Program Progress Performance Report

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By

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University Transportation Center for Highway Pavement Preservation

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Semi-annual

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1. Accomplishments

Program Major Goals and Objectives

Table 1 lists the major goals and objectives outlined in the Center for Highway Pavement Preservation (CHPP) scope of work.

Goal Accomplishments

Currently, all CHPP activities are either in progress or in the planning stages as indicated in the "% Complete" and "Status" columns of Table 1.

Training and Professional Development Opportunities

As indicated in Table 1, multiple opportunities for training and professional development have been implemented and/or are scheduled for future growth and sustainability of the center. During the period April 1, 2015 - September 30, 2015, CHPP provided the following training and professional development opportunities:

- CHPP Short Course Development and Implementation for High School and College Students,
- Middle and High School Engineering Day,
- Open houses,
- Other CHPP professional development activities.

A brief summary of these activities is provided below.

K-12 Outreach

1. **University of Hawaii at Manoa, Manoa Experience**

   Program Description
   On April 11, 2015, a large group of 500 to 700 students came to the College of Engineering and participated in a half-day event filled with engineering exhibits, games, and competitions. The Pavement Engineering Laboratory at UH Manoa was open to the attendees. The research activities related to pavement preservation as part of CHPP's outreach activities were part of the program.

2. **MSU High School Engineering Institute (HSI)**

   Program Description:
   Three sessions for HSI were conducted at MSU on June 25, 30 and July 14, 2015. Each session involved forty three (43) national and international high school students. The program was designed to give in-depth experiences in civil engineering majors. Students spent a half day with an engineering faculty member, graduate and undergraduate students, and participated in short lectures, demonstrations, hands-on experiments, and team-based problem solving. The class lectures emphasized social and environmental relevance of basic science and engineering subject matter. CHPP believes that the strong societal impact and creation of multi-disciplinary teams is crucial to attract female and under-represented minorities to the STEM field. Participating students worked on projects such as:
   - Building a sample of asphalt pavement cross-section using crumb rubber (Road in a box),
   - Using smart materials (piezoelectric sensors) to generate voltage as a measure of deflection,
   - Measuring the permeability of different pavement materials (Sand and clay).

Table 1 CHPP Major Goals and Objectives

Overall		**Status**	**% Complete**
	Kick-off meeting with USDOT, Steering Committee and Advisory Board	Complete	100
	Sub-award contracts in place	Complete	100
	Request for problem statements	Complete	100
	Evaluation and ranking of problem statements	Complete	100
	Request for Proposals	Complete	100
	Proposals and Budgets under External Review	Complete	100
	Research Projects under Contract	On Schedule	100
	Library Resources Posted/Linked on Website	On Schedule	30
Leadership Activities			
	Partner with NCPP to work with regional partnerships	Complete	100
Educational and Outreach Activities			
K-12	Middle and High School Engineering Day	On Schedule	100
	Participate in the activities of Middle and high schools STEM clubs	On Schedule	100
	High School Engineering Institute	Complete	100
	Metro Detroit Youth Day	Complete	100
	Developing Highway Pavement Preservation short courses for HS students	Forthcoming	50
	Preview Day of Highway Pavement Preservation related research	On Schedule	100
	Research Experiences for Teachers (summer 2016)	Forthcoming	50
	Training camps for high school students (summer 2015) Training camps for high school students (summer 2016)	Complete Forthcoming	100 (2015) 50 (2016)
	Science and Engineering Enrichment Program for Deaf	On Schedule	100
	Engineering Teacher Workshop	Complete	100
Grad/Undergrad	CHPP Course Development & Implementation	On Schedule	50
	Summer Research for undergraduates (Summer 2015) Summer Research for undergraduates (Summer 2016)	Complete On Schedule	100 (2015) 50 (2016)
	CHPP/CUTC student of the Year Program - Annually @ TRB	On Schedule	50 (2016)
	Transportation student Chapter (ITE/ASCE/etc.) related activities	On Schedule	100
	CHPP student symposium	Complete	100
	Summer Research for college Students (2015) Summer Research for college Students (2016)	Complete On Schedule	100

3. NGSS Compliant Introduction to Engineering Teacher Workshop at MSU

Program Description:

The workshop was conducted on July 1, 2015 at Michigan State University. Fifteen (15) middle and high school teachers from all over the US participated in this event. The main objective of the workshop was to enhance the integration of the CHPP activities into school curriculum. School teachers were engaged in lectures related to pavement preservation concepts and CHPP research activities. The teachers were exposed to pavement and transportation engineering through laboratory tours and hands-on experimental activities. CHPP joined forces with the MSU research experience for teachers (RET) coordinators to present ways in which such activities can be used in the Next Generation Science Standard (NGSS) aligned engineering curriculum. The agenda for the workshop included:

- Lecture: *Towards a More Mechanistic Approach to Pavement Preservation*
  Presenter: Karim Chatti, Center Director
  "A forward looking approach to pavement preservation, based on mechanistic principles and a scientific understanding of pavement systems behavior and how they deteriorate over time was explained. The presentation focused on how this approach to pavement preservation will allow for taking proactive preventive measures that are supported by a sound understanding of the deterioration mechanisms and a more mechanistically based prediction of pavement performance."
- Lab tour: Advanced *Asphalt Characterization Laboratory (AACL)—Part I*
  Presenter: Salih Kocak, CHPP Ph.D. Student
  Advisor: M. Emin Kutay, Center faculty
  "The focus was to introduce pavement engineering to the teachers through hands-on activities in the lab. The different steps of building a road from asphalt mix design to paving were presented. The teachers learned about different materials that can be used in an asphalt mix, and how the asphalt mix samples are compacted in the lab for further testing."
- Lab tour: *Advanced Asphalt Characterization Laboratory (AACL)—Part II*
  Presenter: Ugurcan Ozdemir, CHPP M.S. Student
  Advisor: M. Emin Kutay, Center faculty
  "The teachers learned about the center research related to Chip seals. They were also educated about innovative ways of testing the performance of mixes in real time through image analysis."
- Lab tour: *Computational Sensor Laboratory*
  Presenter: Amir Alavi, CHPP Ph.D. Student,
  Advisor: Nizar Lajnef, Center faculty
  "The tour introduced the teachers to a new approach for the continuous health monitoring of asphalt concrete pavements based on the self-powered wireless sensor data. The teachers learned about the piezoelectric effect used in these self-powered sensors and how this linear electromechanical interaction between the mechanical and the electrical state in crystalline materials are useful in detecting the damage progression."

4. Metro Detroit Youth Day with a Transportation and Pavement Theme

Program Description

The Metro Detroit Youth Day, the largest youth event in the State of Michigan, was formulated to bring together Metro Detroit area youth from all walks of life for a day of sports, fun, and constructive activities. On July 15, 2015, the CHPP showcased not only transportation and pavement-related research but also all aspects of the STEM field (e.g., Science, physics and mathematics). The activities introduced approximately 34,000 children to innovative and inspiring engineering designs and projects through hands-on experiments. These activities included:

- VEX and VEXIQ robotics
- Bottle rocket launch
- Robotic Fish
- Aluminum foil boat building and testing

- Cardiovascular mechanical systems
- Renewable energy using LEGO Ecolab kits
- Pavement in a box for all ages

Twelve STEM teachers teamed up with the CHPP outreach team during the event. The teachers' institutions are:

- Robotics Engineering for Better Life and Sustainable Future Math and Science Center at MSU,
- Cass Tech High School,
- East Lansing McDonald Middle,
- Haslett Middle School,
- Kalamazoo Area Math and Science Center,
- Pershing High School, and
- Regina High School

5. High School Education and Outreach at NCA&T SU

Program Description:

A sustainable pavements workshop for high school students was conducted on July 26, 2015. The workshop was specifically designed to introduce various aspects of pavement preservation/construction, and their effects on the overall pavement life cycle cost. Twenty (20) students participated in a full day workshop. The workshop agenda included the following lectures and hands-on activities:

- Lecture: the lecture focus was to provide introduction to sustainable pavement practices and preservation. The presenter discussed the application of several materials and construction practices including warm mix asphalt. In addition, students were introduced to commonly used methods of evaluating economic and environmental aspects of aforementioned practices.
- Hands-on activities: Students were teamed up in groups of four. Each group was mentored with one graduate student from the Sustainable Infrastructure Materials (SIM) Lab at NC A&TSU to design and build a paving mixture for a select state within the U.S.; and also recommend possible preservation treatments for several plausible pavement distress types within their selected states. They were mentored on how to design and prepare their paving mixture in the lab. They also learned about how different testing equipment could be used to measure asphalt mixture properties to ensure such properties meet the specifications. The training was followed by a competition to evaluate their understanding of sustainable pavement construction and preservation practices. As part of the competition, students were assigned different materials to use for design of a sustainable pavement mixture for their selected states and special weather condition. Each team presented their design and explained pros and cons while justifying the sustainability aspects.

6. Blueprints: Engineering Your Manoa Success at UH

Program Description

This is a welcoming orientation event for incoming freshmen, transfer students, and families. Students are able to design their own blueprint to success at UH Manoa while meeting the center faculty, listening to industry leaders, learning about the opportunities offered, and making new friends.

7. Annual Science and Engineering Enrichment for Deaf Students (SEEDS) Program at NCA&TSU

Program Description:

This annual program is organized in conjunction with Energy Day at NC A&T State University. Deaf and hard-of-hearing students from local middle and high schools participated in a full-day workshop and training program related to sustainability in the field of transportation and construction practices. They received hands-on training on construction materials testing and characterization. In addition, they learned about three aspects of sustainability (equity, economy, and environment) while recognizing the importance of maintaining and preserving highway infrastructures.

8. **Summer Internship Program for High School Students at UH Manoa and MSU**

Program Description

The UH pavement laboratory hosted two high school students during the Summer Internship Program. This is a highly competitive six-week program that allows high school juniors (heading into their senior year) to have hands-on experience in the College of Engineering research laboratories. Along the way, interns also participated in group activities and a field trip to local engineering companies. At the end of the program, they made a presentation about their learning experience. MSU also hosted one high school student who learned about using smart materials (sensors) for pavement monitoring. Table 2 lists the names of the students and their faculty advisors from the center.

Table 2 High School Students Involved in CHPP-related Research

Student Name	Level	Hosting Institutions	Advisor
Nandan Kodur	High School, Okemos High School	Michigan State University	Nizar Lajnef
Christina Shin	High School, Kalani High School	University of Hawaii at Manoa	Adrian Ricardo Archilla & Jose Corrales
Tyler Villegas	High School, Mililani High School	University of Hawaii at Manoa	Adrian Ricardo Archilla & Jose Corrales

9. **Engineering Day at UH Manoa**

Program Description

During the Engineering Day, the Pavement Engineering Laboratory at UH Manoa was opened to the prospective and current undergraduate students on September 19, 2015. The research activities related to pavement preservation as part of CHPP's outreach events were part of the program. During this event, CHPP collaborated with different student organizations such as AISES (American Indian Science and Engineering Society), ASCE (American Society of Civil Engineers), ECUH (Engineer's Council at the University of Hawaii), HKN (Eta Kappa Nu), IEEE (Institute of Electrical and Electronics Engineers) and SWE (The Society of Women Engineers).

Undergraduate / Graduate Outreach

1. **Education and Training at the Undergraduate and Graduate Levels**

Program Description:

The participants were introduced to the concepts of sustainability i.e., preserving natural resources, managing a network of pavements within fiscal constraints, and reducing greenhouse emissions. The research findings were disseminated through regular department seminars during each semester, publication in scientific journals, presentations, and mini-symposia at major conferences. Table 3 also lists the names of the undergraduate and graduate students and their corresponding advisor involved in the CHPP related research projects.

2. **Summer Research for Undergraduates Students**

Program Description:

CHPP offered 10 weeks (May to July) summer research opportunities for high-achieving undergraduates. The objective of this multi-disciplinary program is to attract young talent from all consortium partners (MSU, UT-Austin, UIUC, U of Minnesota, NCA&TSU, and UH) to increase the quality, number, and diversity of professionals entering the transportation sector. The program offered the selected undergraduate students the opportunity to (a) gain firsthand experience in conducting highway and transportation studies, and (b) actively participate in transportation research with graduate students under the supervision of transportation faculty members.

The students worked full-time on a faculty-guided research project and participated in professional development activities, including attending weekly seminars and completing periodic writing assignments. On July 22, 2015, the students presented posters summarizing their research findings. The students had opportunities to engage in engineering research, interact with faculty and other students from across the country, and develop essential skills for success in graduate school.

Table 3 Students Involved in CHPP-related Research

Student Name	Level	Hosting Institutions	Advisor
Haibin Yu	Undergraduate	Michigan State University	Syed W. Haider
Sebastián Muñiz	Undergraduate	Michigan State University	Syed W. Haider
Derek Hibner	Undergraduate	Michigan State University	M. Emin Kutay
Sahira Melo	Undergraduate	Michigan State University	Nizar Lajnef
John Gondek	Undergraduate	Michigan State University	Syed W. Haider
Asha Patel	Undergraduate	Michigan State University	K. Chatti, R. Dargazany & Shabnam Rajaei
Lance Rothlanc	Undergraduate	Michigan State University	K. Chatti, R. Dargazany & Shabnam Rajaei
Miguel Labrador	Undergraduate	Michigan State University	K. Chatti, R. Dargazany & Shabnam Rajaei
Briana Wendland	Undergraduate	Michigan State University	K. Chatti, R. Dargazany & Shabnam Rajaei
Ronell Joseph Eisma	M.S	Michigan State University	Karim Chatti, Syed Haider & Imen Zaabar
Ugurcan Ozdemir	M.S.	Michigan State University	M. Emin Kutay
Saeed Yadolahi	M.S.	Michigan State University	Nizar Lajnef
Nagesh Ananthakrishna	M.S.	Michigan State University	Nizar Lajnef
Shabnam Rajaei	Ph.D.	Michigan State University	Karim Chatti & Roozbeh Dargazany
Amir Alavi	Ph.D.	Michigan State University	Nizar Lajnef & Karim Chatti
Hassene Hasni	Ph.D.	Michigan State University	Nizar Lajnef & Karim Chatti
Bonni Saust	Undergraduate	University of Hawaii at Manoa	Adrian Ricardo Archilla
Jose Corrales Azofeifa	Ph.D.	University of Hawaii at Manoa	Adrian Ricardo Archilla
Mohammadreza Hashemi	Ph.D.	University of Hawaii at Manoa	Adrian Ricardo Archilla
Ryan Yeargin	Undergraduate	North Carolina A&T State University	Ellie Finie
Ahmed Lamarre	M.S.	North Carolina A&T State University	Ellie Finie
Yillian Rivera	M.S.	North Carolina A&T State University	Ellie Finie
Felix Smith Buabeng	M.S.	North Carolina A&T State University	Sassan Aflaki
Daniel Oldham	M.S.	North Carolina A&T State University	Ellie Finie
Shahrzad Hossein Nezhad	M.S.	North Carolina A&T State University	Ellie Finie
Grant Gorman	Undergraduate	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Michael Blake	Undergraduate	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Andres Sanchez	Undergraduate	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Kuan-Yu Chen	M.S.	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Franco Di Biase	M.S.	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Pedro Serigos	Ph.D.	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Prasad Buddhavarapu	Ph.D.	University of Texas at Austin	Jorge Prozzi & Maria Juenger
Heena Dhasmana	Ph.D.	University of Illinois at Urbana-Champaign	Imad L. Al-Qadi
Ibrahim Abuawad	Ph.D.	University of Illinois at Urbana-Champaign	Imad L. Al-Qadi
Punit Singhwi	M.S.	University of Illinois at Urbana-Champaign	Imad L. Al-Qadi & Hasan Ozer
John Kulikowski	M.S.	University of Illinois at Urbana-Champaign	Imad L. Al-Qadi & Hasan Ozer
Daniel King	M.S.	University of Illinois at Urbana-Champaign	Jeffery Roesler
Sushobhan Sen	M.S.	University of Illinois at Urbana-Champaign	Jeffery Roesler
Ryan Coway	Undergraduate	University of Minnesota	Lev Khazanovich
Thomas Pankau	Undergraduate	University of Minnesota	Lev Khazanovich
Suraj Shah	Undergraduate	University of Minnesota	Lev Khazanovich
Katelyn Freeseman	M.S.	University of Minnesota	Lev Khazanovich
Abbas Booshehrian	M.S.	University of Minnesota	Lev Khazanovich

3. CHPP Student Symposium – July 22, 2015.

Program Description:

An undergraduate/graduate student symposium was held at Michigan State University on July 22, 2015, with participation of students from MSU, UIUC, UT-Austin, U. of Minnesota, NC A&TSU, and UH at Manoa

(consortium partners). The symposium was a full day event. Each student had a poster and a podium presentation for the CHPP related research projects. The event included seventeen presentations (17). The symposium was an important activity for the students from the consortium partners to interact and exchange pavement preservation knowledge.

Professional Development Activities, Conferences, and Workshops

1. **Pavement Sustainability through Pavement Preservation Workshop at the ASCE T&I Conference – June 7, 2015**

   Program Description:
   A half-day workshop was conducted on June 7, 2015 during the ASCE T&DI conference in Miami, Florida. About forty (40) professionals participated in the event. The workshop provided an overview of recent research and implementation examples on the application of pavement preservation techniques to enhance the pavement sustainability.

   The workshop covered the following topics:

   - Introduction to pavement preservation
   - Preservation techniques for asphalt pavements
   - Construction and inspection of seal coats in texas
   - Preservation with and for concrete pavements
   - Performance-related specifications for pavement preservation treatments
   - Life cycle cost analysis and life cycle assessment for pavement preservation

   The workshop combined well established best practices as well as some recent research findings. The instructors of the workshop were:

   - Imad Al-Qadi, University of Illinois at Urbana-Champaign
   - Jorge Prozzi, University of Texas at Austin
   - Karim Chatti, Michigan State University
   - Jeffery Roesler, University of Illinois at Urbana-Champaign
   - Hasan Ozer, University of Illinois at Urbana-Champaign
   - John Harvey, University of California, Davis

2. **Transportation and Pavement Preservation Seminars and Meetings at the National Level**

   Program Description:
   Through the National Center for Pavement Preservation (NCPP), some twenty transportation infrastructure preservation-focused seminars, symposia and distance-learning short courses have reached more than a thousand professionals. The CHPP is currently planning in conjunction with NCPP to organize technical sessions highlighting some of the research findings from CHPP projects in the upcoming National Pavement Preservation Conference to be held in Nashville, Tennessee, October 9-13, 2016.

Results Dissemination and Methods

All CHPP activities are in the implementation or planning phase for the next performance period. Electronic distribution, social media, and professional meetings have been the primary means for dissemination. PowerPoint presentations have also been given. The CHPP member universities also supported student and faculty travel to academic and professional meetings to promote and discuss the goals, objectives and research themes of the Center. Table 4 lists CHPP attendees of professional development opportunities pursued by staff and faculty over the reporting period.

CHPP has connected with 3 newspapers, and 2 TVs located at two of the six partner institutions (MSU and UH at Manoa). Also, CHPP was featured in the August 2015 issue of the USDOT UTC Spotlight Newsletter. The goal is to develop a product that easily translates into a story for media personnel to quickly and effectively report the activities in which CHPP is engaged, such that CHPP and US DOT OST-R are visible and accurately represented to the public.

During the reporting period, CHPP began distributing its online newsletter. Two issues were distributed to all center directors, academia, and state DOTs and featured stories highlighting the research projects, the K-12 and professional development activities at each of the CHPP partner universities. These newsletter stories can be accessed on the CHPP website.

Table 4 List of Professional and Academic Meeting Attendees

Name	Destination	Conference Name	Dates	University
Karim Chatti	Rutgers University	CUTC Summer Conference	June 2-5, 2015	Michigan State University
Neal Galehouse	Rutgers University	CUTC Summer Conference	June 2-5, 2015	Michigan State University
Karim Chatti	Miami, Florida	ASCE T&DI	June 7-10, 2015	Michigan State University
Karim Chatti	Djerba, Tunisia	NATEG Days	July 24-25, 2015	Michigan State University
Syed W. Haider	Miami, Florida	ASCE T&DI	June 7-10, 2015	Michigan State University
Jorge Prozzi	Miami, Florida	ASCE T&DI	June 7-10, 2015	University of Texas at Austin
Hasan Ozer	Miami, Florida	ASCE T&DI	June 7-10, 2015	University of Illinois at Urbana-Champaign
Imad Al-Qadi	Miami, Florida	ASCE T&DI	June 7-10, 2015	University of Illinois at Urbana-Champaign
Jeffery Roesler	Miami, Florida	ASCE T&DI	June 7-10, 2015	University of Illinois at Urbana-Champaign
Jeffery Roesler	IDOT District 1 office, Schaumburg, IL	ISCP Concrete Pavement Technology Transfer Workshop	June 25, 2015	University of Illinois at Urbana-Champaign
Lev Khazanovich	IDOT District 1 office, Schaumburg, IL	ISCP Concrete Pavement Technology Transfer Workshop	June 25, 2015	University of Minnesota
Lev Khazanovich	Taiyuan, China	4th International Concrete Pavement Workshop	August 13-14, 2015	University of Minnesota
Lev Khazanovich	Minneapolis, Minnesota	42nd Annual Review of Progress in Quantitative Nondestructive Evaluation Conference	July 26–31, 2015	University of Minnesota
Katelyn Freeseman	Minneapolis, Minnesota	42nd Annual Review of Progress in Quantitative Nondestructive Evaluation Conference	July 26–31, 2015	University of Minnesota

On May 21, 2015, Lev Khazanovich, who is one of the center faculties, was invited to present at University of Palermo, Italy. The presentation was entitled "Quantitative Ultrasonic Array Evaluation of Concrete Structures". He was also invited to a one day training course on conventional and roller compacted concrete pavements at Riga Technical University, Riga, Latvia, in May 26, 2015.

On April 30, 2015, Karim Chatti, the center director, was invited by the University of Illinois at Urbana Champaign to give a lecture, as part of the UIUC Kent Seminar Series, on preservation practices, challenges and needs. He also presented the research activities of the center. The presentation was entitled "Towards A More Mechanistic Approach To Pavement Preservation". He was also invited to present at The University of Pisa, Italy on July 13, 2015. The presentation was entitled "Pavement preservation with a twist: A look at some innovative research being conducted at MSU-CHPP".

Planned Activities for Next Reporting Period

There will be no change in the agency-approved application for this effort. Implementation of the activities in Table 1 above for all research, education, workforce development, and technology transfer projects will continue on schedule. A brief summary of new activities planned for next reporting period is provided below.

K-12 Outreach

1. **Preview Day Showcase of Highway Pavement Preservation-related Research in Civil Engineering – October 10, 2015.**

   Program Description:
   This one day event will be planned with different activities and sessions for various age groups. Hands-on displays and demonstrations will aim at educating prospective high school students. The event will feature special displays, designed and built to facilitate the communication of basic concepts related to pavement materials, structures, and sensor technology.

2. **MSU Middle and High School Design Day at Michigan State University - December 5, 2015**

   Program Description
   The focus of the event is to involve students and teachers in hands-on and experiential engineering education. The participants will be introduced to innovative, challenging and inspiring engineering designs and projects. The students and teachers will work on projects such as:

   - Building a sample of asphalt pavement cross-section using crumb rubber,
   - Measure the surface texture depth of the samples using laser scanners, and
   - Measure the surface friction of the samples using the British Pendulum.

3. **Summer Internship Program for High School Students**

   Program Description
   CHPP consortium partners will host high school students in a highly competitive six-week program that allows high school juniors (heading into their senior year) to take a hands-on approach by working in College of Engineering research laboratories.

4. **Research Experiences for Teachers (RET)**

   Program Description:
   The program will recruit teachers from schools in Mid- and Southeast regions in the State of Michigan, especially with a focus on those serving socioeconomically challenged populations and students from groups traditionally under-represented in science and engineering. Teachers will attend a 6-week summer institute, to participate in cutting-edge research on transportation-related areas, with mentoring from engineering faculty at CHPP. Working with PIs, faculty mentors and a curriculum development specialist, teachers will develop innovative, standards-compliant curriculum modules and participate in a number of professional development activities. This activity is expected to enrich the professional development of a number of future leaders in STEM education, about half being females with a similar ratio for minorities. It will also result in an innovative curriculum for science and technology courses, and pique the interest of middle and high school students in scientific inquiry, specifically transportation. Through the partnership with schools in Lansing, Detroit, and Grand Rapids, and in cooperation with the all-girls Regina High School, the proposed activity will positively influence the learning and career paths of young students, especially students from under-served districts and under-represented groups in Michigan and beyond for years to come, thus contributing to a technology-savvy workforce that is much needed in the U.S.

Undergraduate / Graduate Outreach

1. **Transportation Safety Seminar at MSU – October 2, 2015**

Program Description
CHPP in collaboration with ITE will invite a guest speaker for a seminar on road safety at Michigan State University on October 2, 2015 entailed "Forgiving Highways". This seminar focuses on methods to identify and treat dangerous roadside hazards. Mike Dreznes, Executive Vice President of the International Road Federation (IRF) has made presentations on the concept of "Forgiving Highways" in over forty countries around the world. Dreznes uses the presentation to explain the significance of the AASHTO Roadside Design Guide and NCHRP 350/MASH. He emphasizes the need for highway engineers to act responsibly and to understand today's technology in order to use products correctly to make highways safer around the world and to meet the challenge of the United Nations Decade of Action for Road Safety.

2. **CUTC Outstanding Student of the Year Award – January 9, 2016**

Program Description
For the past 24 years, the USDOT has honored an outstanding student from each UTC at a special ceremony held during the TRB Annual Meeting. The ceremony is scheduled to take place as part of the CUTC annual banquet on Saturday, January 9, 2016. Each student awardee receives $1,000 plus the travel cost to the 95th Annual TRB Meeting from his/her Center. CHPP will nominate an outstanding student for this activity.

3. **Summer Research for Undergraduates and Under-represented Students**

Program Description:
CHPP offers summer research opportunities for high-achieving undergraduates. The objective of this multi-disciplinary program is to attract young talent to increase the quality, number, and diversity of professionals entering the transportation sector. The program will offer the selected undergraduate students the opportunity to gain firsthand experience in conducting highway and transportation research and actively participate in transportation related studies under the supervision of CHPP faculty members.

Professional Development Activities, Conferences, and Workshops

1. **ASCE webinar series on pavement preservation**

Program Description:
The research team is currently planning in conjunction with ASCE Highway Pavement Committee to submit a proposal for a webinar series on pavement preservation to ASCE. The webinars will provide an overview of recent research findings and implementation examples on the application of pavement preservation techniques to enhance the pavement sustainability. It will also highlight some of the research findings from CHPP projects.

2. **Technical session at the upcoming 2016 National Pavement Preservation Conference- October 9-13**

Program Description:
The research team is currently planning in conjunction with NCPP to organize technical sessions highlighting some of the research findings from CHPP projects in the upcoming National Pavement Preservation Conference to be held in Nashville, Tennessee, October 9-13, 2016.

Results Dissemination and Methods

Electronic distribution and social media has primarily been utilized for dissemination of CHPP activities. PowerPoint presentations will also be given. The CHPP member universities will support students and faculty travel to professional

meetings, which attract transportation professionals from across the country to promote and discuss the goals, objectives and research themes of the Center. Table 5 lists CHPP attendees of the upcoming professional development opportunities planned by staff and faculty during the next reporting period.

Table 5 List of Planned Professional and Academic Meeting Attendees

Name	Destination	Conference Name	Dates	University
Karim Chatti	Washington D.C.	TRB	January 10-14, 2016	Michigan State University
Karim Chatti	Washington D.C.	CUTC Annual Meeting and Awards Banquet	January 9-10, 2016	Michigan State University
Syed W. Haider	Washington D.C.	TRB	January 10-14, 2016	Michigan State University
Imen Zaabar	Washington D.C.	TRB	January 10-14, 2016	Michigan State University
Imen Zaabar	Washington D.C.	CUTC Annual Meeting and Awards Banquet	January 9-10, 2016	Michigan State University
M. Emin Kutay	Washington D.C.	TRB	January 10-14, 2016	Michigan State University
Larry Galehouse	Washington D.C.	TRB	January 10-14, 2016	Michigan State University
Neal Galehouse	Washington D.C.	TRB	January 10-14, 2016	Michigan State University
Neal Galehouse	Washington D.C.	CUTC Annual Meeting and Awards Banquet	January 9-10, 2016	Michigan State University
Patte Hahn	Washington D.C.	TRB	January 10-14, 2016	Michigan State University
Ronell Joseph Eisma	Washington D.C.	TRB	January 10-14, 2016	Michigan State University
Jorge Prozzi	Washington D.C.	TRB	January 10-14, 2016	University of Texas at Austin
Ellie Finie	Washington D.C.	TRB	January 10-14, 2016	North Carolina A&T
Sassan Aflaki	Washington D.C.	TRB	January 10-14, 2016	North Carolina A&T
Ahmed Lamarre	Washington D.C.	TRB	January 10-14, 2016	North Carolina A&T
Ryan Yeargin	Washington D.C.	TRB	January 10-14, 2016	North Carolina A&T
Yillian Rivera	Washington D.C.	TRB	January 10-14, 2016	North Carolina A&T
Daniel Oldham	Washington D.C.	TRB	January 10-14, 2016	North Carolina A&T
Adrian Ricardo Archilla	Washington D.C.	TRB	January 10-14, 2016	University of Hawaii at Manoa
Hasan Ozer	Washington D.C.	TRB	January 10-14, 2016	UIUC
Imad Al-Qadi	Washington D.C.	TRB	January 10-14, 2016	UIUC
Heena Dhasmana	Washington D.C.	TRB	January 10-14, 2016	UIUC
Jeffery Roesler	Washington D.C.	TRB	January 10-14, 2016	UIUC
Daniel King	Washington D.C.	TRB	January 10-14, 2016	UIUC
Sushobhan Sen	Washington D.C.	TRB	January 10-14, 2016	UIUC
Lev Khazanovich	Washington D.C.	TRB	January 10-14, 2016	University of Minnesota
Katelyn Freeseman	Washington D.C.	TRB	January 10-14, 2016	University of Minnesota
Abbas Booshehrian	Washington D.C.	TRB	January 10-14, 2016	University of Minnesota

2. Products

Publications, Conference Papers, and Presentations

During this reporting period, CHPP researchers prepared and produced several conference and journal papers based on the research being conducted as part of the center. In addition, to disseminate the research findings, presentations were also made at various appropriate venues and meetings. The following is the list of publications and presentations related to different CHPP research projects.

1. Impact of Site Factors on the Effectiveness of Flexible Pavement Preservation Treatments, Syed W. Haider, Ronell J. Eisma, Karim Chatti, Gilchrist Ireland, and Nicholas McDonald, paper accepted for presentation and publication at the Airfield & Highway Pavement Conference, June 7-10, Miami, 2015.
2. Impact of Diamond Grinding on Rigid Pavement Performance, Syed W. Haider, Karim Chatti, Ronell J. Eisma, Imen Zaabar, and Tyler Frederick, paper accepted for presentation and publication at the Airfield & Highway Pavement Conference, June 7-10, Miami, 2015.

3. Structural and Environmental Benefits of Concrete Inlays for Pavement Preservation, Sushobhan Sen, Daniel King and Jeff Roesler, paper accepted for presentation and publication at the ASCE T&DI International Airfield & Highway Pavements Conference, Miami, FL, June 7-10, 2015.
4. Invited presentation: Performance Characterization of Hot In-Place Recycled Mixtures, Imad Al-Qadi and Hasan Ozer, ASCE T&DI Pavement Specialty Conference in June 2015, Miami, FL.
5. Structural and Environmental Benefits of Concrete Inlays for Pavement Preservation. Sushobhan Sen, Daniel King and Jeffery Roesler. Airfield and Highway Pavements 2015, pp. 697-707, doi: 10.1061/9780784479216.062
6. Seminar Presentation: Quantitative Ultrasonic Array Evaluation of Concrete Structures, L. Khazanovich, University of Palermo, Italy, May 21, 2015.
7. One day training course on conventional and roller compacted concrete pavements, L. Khazanovich, Riga Technical University, Riga, Latvia, May 26, 2015,
8. Presentation: Composite, or Thermally Insulated Concrete Pavements, L. Khazanovich, ISCP Concrete Pavement Technology Transfer Workshop, June 25, 2015.
9. Extended Synthetic Aperture Focusing Technique for Ultrasonic Imaging of Concrete, Hoegh, K. and L. Khazanovich, accepted for publication in NDT & E International.
10. Performance-Related Specifications for Pavement Preservation Treatments, Karim Chatti. Workshop on Sustainability Through Pavement Preservation, ASCE T&DI Airfield & Highway Pavement Conference, Miami, June 7-10, 2015.
11. Preservation for and with concrete pavements, Jeffery Roesler. Workshop on Pavement Preservation, ASCE T&DI International Airfield & Highway Pavements Conference, Miami, FL, June 7-10, 2015.
12. Introduction to Pavement Preservation, Imad L. Al-Qadi. Workshop on Pavement Preservation, ASCE T&DI International Airfield & Highway Pavements Conference, Miami, FL, June 7-10, 2015.
13. Construction and Inspection of Seal Coats in Texas, Jorge A. Prozzi. Workshop on Pavement Preservation, ASCE T&DI International Airfield & Highway Pavements Conference, Miami, FL, June 7-10, 2015.
14. Preservation Techniques for Asphalt Pavements, Hasan Ozer. Workshop on Pavement Preservation, ASCE T&DI International Airfield & Highway Pavements Conference, Miami, FL, June 7-10, 2015.
15. Life Cycle Cost Analysis and Life Cycle Assessment for Pavement Preservation, John Harvey. Workshop on Pavement Preservation, ASCE T&DI International Airfield & Highway Pavements Conference, Miami, FL, June 7-10, 2015.
16. Towards A More Mechanistic Approach To Pavement Preservation, Karim Chatti, Invited Lecture, The Kent Seminar Series, University of Illinois at Urbana-Champaign, April 30, 2015.
17. Overview of Research Projects at the UTC Center for Highway Pavement Preservation, Invited presentation for the TRB Committee AHD18 on Pavement Preservation, Karim Chatti, 93rd Transportation Research Board Conference, January 10-15 2015, Washington DC.
18. Towards a More Sustainable Approach to Road Infrastructure Preservation, Karim Chatti, NATEG Days 2015, July 24-25, 2015, Djerba, Tunisia.
19. Pavement preservation with a twist: A look at some innovative research being conducted at MSU-CHPP, Karim Chatti, Invited Lecture, The University of Pisa, Italy, July 13, 2015.

Website or Other Internet Site

The CHPP's website can be accessed at www.chpp.egr.msu.edu. By understanding and capitalizing upon the knowledge acquired over the past two years, we are able to make our homepage engaging, relevant, and resourceful for our viewers by posting courses, presentations and reports in the website.

Technologies or Techniques

All current research and workforce development activities are being implemented.

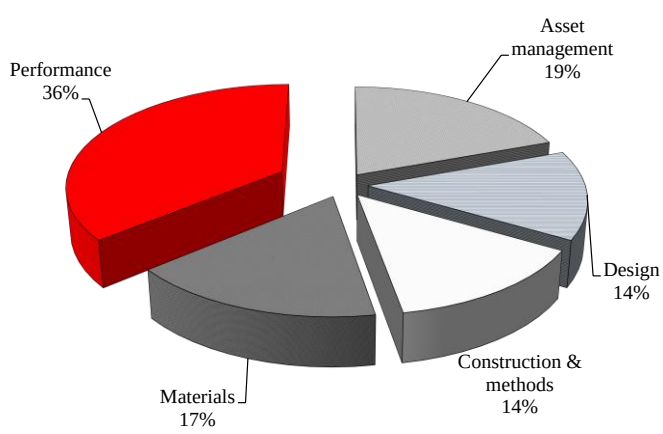
Inventions, Patent Applications, and / or Licenses

All current research and workforce development activities are being implemented.

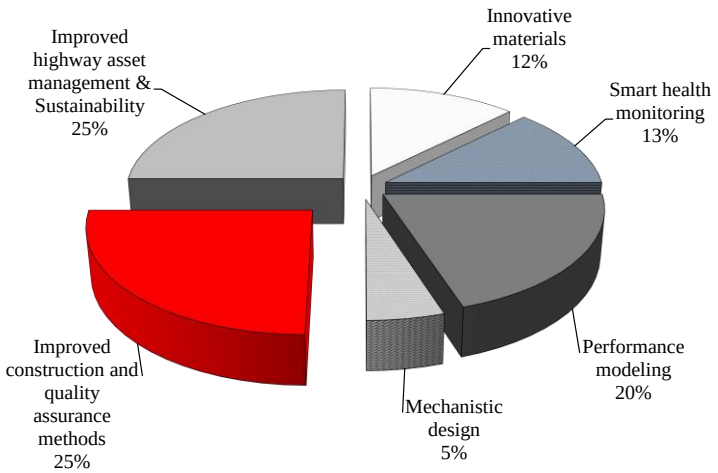
Other Products

Research Projects

As mentioned in the previous reporting period, a total of thirteen (13) research ideas were selected in cycles 1 and 2 based on the inputs from the advisory board (members from the various state highway agencies, the Illinois toll way authority and the city-county of Honolulu and FP[2]). Subsequently, detailed proposals were submitted by the principal investigators (PIs) documenting the detailed scope of work, research plan, and funding needs (budget). However, some of these projects are being considered for cycle 3. During the project identification and selection process, emphasis was given to a balanced portfolio for the research topics. Additional six (6) research projects are being considered for cycle 3. Figure 1 shows the distribution of the nineteen (19) research topics by the AASHTO Pavement Preservation Roadmap categories and CHPP research themes. It can be seen from the figure that the areas of research are well distributed among various Roadmap categories and CHPP research themes. While some of the topics address more fundamental research, the research findings will be useful in solving pavement preservation challenges in the long-term. On the other hand, some of the research studies involve more practical research to fill in the short-term knowledge gaps.



(a) Roadmap research categories



(b) CHPP research themes

Figure 1 Research Portfolio

Table 6 shows the progress of the active research projects till the end of the reporting period. The split between advanced and applied research projects is about 50% (advanced=7, applied=6). While the center will be focusing on some of the innovative and cutting-edge research topics to address the emerging questions regarding pavement preservation, it will

also address some of the knowledge gaps in the current preservation practices. The progress and expected research findings from some of the active projects were highlighted in the center's newsletters. It should be noted that the additional projects for cycle 3 are under review or the contract is in process with the US Department of Transportation.

Table 6 CHPP Research Projects and Assignments

No.	University	Project Title	PI/Assignment	Research Category	Progress
1	MSU	Feasibility of Early Damage Detection Using Surface Mounted Sensors on Existing Pavements	Lajnef/Chatti (MSU)	Advanced	56%
2	MSU	Pavement Surface Characterization for Optimization of Trade-off between Grip and Rolling Resistance	Dargazany/Chatti (MSU)	Advanced	56%
3	TSP2	Development of an Acceptance Test for Chip Seal Projects	Kutay (MSU)	Applied	50%
4	UIUC	Environmental and Functional Benefits and Trade-offs of Hot In-Place Recycling Treatment Techniques	Al-Qadi (UIUC)	Applied	56%
5	UIUC	Mechanistic Characterization of Thin Asphalt Overlays for Pavement Preservation using Finite Element Modelling Approach	Al-Qadi (UIUC)	Advanced	56%
6	UIUC	Multi-Functional Concrete Pavement Inlays	Roesler (UIUC)	Advanced	56%
7	UTA	Designing Quieter Pavement Surfaces	Prozzi (UTA)	Applied	83%
8	UTA	Determination of Field Performance of Thin Overlays Relative to Alternative Preservation Techniques	Prozzi (UTA)	Applied	47%
9	UTA	Evaluation of Pavement Surface Micro- and Macro-Texture	Prozzi (UTA)	Advanced	56%
10	UTA	Quantification of Surface Micro- and Macro-Texture	Prozzi (UTA)	Applied	62%
11	UMn	Development of Objective Methods for Determining Damage Accumulation in Pavements Prior to Visual Distress Becoming Apparent	Khazanovich (UMn)	Advanced	56%
12	NCA&T	Developing a Test Method to Investigate Water Susceptibility of Joint and Crack Sealants	Fini (NCA&T)	Advanced	56%
13	UH	Performance Monitoring of Preservation Treatments in Honolulu	Archilla (UH)	Applied	56%

3. Participants and Collaborating Organizations

Partner Organizations

During the current reporting period, CHPP has worked with unique organizations across the United States to develop the research, education, workforce development, and technology transfer activities that are currently underway at the center. The organizations and their locations are listed in Table 7 along with information describing specific areas or capacities in which the respective organizations have committed to support the center.

Collaboration among University Partners

CHPP offered summer research opportunities for high achieving undergraduates. The intent of this program is to encourage students from all consortium partners (MSU, UT-Austin, UIUC, NCA&TSU, and UH) to: (a) pursue graduate degrees; (b) provide an early opportunity to involve in research activities. The undergraduate and graduate students are encouraged to apply for summer internships at any university from the consortium.

Dr. Chatti was invited by the University of Illinois at Urbana Champaign to give a lecture on April 30, 2015, as part of the UIUC Kent seminar series, on preservation practices, challenges and needs. He also presented an overview of the center's research activities.

Table 7 Organizations Involved in CHPP Activities

CHPP Program	Organization Name	City	State	Financial Support	In-Kind Support	Contribute Facilities	Collaborative Research	Personal Exchange
Research	Steve Bower	Michigan DOT	MI	X	X			X
Research	Jim Moulthrop	FP2	TX		X			X
Research	Judith Corley-Lay	North Carolina DOT	NC		X			X
Research	Maureen Jensen	Minnesota DOT	MN		X			X
Research	Magdy Mikhail	Texas DOT	TX		X			X
Research	Cyndy Aylett	City and County of Honolulu	HI		X			X
Research	Alicia Pitlik	Illinois Toll way	IL		X			X
K-12	Leyf Pierce	TeachEngineering.org	VA				X	X
K-12	Okemos High School	Okemos	MI		X	X		X
K-12	MacDonald Middle school	East Lansing	MI		X	X		X
K-12	East Lansing High School	East Lansing	MI		X	X		X
K-12	Haslett High School	Haslett	MI		X	X		X
K-12	Regina High School	Warren	MI		X	X		X
K-12	Union High School	Grand Rapids	MI		X	X		X
K-12	Kaimuki High School	Honolulu	HI		X	X		X
K-12	Wilson Elementary School	Honolulu	HI		X	X		X
K-12	Stevenson Middle School	Honolulu	HI		X	X		X
K-12	Chiefess Kamakahelei Middle School	Honolulu	HI		X	X		X
K-12	Halau Ku Mana School	Honolulu	HI		X	X		X
Tech Transfer	National Center for Pavement Preservation	Okemos	MI		X	X	X	X
Summer program	Michigan State University	East Lansing	MI	X	X			
Summer program	University of Hawaii at Manoa	Manoa	HI	X	X			
K-12	North Carolina A&T		NC	X	X			
Tech Transfer	North Carolina DOT		NC		X	X		X
Education	Michael Dreznes, International Road Federation (IRF)	Washington DC	DC		X		X	X
Education	MSU student chapter of the Institute of Transportation Engineers (ITE)	East Lansing	MI		X		X	X

Six center faculty members collaborated in a half-day workshop conducted during the ASCE T&DI conference in Miami, Florida on June 7, 2015. About forty (40) professionals and practitioners participated in the event. The workshop provided an overview of research activities and implementation examples on the application of pavement preservation techniques to enhance the pavement sustainability. The workshop combined well established best practices as well as some recent research findings.

An undergraduate/graduate student symposium was held at Michigan State University on July 22, 2015, and included students from the CHPP university consortium members. The symposium was a full day event. Each student had a poster and a podium presentation for the CHPP related research projects. The symposium is an important activity for the students from the consortium partners to interact and exchange pavement preservation knowledge.

External Collaborations

On May 21, 2015, Dr. Lev Khazanovich from University of Minnesota (UMN) gave a keynote presentation entitled "Quantitative Ultrasonic Array Evaluation of Concrete Structures" at the University of Palermo, Italy. He was also invited

to a one day training course on conventional and roller compacted concrete pavements at Riga Technical University, Riga, Latvia, in May 26, 2015.

On July 13, 2015, Dr. Karim Chatti gave a keynote presentation at The University of Pisa, Italy entitled "Pavement preservation with a twist: A look at some innovative research being conducted at MSU-CHPP".

The center also collaborated with the University of California at Davis to organize the half-day workshop conducted on June 7, 2015 during the ASCE T&DI conference in Miami, Florida. Dr. John Harvey presented a lecture entitled "Life Cycle Cost Analysis and Life Cycle Assessment for Pavement Preservation". Michigan State University (MSU) is also collaborating with University of California at Davis (UC Davis) to investigate the effect of pavement structure and rolling resistance on fuel consumption. Rolling resistance between tires and pavement surface is one of the most significant factors in transportation industry since it accounts for 5 to 7% of the total fuel consumption. Therefore, there is a substantial economic and environmental interest to reduce the rolling resistance. If findings are promising, this could transform the pavement friction design and ultimately improve the sustainability of pavements which directly leads to environmental and economic benefits. The results from the collaboration can strongly assist highway engineers in (i) analyzing the trade-off between pavement grip and rolling resistance, (ii) instituting pavement design processes for different traffic conditions, and (iii) ranking and rating of current road surfaces including pavement preservation treatments.

4. Impact

Development of Principal Discipline(s)

Activities conducted during the current reporting period are expected to have the short- and long-term impacts on the transportation engineering discipline through better understanding of pavement preservation benefits. The results from a number of research projects are being incorporated into short courses for the public and students that will shape future knowledge of specific transportation- related technologies.

Other disciplines

Three (3) of the center research projects involve other disciplines: (1) Feasibility of early damage detection using surface mounted sensors on existing pavements, (2) Development of objective methods for determining damage accumulation in pavements prior to visual distress becoming apparent, and (3) Pavement surface characterization for optimization of trade-off between grip and rolling resistance. The first two research topics are investigating the early damage detection in concrete and asphalt pavements. This effort involves experts from electrical engineering to evaluate the abilities of nondestructive testing and structural health monitoring. The third project is looking for an optimal method to characterize the pavement surface properties that yield the least rolling resistance without sacrificing grip and safety. In order to achieve these objectives the surface profile of the pavement will be represented as a spectrum of spatial frequencies using the fractal surfaces technique. If findings are promising, this could lead to new pavement preservation treatment mix design specifications that will contribute to a better balance between safety and sustainability. This effort involves experts from electrical engineering and material science to understand the behavior of tires in multi-scales.

Development of Human Resources

Some highway agencies still continue to assign their highest priorities to reconstructing or rehabilitating their worst roads. However, this practice of "worst first" is a proven death spiral strategy because reconstruction and rehabilitation are the most expensive ways to maintain or restore serviceability of the infrastructure. Furthermore, rarely are sufficient funding levels available to sustain such a wasteful strategy. The mission of CHPP focuses on providing a new platform for accelerating innovations in highway pavement preservation area. The center will assist in meeting the increasing demand for highway pavement preservation research and practice, and will further assist industry and highway agencies in

increasing the reliability and performance of the nation's highways. Clearly, adequate and trained human resources will remain a continuing challenge in meeting future transportation needs. Therefore, encouraging the best and brightest to pursue degrees in transportation-related engineering disciplines is a big priority for CHPP. Such actions are exemplified by the Center's emphasis on students' research and pre-professional involvements. The effort is thus focused on showcasing the challenges, opportunities, and, most importantly, the rewards of pursuing a college degree in a transportation-related area. Existing efforts such as the CHPP summer research program for undergraduates/graduates students, and the education and training at the undergraduate and graduate levels program, are designed to extend opportunities while enhancing interests and skills. Moreover, it is anticipated that K-12 students participating in our outreach programs will benefit significantly. The interdisciplinary lessons and activities surrounding these programs enhance students' conceptual and practical skills related to math, science, and technology. Also, The Research Experience for Teachers (RET) program described above is expected to enrich the professional development of a number of future leaders in STEM education, about half being females with a similar ratio for minorities. It will also result in innovative curricula for science and technology courses, and increase the interest of middle and high school students in scientific inquiry, specifically related to transportation areas. Through partnerships with local schools, the program will positively influence the learning and career paths of young students, especially students from under-served districts and under-represented groups in Michigan and beyond for years to come, thus contributing to a technology-savvy workforce that is much needed for keeping the U.S. infrastructure sustainable and efficient.

Physical, Institutional, and Information Resources

Nothing to report.

Technology Transfer

Various technology transfer activities by the center focused on a wide spectrum of relevant audience. The knowledge of pavement preservation was transferred to young potential work force and current practitioners. It is anticipated that the trained personnel will better understand the benefits and sustainability aspects of pavement preservation and will assist in bringing the gap between preservation practices and implementation of such choices in the field.

Society beyond Science and Technology

The national need to protect the massive national highway infrastructure investment is recognized by Congress and clearly cited in "Moving Ahead for Progress in the 21st Century Act'' or the ''MAP–21". The establishment of CHPP is consistent with the U.S. Secretary of Transportation's strategic goal of "State of Good Repair". The mission of CHPP seeks to provide a new platform for accelerating innovation in highway pavement preservation. The center will assist in meeting the increasing demand for highway pavement preservation research and will further the goal of increasing the reliability and performance of the nation's highways. In addition, the research targeted by CHPP provides an ideal platform to emphasize social and environmental relevance of basic science and engineering subject matter. It is known that minorities and women have a lower representation in the science and engineering programs of universities. Several reasons suggested for this disconnect are lack of knowledge and emphasis on the social value and relevance of science, mathematics and engineering subject matters as well as the lack of multi-disciplinary project teams. The lack of a connection between subject material and life applicability has been shown to affect the retention of women in engineering. The strong societal impact and creation of multi-disciplinary teams will be crucial to attract female and under-represented minorities for the graduate and undergraduate student positions supported by this research. CHPP is reaching out to high school students, females and minorities in particular, mainly through summer camps and open house activities, as described above, and will continue to do so in the future.

5. Changes/Problems

Nothing to Report.