



# C<sup>2</sup>M<sup>2</sup> NEWS



May, 2018

## USDOT CENTER FOR CONNECTED MULTIMODAL MOBILITY

AN INNOVATION CENTER FOR TRANSFORMING MULTIMODAL TRANSPORTATION THROUGH CONNECTIVITY, DATA ANALYTICS, AND AUTOMATION

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Editors: Charlotte Ryggs and Dr. Eric A. Morris

## Letter from the Director

Welcome to the third edition of our USDOT Center for Connected Multimodal Mobility (C<sup>2</sup>M<sup>2</sup>) newsletter. In this quarter, we have kept our momentum moving forward at full speed as we seek to make a lasting impact on the future of transportation. The past few months have been spent focusing on supporting our researchers as they work on their funded projects, offering a two-day training workshop at Tri-County Technical College, inviting several transportation professionals to speak as part of our “Distinguished Speaker Series,” planning exciting future events, and building important relationships within the transportation community. All of these initiatives are moving us towards our goal of making C<sup>2</sup>M<sup>2</sup> a globally recognized innovation center.

In this quarter we have started looking towards our next round of funded research. Currently our Associate Directors and Advisory Board members are collaborating on our next request for proposals, which we expect to send out this spring. Acting under the guidance recently laid out by the US Department of Transportation (USDOT), this upcoming year we will focus on research that aims to impact the current and future practice of transportation, specially seeking proposals that emphasize technology transfers from our activities to transportation agencies, the transportation industry, and our communities. One of our first efforts to meet this new goal is the training workshop that we have developed for technical colleges based on our research on connected and autonomous vehicles (CAVs).



*Dr. Mashrur “Ronnie” Chowdhury*

We have also been fortunate to host several eminent scholars through our Distinguished Speaker Series, giving students from our partner C<sup>2</sup>M<sup>2</sup> institutions access to both transportation scholars and industry professionals. To date we have hosted six speakers from a variety of backgrounds, with another speaker scheduled in the next few weeks. These presentations have given students at all five of our consortium institutions the opportunity to learn about ongoing research from around the country and be exposed to various career options.

This quarter has also seen us meeting with a wide variety of industry professionals to discuss potential collaboration as we look towards moving our research from the lab to the real world. We are excited to work with a wide-ranging group of industry partners to extend the scope and reach of our research. We are developing educational and training modules and CAV applications for transportation professionals. As we look towards the start of the second year of our Center’s existence, we are striving to make a lasting impact on current and future transportation systems.

*- Dr. Mashrur “Ronnie” Chowdhury*

## C<sup>2</sup>M<sup>2</sup> WORKSHOP AND TRAINING FOR TECHNICAL COLLEGES

As part of its Technology Transfer to Technical Colleges Initiative (T<sup>3</sup>CI), on Thursday and Friday, March 29 and 30, 2018, C<sup>2</sup>M<sup>2</sup> hosted a two-day hands-on workshop and training event in Clemson, South Carolina. This program focused on the design and use of software and coding techniques used in the development and implementation of connected and autonomous vehicle (CAV) applications. This inaugural workshop was created by Dr. Mashrur “Ronnie” Chowdhury with support from Clemson students and faculty. Eleven faculty and staff members from the Tri-County Technical College in South Carolina, with diverse backgrounds spanning the electrical, automotive, and computer science disciplines, participated.



*Dr. Mashrur “Ronnie” Chowdhury presenting to Tri-County Technical College representatives*



The purpose of this workshop and training program was twofold. First, we aimed to create a fundamental knowledge base in CAV software and hardware so that the Tri-County Technical College faculty and staff can transfer this knowledge to their students. Second, and more broadly, our center is creating a series of programs aimed at technical colleges to disseminate our research throughout the country. These programs will help to train the professionals that are needed to build and maintain CAVs and complementary transportation infrastructure. We see a great need for trained engineers and technicians in the coming years as CAVs become the norm; it is our goal to help train these professionals by creating workshops, training programs, and courses to be shared with technical schools and junior colleges around the country. We will use the feedback from the participants at our inaugural workshop and training program to further improve the program before taking it to other technical colleges in South Carolina. We believe that this program, and the partnerships that it will create, will help facilitate the adoption of the future CAV applications our center is developing, and will also aid in recruiting students to the field of transportation, helping to develop a skilled workforce to design, launch, operate, and maintain CAVs and their associated digital transportation infrastructure.



*Dr. John Wagner presenting to Tri-County attendees*



*C<sup>2</sup>M<sup>2</sup> students assisting with coding techniques*



## C<sup>2</sup>M<sup>2</sup> DISTINGUISHED SPEAKER SERIES

One of our cornerstone programs is our “Distinguished Speaker Series.” This series of talks, which we broadcast via webinar to our consortium partners, has given our center the opportunity to impact future transportation professionals. In the past, we have hosted Dr. Essam Radwan, formerly of the University of Central Florida, and Dr. Chris Hendrickson of Carnegie Mellon University and the Traffic21 Institute. This quarter, we hosted Dr. Yan (Joann) Zhou of the Argonne National Laboratory, Dr. Mohan Venigalla of George Mason University, Dr. Chris Gerdes of Stanford University, and Dr. Patricia Mokhtarian of the Georgia Institute of Technology.

Dr. Zhou spoke to students, faculty and staff at Clemson University’s Watt Family Innovation Center on February 23<sup>rd</sup>, 2018. She highlighted her ongoing work entitled “National Inter-City Freight Energy Analysis of Smart Technologies and Mode Shift” and “National Energy Impact of Electrified Shared Mobility with Infrastructure Support.” Dr. Zhou, a Clemson University graduate, also had lunch with C<sup>2</sup>M<sup>2</sup> students and answered questions about her roles as Principal Transportation Systems Analyst at the Argonne National Laboratory and Operations Manager for the US-China Clean Energy Research Center, Clean Vehicle Consortium and Truck Consortium. Her talk was seen remotely by students at our C<sup>2</sup>M<sup>2</sup> partner institutions.



*Dr. Yan (Joann) Zhou presenting at Clemson*



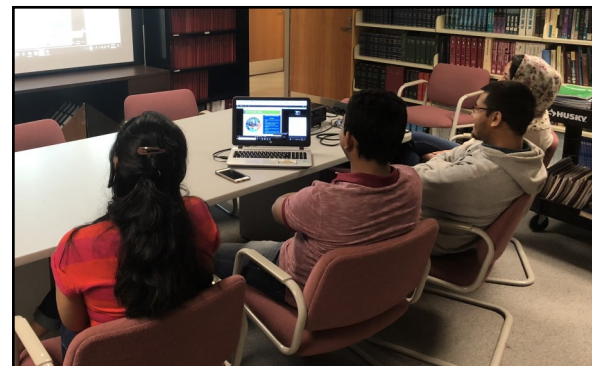
*Dr. Mohan Venigalla speaking at Clemson*



*Dr. Chris Gerdes speaking at Clemson*

On March 15, 2018, C<sup>2</sup>M<sup>2</sup> hosted Dr. Mohan Venigalla of George Mason University. Dr. Venigalla spoke on “Price Discovery in Shared Mobility: Lessons from Capital Bikeshare.” He discussed the relationship between bikeshare pricing and ridership, using the Capital Bikeshare program in Washington D.C. as an example.

Dr. Chris Gerdes, Director of the Center for Automotive Research at Stanford University (CARS), came to Clemson on March 28<sup>th</sup>, 2018. He started his visit with a meeting with C<sup>2</sup>M<sup>2</sup> students to discuss their ongoing research, and then took a tour of the C<sup>2</sup>M<sup>2</sup> Transportation Cyber-Physical Systems Laboratory. After lunch, Dr. Gerdes gave a talk at the Watt Family Innovation Center to an audience made up of faculty, staff, and students. Dr. Gerdes spoke about the work he is doing at CARS, including studying how humans drive cars and building autonomous vehicles. Dr. Gerdes showed several clips of CARS’ autonomous vehicles on the test track, and discussed some of the issues facing autonomous vehicles moving forward. Dr. Gerdes’s talk was co-sponsored by the Clemson University Division of Research. As a result of his visit, one of our C<sup>2</sup>M<sup>2</sup> students, Ms. Katherine Brunk, will be joining Dr. Gerdes in Stanford this summer to collaborate on one of his research projects.



*University of South Carolina students joining remotely*

(Continued from page 3)

Dr. Patricia Mokhtarian from Georgia Tech joined us on April 27th, 2018. Her talk took place at the Watt Family Innovation Center. The title of her talk was “It’s Not All Fun and Games: An Investigation of the Reported Benefits and Disadvantages of Conducting Activities while Commuting.” The talk focused on her research with F. Atiyya Shaw, Aliaksandr Malokin, and Giovanni Circella, which used the results from a rich survey of Northern California commuters on their attitudes towards travel, with a particular focus on the benefits and disadvantages of travel-based multi-tasking. Dr. Mokhtarian’s talk was well attended and facilitated an engaged question-and-answer session. After her talk Dr. Mokhtarian toured C<sup>2</sup>M<sup>2</sup>’s Transportation Cyber-Physical Systems Laboratory.



Dr. Patricia Mokhtarian

## C<sup>2</sup>M<sup>2</sup> SPONSORED PROJECTS UPDATE

As we move into the second quarter of this year, our funded projects from last year’s call for proposals are now in full swing. Our colleagues, both at Clemson and all of our partner institutions, are busy working with researchers, students and industry partners to further the goals of our Center. Below are highlights of some of our ongoing funded research.

### Development of a Tool to Assess the Effectiveness of Intermodal Facility Locations and Designs

Principal Investigator: Nathan Huynh, University of South Carolina (USC)  
Co-Principal Investigator: William Ferrell, Clemson University  
Project Duration: October 2017 – October 2018

Drs. Huynh and Ferrell, and their team are studying freight flows in South Carolina and are creating tools to optimize them. They are meeting weekly with their students to collaborate and share their findings. Currently, they have completed a literature review on intermodal freight terminals and collaborative logistics, and have recently started a review of studies that document the changing nature of freight. They are also quantifying and estimating freight flows in South Carolina using the “Freight Analysis Framework Data Tabulation Tool” (FAF4) database. The majority of their time has been spent developing a model and tool for decision making in the area of goods movement. A preliminary model to identify the optimal locations for freight terminals, as well as another model to determine optimal freight flows when carriers collaborate, have been developed.

### Assessing the Experience of Providers and Users of Transportation Network Company Ridesharing Services

Principal Investigator: Eric Morris, Clemson University  
Co-Principal Investigators: Mashrur Chowdhury, Clemson University; Sakib Khan, Clemson University; Angela Pratt, Clemson University; Judith Mwakalonge, South Carolina State University  
Project Duration: October 2017 – October 2018

The research team is studying the attitudes of drivers and travelers about the shared for-hire mobility services UberPool and Lyft Line. A literature review about these services has been written and revised by Clemson students Ying Zhou and Jay Keaveny. Simultaneously, Dr. Angela Pratt is leading a social media mining study, checking sentiment scores based on the tone of commentary about the services on Twitter, and coding samples of Tweets to extract themes that arise in online commentary. At the same time, Dr. Morris is leading an effort to create surveys focusing on the following groups:

- **Drivers**  
Examines satisfaction with driving for UberPool/Lyft Line, ways the services could be improved for drivers, and driver demographics.
- **Current UberPool and Lyft Line riders**  
Examines how much, and in what circumstances, current users use the services, their satisfaction with the services, factors that promote their use of the services, and their demographics.
- **Former UberPool and Lyft Line riders**  
Examines reasons that people no longer use these services, possible incentives that may get them to use the services again in the future, and their demographics.
- **Uber and Lyft riders who have never used UberPool or Lyft Line**  
Examines reasons people don't use UberPool or Lyft Line, their attitudes towards possible incentives that might persuade them to ride, and their demographics.

Drafts of the surveys have been created and tested on subjects; the surveys are now being revised for wide-spread deployment.

## Infrastructure and Policy Needs for Personal Electric Mobility Devices in the Connected Vehicle World: The Last Mile Solution

Principal Investigator: Judith Mwakalonge, South Carolina State University

Co-Principal Investigators: Mashrur Chowdhury, Clemson University; Jae Dong Hong, South Carolina State University

Project Duration: October 2017 – October 2018

This project studies the potential benefits of, and challenges facing, Personal Electric Mobility Devices (PEMDs). In particular, it seeks to understand how infrastructure might be updated to accommodate PEMDs. The project began with a review of literature done by Dr. Judith Mwakalonge, Dr. Jae Hong, and Ms. Grace Mbiaji. This research provides insight on what constitutes a PEMD and investigate current regulations governing PEMD operation on public roads. Ms. Mbiaji has led the research team in analyzing data from the “National Electronic Injury Surveillance System” (NEISS). Data from 2006 to 2016, queried from the *NEISS Query Builder* website, which is maintained by U.S. Consumer Product Safety Commission, contains information on those injured in accidents involving PEMDs, including age, gender, race, date of injury, diagnosis, injured body part, location of incidence, and narrative of the injury. Results include:

- The study identified 13,306 users injured by PEMDs.
- The year 2006 saw the most injuries (628 cases, or 11% of the total), with slight fluctuations during the following years.
- Two-thirds of PEMD crashes occurred during weekdays.
- The largest number of injuries (36%) occurred during summer months.
- 65% of patients with PEMD-related injuries were male.
- 25% of PEMD injuries affected the head and face.

Currently the team is developing field experiments on PEMDs. These aim to acquire information on:

- Interactions between PEMDs and pedestrians.
- The safety of PEMD usage in urban areas.
- Effects of operating PEMDs in different environmental conditions, such as different locations, different times of the day, and different weather conditions.



## INTRODUCE A GIRL TO ENGINEERING DAY

**Charleston, SC, February 25, 2018**

This year, the Citadel student chapter of the Society of Women Engineers (SWE), the Lowcountry Branch of the SWE, the Girl Scouts of Eastern South Carolina, and the Charleston Office of the Deputy County Administrator of Transportation and Public Works collaborated to plan the “Introduce a Girl to Engineering Day,” a three-hour outreach event designed to excite middle-school-aged females about engineering. More than 100 girl scouts, and 40 student and professional volunteers attended this year’s event. Upon arriving, participants were split into groups of six, with each group being led by at least one college student and one professional mentor. The groups worked with their mentors on three engineering challenges:

1. Building a replica of the Ravenel Bridge (over the Cooper River) in Charleston, SC.
2. Building a wind powered vehicle.
3. Constructing a truss ladder.



*Professional and Student Volunteers*



*Replica of the Ravenel Bridge*

*Photo Credit : Dr. Dimitra Michalaka*

## UPCOMING EVENTS

**AEWG 60 Meeting—Charleston, SC, June 19-20, 2018**

The 60<sup>th</sup> Anniversary of the Acoustic Emission Working Group (AEWG) will be held at the Mills House Wyndham Grand Hotel in Charleston, SC, June 19 – 20, 2018. Acoustics Emissions (AE) is a means by which the health of structural systems may be monitored. The approach takes advantage of the piezoelectric effect, using specialized sensors and data acquisition systems to detect stress waves generated by damage within materials and structural systems. This will be an international gathering of experts, with over forty presentations from scholars and practitioners from around the globe including Japan, China, Germany, the United Kingdom, Poland, and more.

Topics will include:

- Infrastructure and health monitoring.
- Wave propagation of AE source mechanisms.
- Advances in AE instrumentation and sensors.
- Materials research, fracture and fatigue failure mechanisms.

- Diagnostic techniques & procedures.
- Codes and standards development.
- AE theories, methods, validation, and verification.
- AE applications.
- Advances in fundamentals, sensing and signal processing.

Student participants will submit extended abstracts for consideration for the AEWG Student Award.

One focus of AEWG is transportation infrastructure health monitoring through connected mobility. This will be highlighted in a keynote presentation by Lee Floyd, former Chief Bridge Maintenance Engineer with SCDOT. An additional keynote will be delivered by Professor Kanji Ono of the University of California, Los Angeles.

The event will be chaired and hosted by Dr. Paul Ziehl from the Department of Civil and Environmental Engineering at the University of South Carolina. The conference is sponsored by many industrial and academic partners. C<sup>2</sup>M<sup>2</sup> will provide funding that will enable participation by graduate and undergraduate students, as well as support the keynote addresses.

### **AREMA Railway Engineering Education Symposium 2018 – Columbia, SC, June 26-27, 2018**

As is well-known in the railway industry, high rates of retirement in the near future, projected growth in the industry, and renewed interest in passenger rail have resulted in a substantial increase in the industry's need to hire new graduates. However, railway engineering education at the university level is limited, which causes difficulty in attracting students to the railway engineering profession.

To foster the growth of railway engineering education at universities, the American Railway Engineering and Maintenance-of-Way Association (AREMA) is organizing the Railway Engineering and Education Symposium 2018 (REES 2018), to be held June 26-27, 2018 at the University of South Carolina. Dr. Dimitris Rizos is the organizing co-chair. The goal of REES 2018 is to provide engineering professors with railway curriculum materials and a forum for the exchange of effective program content to increase the visibility of the railway industry in the classroom.

REES 2018 will be the 6<sup>th</sup> such event. Past events have hosted a total of 113 professors from 70 different universities. Reactions to these symposia were overwhelmingly positive. Knowledge gained at the REES events has led to new courses in railway engineering and new course content in existing transportation courses, with additional courses and programs in development for future academic years. In addition, the number of AREMA student chapters at universities in the United States and Canada has expanded to twenty-two. Each year, students in these chapters, and others who have been educated by REES's work, have secured dozens of internships and permanent positions in the railroad industry, including employment with railroads, railroad-focused consultants, manufacturers, and government agencies.

REES 2018 promises to have similar success, with a new group of professors attending. The symposium will begin with a day of presentations on implementing railway engineering course materials, education strategies, classroom activities, and lab activities, as well as presentations by invited industry speakers to highlight the exciting challenges and opportunities available to new graduates entering the railway engineering profession. The second day will begin with panel discussions and workshops on current and future research activities, and will conclude with a half-day field visit to railway operations and manufacturing facilities near Columbia.

C<sup>2</sup>M<sup>2</sup> is providing travel support for five new faculty participants.

## 6<sup>th</sup> Annual UTC Conference for the Southeastern Region – Clemson, SC, October 24 – 25, 2018

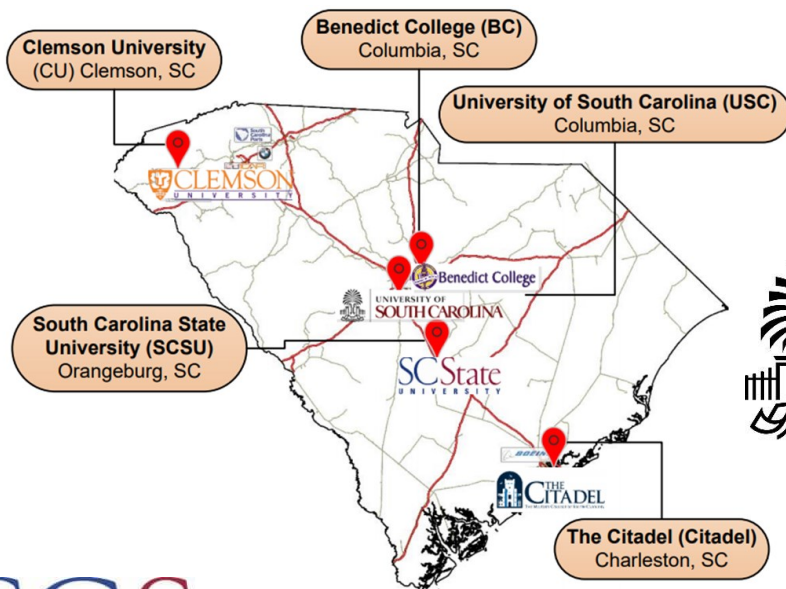
C<sup>2</sup>M<sup>2</sup> is pleased to announce that we will be hosting the upcoming 6<sup>th</sup> Annual University Transportation Center Conference for the Southeastern Region on October 24th -25th, 2018 at Clemson University's Madren Conference Center. This annual conference was established in 2013 by a consortium of UTCs to bring together transportation professionals from both the private and public sectors, faculty, and students from all over the Southeastern region. The goal of the conference is to disseminate information about UTC research and encourage collaboration on future projects. We will feature Caesar Singh, Director of the UTC Grants Program, as our keynote speaker, and will have a wide variety of demonstrations of products developed by UTCs in the region. We anticipate significant participation from academic institutions associated with UTCS, public agencies, and private industry, and in the coming months, we will send out a call for poster and paper presentations to participating UTCs to solicit student participation. We look forward to seeing the innovative work that is being produced by Southeastern UTCs. Keep an eye on our C<sup>2</sup>M<sup>2</sup> website for conference details as they develop.

## See You Soon!

Thanks for following C<sup>2</sup>M<sup>2</sup>'s activities! More on how we are striving to advance the field of transportation will appear in our next newsletter. In the meantime, check our website at <https://cecas.clemson.edu/C2M2/> for new information.



Benedict College



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THE  
CITADEL  
THE MILITARY COLLEGE OF SOUTH CAROLINA