paving
2. ATSSA Flagger Certification.
3. Access Management Training
4. ADA PROW Curb Ramps
5. APWA - MUTCD Training
6. APWA - PROW ADA Ramp Design
7. APWA Construction Inspector Training
8. Asphalt Maintenance II
9. Asphalt Paving Maintenance I
10. Asphalt Paving Maintenance 2  
11. ATSSA Flagger Certification  
12. ATSSA Traffic Control Supervisor (TCS)  
13. ATSSA Traffic Control Technician (TCT)  
14. Basic Surveying / Grade Checking  
15. Basics of a Good Road  
16. Casper, Work Zone Safety  
17. Communication Skills for Supervisors  
18. Communication Skills Level 2  
19. Concrete III  
20. FHWA Work Zone Safety Grant Training Program  
22. Heavy Equipment Operation (Hands On)  
23. Heavy Equipment Operations - Safety  
24. Heavy Equipment Safety Operations  
25. Heavy Equipment Training Workshop  
26. Integrated Roadside Vegetation Management  
27. Integrated Vegetation and Roadside Management  
28. Intellligent Compaction  
29. Intersection and Interchange Geometrics: Safer, Faster, Cheaper!  
30. Loader Refresher Course  
31. LPA Certification  
32. MUTCD Training  
33. OSHA 10 Hour Training  
34. Registered Storm Water Inspector  
35. Registered Storm Water Inspector Training  
36. Retro Reflectivity for Signs  
37. Roadway Drainage  
38. Speed Limit  
39. Speed Limits & School Zones  
40. Survey & Grade Checking  
41. TCT Course - Consolidated Paving  
42. Tree Trimming  
43. University of Utah American Concrete Institute Sixth Annual Spring Concrete Symposium  
44. Utah Asphalt Conference  
45. Winter Road Maintenance  
46. Workplace, Equipment & Jobsite Safety  

Conferences, workshops, and publications are summarized under “products.”

**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. Because effective starting dates of most projects were after March 30, 2014, no tangible results have been produced at this time. Therefore, we have nothing to report.

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

No changes are foreseen to the accepted plan and implementation schedule.

2. Products: What has the program produced?

a. Publications, conference papers, presentations

i. Key Conferences and Workshops

- American Concrete Institute (ACI): Reno, NV; March 2014
- ACI-congress 2013, Minneapolis, MN,
- Aggregate Certification, December 9-11, 2013 Laramie, WY
- Aggregate Certification, January 6-8, 2014 Laramie, WY
- American Concrete Institute conventions in Mar 2014: Evaluation of concrete bridges and bridge elements (ACI-342); Concrete bridge construction, maintenance, and repair (ACI-345), Fiber reinforced polymer reinforcement (ACI-440), and FRP-prestressed concrete
- Asphalt Certification, December 11-13, 2013 Laramie, WY
- Asphalt Certification, January 8-10, 2014 Laramie, WY
- Concrete Certification, February 12-14, 2014 Laramie, WY
- Concrete Certification, March 17-19, 2014 Laramie, WY
- Concrete Certification, November 13-15, 2013 Laramie, WY
- Congress for the New Urbanism (CNU) Transportation Summit: Chicago, IL; November 2013
- ISEC 7th conference, Honolulu, Hawaii, 2013,
- Transportation Research Board (TRB): Washington, DC; January 2014

ii. Key Publications

- J. Y. Chen, P. R. Heyliger, E. Pan, Free vibration of three-dimensional multilayered magneto-electro-elastic plates under combined clamped/free boundary conditions, *Journal of Sound and Vibration.* (related to MEMS sensor projects)


• Musunuru, A. and Porter, R.J. “A Reliability-Based Geometric Design Approach to Freeway Number of Lanes Decisions,” *Transportation Research Record, Journal of the Transportation Research Board*. Accepted for publication.


• Tasic, I., Musunuru, A., and Porter, R.J. Quantifying Accessibility of Non-Motorized Transportation Modes in Recreational Areas: Case Study of Mill Creek Canyon, Utah. *Journal of Park and Recreation Administration*. Accepted for publication.


• Truong, L. and Wesley E. Marshall. Are Park-n-Rides Saving the Environment or Just Saving Parking Costs? A Case Study of the Denver
Light Rail System. *Transportation Research Record, Journal of the Transportation Research Board.* Accepted for publication.


### iii. Key Conference Papers


- Saboori; S. Yazdani; Reberg; M. Yang, D. Toliver, and S. Mamani, Modeling Freeze and Thaw damage in Concrete Decks using Damage mechanics. ASEA-SEC-II Conference, Bangkok, Thailand. 2014.


iv. Key Presentations

• Atadero, R., Ozbek, M.E., and Hesse, (2014) “Uncertainty in Bridge Inspection Results in Bridge Management and Inspection Planning.” Presented at ASCE Structures Congress April 2-5, Boston, MA


- Xiaoyue Liu. Congestion Pricing and Managed Lanes: 20 Years of Learning – Where have we been, where are we now, and where are we going? Invited Talk. Transportation Research Board. Washington, D.C. January 2013.

v. Other Items Produced During this Period
- A prototype of the detection system is developed and tested in the structural lab of NDSU. Initial results are positive.
- Developing two more journal papers for publication, S. Yazdani.
- Development of Class II and Class III data/statistics used by Sec of DOT to respond to Congress, D Benson
- Ph.D. dissertation proposed and ongoing from Small Railroad Financial needs project, E. Campbell

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

Nothing to report at this time.

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

The MPC website is fully operational at: http://www.mountain-plains.org/

The MPC Center Director can be found at: http://www.mountain-plains.org/resources/downloads/KeyCenterDirectory.pdf?year=2014
d. Technologies or Techniques
Nothing to report at this time.

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?
Nothing to report at this time.

   b. What other organizations have been involved as partners?
The timing of match funding and the commitments of collaborators vary widely and are still unfolding. At this time, we have identified potential collaborators, however, others may be added. Key participants from many organizations will be named at a later date, when their funding and personnel availability becomes more certain.

   c. Have other collaborators or contacts been involved?
Nothing to report at this time.

4. Impact
Nothing to report at this time.

5. Changes/Problems
No changes are foreseen 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