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Learn more at ptvtraffic.us/ITE
president’s message

**Were the Jetsons’ Vehicles Level 5?**

It’s 2062. Meet George Jetson and his wife Jane. Both are holding the controls to their vehicles—and it’s 40 years from now! I figure most rural areas will likely still have drivers “driving” vehicles in 40 years. In the technological world of the future, our ability to visualize the safety benefits of a fully autonomous vehicle network exceeds the world’s transition from driver controls. Does that mean we won’t attain Vision Zero without Level 5? I say NO.

It’s 2020, and we’re more than halfway to the Jetsons. Let me share with you a vision for the next 40 years and how technology can help us zero in on Zero.

As part of transportation reauthorization, we set a five-year goal for all vehicles to be equipped with interlocks that prevents new vehicles from releasing from park without all occupants securing seatbelts and the driver not being under the influence of drugs or alcohol.

Associated with this, we set a 10-year standard that if people unbuckle while driving, or become intoxicated while driving, their vehicle is automatically routed to the nearest safe parking area and stopped until the condition changes to buckled or not under the influence.

If a driver is distracted, autonomous controls become active and connect to surrounding vehicles to avoid collisions. And all vehicles are equipped with V2I (vehicle-to-infrastructure) technology that slows them to 20 miles per hour (32 kilometers per hour) in all official school parking areas and stopped until the condition changes to buckled or not under the influence.

In just these four actions, existing technology applied to new cars could substantially reduce 90 percent of fatalities for several reasons. Seat belt use is nearly 90 percent in the United States, and for the 10 percent who do not use seat belts, they are over-represented in fatalities (nearly 50 percent of annual fatalities involve persons not using seat belts). Twenty-five to 30 percent of fatalities involve alcohol-impaired drivers (which is down following 0.08 per se laws), and another 10-plus percent involve drug-impaired driving (which is increasing). Furthermore, rural run-off-the-road fatalities are overrepresented in the total number of fatalities. And finally, more than a quarter of the fatalities involve speeding; only one-third do not involve drivers under the influence.

Think of the late 1960s when nascent seatbelt, airbag, anti-lock brake technology began. Now, jump forward to today where nearly the entire driving fleet has this technology. Think of late 1970s and the U.S. dependency on foreign oil and with the government corporate average fuel economy (CAFE) standards. Today, we are energy independent. We can get to Vision Zero. We will have Jetsons-like vehicles by 2062, but by then we could have reduced much of the toll of our highway system using advanced transportation technologies today.

Do we need a coronavirus-like focus to get there? One thing is for sure, we cannot achieve this without superior communication technology. Taking away 5.9 Ghz communication from transportation safety is like throwing in the towel on Vision Zero, setting back emergent technology from the task at hand. We can do this now—today—and Shape Your Community for safer transportation.
Connected & Automated Vehicles

31 Leveraging Connected and Automated Vehicle (CAV) Technology Initiatives to Advance Safety and Mobility
By Raj Ponnaluri, P.E., PTOE, Ph.D., PMP (M)

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By Holly Gilbert Stowell

44 Safeguarding Safety for Road Users Now While Planning for an Automated Future
By Eleanor Leshner, Nico Boyd, and Alice Grossman, Ph.D.
director’s message

Trip Generation – Looking Back, Moving Forward
Since 1976, ITE has been the go-to source for trip generation data and tools. We have come a long way, particularly in the last five years. The First Edition of *Trip Generation* was less than 200 pages and included only approximately 50 land uses. Today, we provide a Web-based App allowing access to trip generation data for 177 land uses, in rural, suburban and urban settings, parking generation data, and are continuing to enhance the person-based and multimodal aspects of our data set.

In February of this year, ITE released the *Trip Generation*, 10th Edition Supplement. This supplement significantly expands the multimodal data available to users. It provides walk, transit, and bicycle trip generation data for 53 land uses, adds truck trip generation for 50 land uses, and includes a new affordable housing land use. It is available in both digital and hardcopy in the ITE Bookstore; both include an upgrade to the ITE TripGen Web App. A recorded webinar on the supplement is available on the ITE Learning Hub. Thanks to our software partner, Transoft Solutions, for their continued support.

As we prepare to initiate the development of the *Trip Generation Manual*, 11th Edition, planned for delivery in late 2021, we are enhancing our existing offerings and the application of these resources. In 2019, we released the ITE Trip Generation Education Program providing university professors and their students discounted access to ITE’s *Trip and Parking Generation Manuals* and lesson plans to guide their application in an academic setting.

Later this summer, we expect to release a proposed recommended practice (RP) on *Multimodal Transportation Impact Assessments for Site Development* to replace the recommended practice published in 2010, led by Dan Hardyunder the auspices of the Planning Council. The new RP will include assessing travel behaviors for multiple modes in various land use types and contexts, tools for designing sites to encourage more multimodal transportation use, using long-range plans to drive determinations in a site assessments process and look beyond traditional Level of Service (LOS).

In the fall, we will debut a new Traffic Impact Analysis (TIA) Certificate Program as part of our professional development program. This blended learning program will allow those charged with preparing or reviewing TIAs to gain a full understanding of the practice of traffic impact analysis. It will include the rationale behind conducting a TIA, the steps involved in performing a TIA, training on the tools used in conducting analyses for a TIA, and discussion of new and emerging issues. The ITE Public Agency and Consultants Councils are supporting the development of this new program.

We have come a long way since releasing the first edition of *Trip Generation* in 1976, but we recognize the need to expand and evolve our offerings to keep pace with a changing profession. Our volunteers and staff are working hard to keep ITE positioned at the forefront of trip generation and traffic impact analysis, and we ask that you continue to assist ITE in the on-going collection of both trip and parking generation data through ITE’s Trip and Parking Generation Web page. If you have thoughts or suggestions, feel free to reach out to me at jpaniati@ite.org or on Twitter: @JeffPaniatiITE.

Jeffrey F. Paniati, P.E. (F)
Executive Director and Chief Executive Officer
SIDRA INTERSECTION 9

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New Members
ITE welcomes the following new members who recently joined our community of transportation professionals.

**Canadian**
Zoe A. Athans, E.I.T.
Ashley Borne
August Habesch
Garrett JW Hill, E.I.T.
Lacey E. Hirtle, P.Eng.
Henry Huotari
John Kingsley
Toby L. Lewis, Eng.L.
Will Rose Canadian
James Schofield, P.Eng.
Laura J. Smith, E.I.T.
Winnie W. Wong, P.Eng.

**Florida Puerto Rico**
Eren Erman Ozguven
Juan Rivera Ortiz
Cameron Hamilton Smith
Mike Soloka
Bronce Stephenson

**Global**
Mike Evans

**Great Lakes**
Robert Fijol
Aubrea M. Kabryn
Steven Lam, E.I.T.
Ting Nahrwold
Santos Eduardo Ramos
Eric Ross

**Mid-Colonial**
Edna Gomez-Rosario
Philip Koloski
Barbara McCann
Kate Norris
Tyler Olsen
Matt Remner

**Midwestern**
John Fitzpatrick
Ryan Hale, P.E.

**Mountain**
Jennifer V. Bartlett
Jeff Binning
Jeremy W. Cok, P.E.
AJ Fisher
Joel Benjamin Gilbert
Kyle Lehto
Josie Paxton
Allison M. Read
Robert Taylor Settles
Peter Vargas

**Northeastern**
Zamir Alam
Steve Alpert
Christian Arkell
Taylor Dennerlein
Basem Gorgi
William Harrison
Karen Hill
Janet Jenkins, AICP
Yelena Kushnir
MD Sa'idur Rahman
Justin Romeo
Julie Schipper
Navjodh Singh, P.E.
Joshua Taylor, E.I.T.
William Ullom

**Southern**
Kennedy Adams
Shelby Lynn Brannen
David Chang
Enid M. Colon-Torres
Daniel Conner
Mark A. Doctor
Melissa Edmonds, P.E.
Shalini Ghosh
Eric Hall, P.E.
Ron Hinson, P.E.
Susan H. Keen, P.E.
Nathan M. Milaszewski, P.E.
Demetrius Moore
Carrie L. Simpson, P.E.
Thor Steffen
Cheryl L. Tate, P.E.
Eileen Vaughan
Olivia Zuwanich

**Texas**
Brian Glenn Fariello
Pa Ousman Gaye
Jaime Alejandro Gomez
Kendall Kyle
Daniel James Malsom
Daniel Ortiz
Gordon Rogers
Michael Sexton

**Western**
George Abcede
Shravan Aeneni
Marshall Ando
Mehnoosh Arabestani
Deanna Brewer
Alec Bumgarner
Ilana Burstein
Bryan Case
Brian Daniel Chase, P.E., PTOE
Dennis Chavez
Karen Chung
Mel Chung
Vinh Dang, P.E.
Martin Dedinsky, P.E.
Larry Dill
Duke Do, P.E.
Amy Ford-Wagner
Martin Fuest
Freddy Garcia
Ross Hironaka
Dan Hollrah
Neal Honna
Tina Jang
Blaine Kawamura
Hanh-Dung T. Khuu, P.E.
Mike Koidal, P.E.
Sayuri Koyamatsu, P.E.
Eduardo Martin
Reed Matsuo
Adrian Mercado, E.I.T.
Scott Mercer
Calvin Miguel, E.I.T.
Bonnie Nau
Matthew Neeley, P.E.
Shane Oden, P.E.
Kristine Pascua
Clay Peterman, P.E.
Dario Qiu
Courtney Sell
Noely Serrato
Robin Shishido
Maan Sidhu, P.E.
James Sims, P.E.
Jason Situ
Raymond Smith
Edwin Sniffen
Michael Southwick
Matthew Stewart
Christina Strand
Shane Sullivan
Allyn Y. Tabata
Harry Takiue
Ken Tatsuuchi
Jeyan Thirugnanam
Rosalva Ureno
Ron Vessey, P.E.
Kyle Wachtler
Greg Wagner, P.E.
Yuan Wen
Jacob Whitfield
John Williams
Derek Yee
Alex Zhang, P.E.

Letters in parentheses after individuals’ names indicate ITE membership status: S - Student Member; IA - Institute; M - Member; F - Fellow; R - Retired Member; and H - Honorary Member. Information reported here is based on news releases and other sources. If you have news of yourself or the profession that you would like considered for publication, please send it to Holly Stowell, hstowell@ite.org.
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ITE NEWS

ITE Election Results
Congratulations to the newly elected ITE International officers for 2021. The results are:

**International President**
Alyssa A. Rodriguez, P.E., PTOE (F)
Director of Information Technology
City of Henderson, Nevada
Henderson, Nevada, USA

**International Vice President**
Beverly Thompson Kuhn, Ph.D., P.E., PMP (F)
Division Head | Regents Fellow
Texas A&M Transportation Institute
College Station, Texas, USA

ITE thanks Vice-President candidate Jason Crawford, P.E. (F) for running a positive and professional campaign and looks forward to his continued leadership as Chair of the Coordinating Council.

WHERE IN THE WORLD?
Can you guess the location of the “Where in the World?” photo in this issue? The answer is on page 50. Feel free to send in your own photos to hstowell@ite.org. Good luck!
Florida Puerto Rico District Holds Third Annual Student Leadership Summit
By Priyanka Alluri, P.E., Ph.D. (M), FIU-ITE Student Chapter Faculty Advisor

The FIU-ITE (Florida International University) Student Chapter organized and held the Third Annual Florida Puerto Rico District ITE Student Leadership Summit (SLS) in Miami, FL, USA, from Feb 7-9, 2020. The SLS was well-attended, with more than 70 students and approximately 40 professionals from across Florida.

The summit kicked off with a kayaking and icebreaking session at FIU Biscayne Bay Campus on Friday. The Welcome Session on Saturday included a panel discussion with Dr. Pablo Ortiz (FIU Vice President), ITE International Vice President Alyssa Rodriguez, P.E., PTOE (F), Javier Rodriguez, executive director of the Miami-Dade Expressway Authority, and Wilson Fernandez, deputy director of the Miami-Dade Metropolitan Planning Organization. Eric Rensel, (M), vice president at Gannett Fleming, moderated the discussion. The second session on “Professional Dilemmas” was very interactive. Patrick Son, NOCoE managing director, gave an excellent keynote address during lunch and the students were captivated by his talk.

The afternoon session “Leading from Within” focused on finding your inner leader. The Traffic Bowl was one of the most exciting sessions; a total of nine teams (six companies and three ITE Student Chapters) competed in the Jeopardy-style competition. The District developed its own software (game board), scoring system, and buzzer system to conduct the competition. Pete Yauch, P.E., PTOE, RSP2I (F) served as moderator. The three finalists included: Gannett Fleming, A&P, and the University of Florida.

The career fair, onsite interviews, and professional headshot sessions in the evening were a great success. For the first time, they facilitated onsite interviews, and several students loved the opportunity to be interviewed by several companies in one day. The keynote speaker during dinner was James Wolfe, Florida Department of Transportation District 6 secretary. He inspired the students so much that they continued to talk about the keynote even a day later. The Traffic Bowl finals were also during the dinner session and were as entertaining as one could expect. A&P was the winner.

Sunday morning’s session focused on several team-building activities and the event concluded. Each attendee left the SLS with beautiful memories, great ideas and insights, and many more friends.

ITE Talks Transportation Podcast
New from the Thought Leadership Series

Equity with Tamika L. Butler, Esq.

Tamika L. Butler, Esq., director of Equity and Inclusion at Toole Design, joins the ITE Talks Transportation Podcast to discuss the critical issue of equity in transportation. She delves deep into the challenges confronting transportation professionals when it comes to designing systems and communities that are safer, more accessible, and more equitable for all, and discusses key disparities and concerns currently at play in the industry.

All episodes available at www.ite.org/learninghub/podcast.asp | Subscribe for free via iTunes at http://apple.co/2hOUz8t
Community Corner

Community Corner highlights the efforts of ITE members to not only encourage transportation education among our youth but to improve the daily lives of people in their community beyond transportation through acts of service.

Bradly Coy, P.E., PTOE (M) of the Western District’s Alaska Section has been conducting hands-on STEM activities for the past seven years at his kids’ elementary school in Anchorage, AK, USA. When his oldest daughter started kindergarten, Brad, a traffic engineer with DOWL, decided to take a personalized approach to volunteering in her classroom by planning and conducting STEM exercises. Now he has four kids in elementary school, and he makes it a point to visit each class every year—it’s obvious from the thank-you letters how much the kids enjoy learning about the transportation profession from his visits.

To personalize the activity, Brad visits each grade separately and coordinates with teachers to correlate activities with their curriculum. With kindergarteners, this means learning about colors and shapes of traffic signs and then taking a trip outside to identify signs around the school. The kids love dressing up in safety gear while doing it.

For other grades, Brad introduces various traffic measurement equipment—such as measuring wheels, radar guns, count boards, and traffic cameras—and the students get to handle them and see how they work. By fourth grade, the kids are ready to go outside and rotate between stations where they perform a speed study, intersection count, parking study, and other measurements. One of the highlights is using the radar gun.

For his oldest daughter’s sixth grade class this year, Brad is developing a new inside activity where the students rotate around to different stations to explore and use the traffic measurement equipment, similar to a museum exhibit.

Brad’s STEM lesson plans and student worksheets for each grade level are posted on the ITE STEM Subcommittee’s resources page at http://bit.ly/ITESTEMK-12Resources.
CELEBRATING NATIONAL ENGINEERS WEEK

During National Engineers Week, several ITE members shared blogs about how they found their career passion and how they envision the future of transportation.

It is up to each and every ITE member to seek different voices, quiet voices, voices of women who may be juggling so many balls that while she might have a story to tell, she doesn’t have the time to find her platform. It’s up to us to find these people, and give them a platform.

Laura Aston
Senior Consultant, Movement and Place Consulting

...ITE has introduced me to some of the most influential people in the transportation industry...Thanks to that exposure, I am growing up to be a female engineer who believes in limitless possibilities and understands that everyone deserves a seat at the workforce table.

Cecilia Kadeha
PhD Student/Graduate Research & Teaching Assistant at FIU, President of the FIU ITE Student Chapter

Making the world a better place starts with curiosity which is nurtured by the collaboration of passionate people who share their experiences...We are only the next young engineer away from getting there, and who knows you might be the one to introduce them to the challenge. Shape your community.

Randy McCourt
President, ITE

Connections made possible by transportation professionals are at the heart of everything – they weave together the fabric of our culture and they define what our evolution will look like.

Eric Rensel
Vice President, Gannett Fleming, Inc.

DEADLINE FOR SUBMISSIONS IS APRIL 15

Micromobility “Sandbox” Design Competition

Your mission: Using a corridor in Las Vegas, NV USA* and one from your home city, apply your creativity and technical skills to propose solutions that will integrate current and future micromobility options safely and efficiently into the urban environment. The goal is to develop innovative design solutions that can best accommodate the needs of all users.

Winners will be presented with an ITE Micromobility Design Competition Award during the Annual Award lunch on August 11 held in conjunction with the Joint ITE International and Southern District Annual Meeting and Exhibition (#ITENOLA2020).

Visit www.ite.org/micromobilitycompetition for more information

HIGHLIGHTS:

• Separate professional and student categories. Two top teams in each category will be invited to present their solutions during #ITENOLA2020.

• Teams can include an unlimited number of participants. The competition is open to all (at least one ITE member must be on a team).

• Collaboration between urban planners, engineers, architects, and landscape architects, among others is encouraged.

• Submissions will be evaluated on a set of factors, focusing on creative and innovative solutions that are transferable, scalable, and address safety, operational, and economic concerns.

If we want to continue to encourage diversity, we need to ensure that we are creating an environment where professionals aren’t afraid to share their thoughts and ideas...Collaboration with people from different perspectives ensures that we find successful solutions that will move our profession forward.

Cathy Leong
Associate Director, Wilson Okamoto Corporation

Visit www.ite.org/micromobilitycompetition for more information
ITE’s Role in Developing Connected Vehicle Guidelines and Standards

By Siva R. K. Narla (M) and Nicola Tavares

ITE has traditionally been one of five Standards Development Organizations (SDO) designated by the U.S. Department of Transportation (USDOT) to develop ITS standards for over two decades under a cooperative agreement with the USDOT. ITE has also been the lead SDO for ITS Standards with the American Association of State Highway Transportation Officials (AASHTO) and National Electrical Manufacturers Association (NEMA) as partners in the past decade.

Beginning in 2019, USDOT has designated ITE as a lead organization to work cooperatively with the other SDOs in developing the first generation of standards products related to connected vehicles (CV). These Standards and Recommended practices accelerate Cooperative Automation deployments across the nation, and enable interoperability between infrastructure, automotive sector, and mobile solutions sectors.

Above mentioned efforts help ITE’s membership develop an understanding of CV through engagement with Connected Vehicle groups. ITE members also get an opportunity to interact with automotive, and mobile solutions sectors and in understanding each other needs. ITE membership is expected to be part of developing operational guidelines through consensus building and standards development.

Following sections provide a brief overview of the two CV standards projects underway, which are RSU (Roadside Unit) Standardization and Connected Signalized Intersection Guideline development, being led by ITE and supported by the USDOT ITS Joint Programs Office. A section on how to participate and follow the effort follows.

RSU (Roadside Unit) Standardization
The USDOT ITS Joint Programs Office has initiated a new project, RSU (Roadside Unit) Standardization, to develop and publish an RSU standard that defines the key capabilities and interfaces an RSU must support to ensure interoperability for state and local infrastructure owner/operators (IOO). In cooperation with AASHTO, NEMA, SAE, and IEEE, ITE is inviting stakeholders representing public and private sectors, as well as individuals, to participate.

The scope of the proposed standard is to incorporate relevant user needs, requirements, and design elements of RSUs defined in the RSU Specification 4.1, and NTCIP 1218 Object Definitions for RSUs, and subsequently validate it through outreach to the real-world RSU deployments such as the Connected Vehicle Pilots programs and the Signal Phase and Timing (SPaT) Challenge. Stakeholders should anticipate up to 15 web-enabled conference calls and three face-to-face meetings within the United States, during years 2020-2021.

Connected Signalized Intersection (CI) Guidelines
The USDOT ITS Joint Programs Office has initiated another CV standards and guidelines project for a connected signalized intersection. Stakeholders representing public and private sectors as well as individuals are invited to participate.

A connected signalized intersection is defined as an infrastructure system that broadcasts signal, phase and timing (SPaT), mapping information, and position correction data to vehicles. The project is meant to complement the RSU Standardization effort and have a balanced list of stakeholders representing infrastructure, automotive sector, and smart mobility to ensure consistency and interoperability while receiving timely input from the industries mentioned.

The project’s purpose is to develop and publish a Connected Signalized Intersection guideline that addresses ambiguities and gaps identified in CV and SPaT deployments. This project scope is to ensure that future CV and SPaT deployments are interoperable across the United States, especially for automated transportation systems. The first version of this guideline focuses on harmonizing existing SPaT, using the USDOT sponsored Cooperative Automated Transportation Clarifications for Consistent Implementations (CCLCs) To Ensure National Interoperability Connected Signalized Intersections as a starting point.

How to Participate in RSU and CI Projects
To participate as a stakeholder in the RSU Standardization or the Connected Signalized Intersection Guidelines, please email us at Standards@ite.org with subject line RSU Standardization or Connected Signalized Intersection. Project progress and updates can be found at www.ite.org/technical-resources/standards.

How to Take Part in CV and ITS Standards Training:
Please refer to the ITE Technical Resources webpage and review the ITS Professional Capacity Building section at https://www.ite.org/technical-resources/topics/transportation-education.
2020 EVENTS

TEXAS DISTRICT SPRING MEETING
April 15-17 | Corpus Christi, TX, USA

MOVITE SPRING MEETING
May 6–8 | Tulsa, OK, USA

NORTHEASTERN DISTRICT ANNUAL MEETING
May 13–15 | Wading River, NY, USA

60TH ANNIVERSARY INTERMOUNTAIN SECTION MEETING
May 14–16 | Jackson, WY, USA

CITE/QUAD JOINT 2020 ANNUAL CONFERENCE
May 24–27 | Vancouver, British Columbia, Canada

JOINT MIDWESTERN AND GREAT LAKES DISTRICTS ANNUAL MEETING
June 3–5 | Chicago, IL, USA

SOCAL ITE ANNUAL BUSINESS MEETING/Joint Meeting with ITS-CA
June 17 | Monterey Park, CA, USA

FLORIDA SECTION SUMMER MEETING
June 24–26 | Ft. Lauderdale Beach, FL, USA

2020 JOINT WESTERN & MOUNTAIN DISTRICTS ANNUAL MEETING
June 29–July 1 | Honolulu, HI, USA

JOINT ITE INTERNATIONAL AND SOUTHERN DISTRICT ANNUAL MEETING AND EXHIBITION
August 9–12 | New Orleans, LA, USA

TEXAS DISTRICT ANNUAL MEETING
September 16–18 | Denton, TX, USA

TRANSPO 2020/FLORIDA PUERTO RICO DISTRICT ANNUAL MEETING
October 11–14 | Bonita Springs, FL, USA

MET SECTION ANNUAL MEETING
November 12, 2020 | Astoria, NY, USA

Help ITE Celebrate 90 Years by Giving $90

In honor of ITE’s 90th anniversary year, please consider donating $90 to support the ITE Legacy Fund. The Legacy Fund helps support our Diversity Scholars, the student-led Student Leadership Summits, LeadershipITE scholarships, the STEM competition, and the Matson and Hammond Mentoring Program. Throughout our 90th anniversary year, members will have several opportunities to contribute to the $90 for 90 campaign. Visit bit.ly/ITE90for90Campaign to give. To see who has already donated, go to bit.ly/90for90contributors. Make a difference by adding your name to the list today!

bit.ly/ITE90for90Campaign

ITE has been one of the most important elements in my career as a transportation professional. Whether providing me with tools to improve my technical abilities, opportunities to hone my leadership skills, or the ability to develop an international network, ITE has profoundly shaped my career.

ITE has been a place where I have forged lifelong friendships. I have interacted with many wonderful people across the world. The willingness of people to devote their time to volunteer positions is remarkable. Giving back, even in a small way, helps others become a part of this great organization.

Lynn A. LaMunyon, P.E., PTOE, IMSA II, FITE (F)
Senior Principal, Maser Consulting | Hamilton, NJ, USA

www.ite.org
April 2020
The ITE Connected and Automated Vehicle (CAV) Steering Committee is a multidisciplinary, crosscutting steering committee intended to give ITE a voice in the conversation concerning the future of connected and automated vehicles. The group has been playing a key role in collaborating with other CAV working groups and committees around the country and worldwide. The committee has also been actively participating in initiatives focused on understanding the need for infrastructure owners and operators and tracking the industry capabilities for addressing those needs.

The committee represents ITE on key issues that will determine the future of emerging technologies in saving lives and improving mobility. Activities include responding to proposed changes in 5.9 gigahertz (GHz) spectrum reallocation by the Federal Communication Commission (FCC), reviewing United States Department of Transportation (USDOT) guidelines and publications, circulating the key information among the members at large, and collaboration with other organizations on CAV issues. Among other accomplishments, the committee completed the following activities in the last year:

- The committee has been actively and periodically circulating key updates on activities in the CAV world. ITE also released its position statement on CAVs last year, which can be found at http://bit.ly/CAVStatement1218.
- In response to the USDOT’s request for comments on the vehicle-to-everything (V2X) communications, the committee solicited comments from the membership at large and crafted an overarching response on behalf of ITE.
- The committee also launched a new subgroup on communications and outreach, which focuses on internal and external outreach to track activities in the CAV area. The subgroup also intends to be comprised of and maintain close collaboration with other ITE Councils, including the Traffic Engineering Council, the Smart Communities Institute Initiative, and the Transportation Planning Council.
- The committee represented ITE as part of the Joint Task Force of the American Association of State Highway and Transportation Officials, ITE, and ITS America helping to craft Infrastructure Owner Operators Guiding Principles for connected infrastructure supporting Cooperative Automated Transportation.
- The FCC opened a comment period on the 5GAA petition to allow the deployment of cellular vehicle-to-everything (C-V2X) in the 5.9 GHz band. The committee solicited comments from the steering committee and membership at large. It crafted and provided a detailed response from the transportation safety and mobility perspective and submitted it to the FCC through ITE leadership.
- The committee circulated information on FCC’s draft Notice of Proposed Rulermaker (NPRM) on the reallocation of the 5.9 GHz spectrum among the committee members and assisted the ITE staff in drafting a statement on behalf of ITE in response to the NPRM. It also represented ITE at several national association
meetings and on conference calls where the NPRM was discussed. For more on this issue, see the feature article on page 37.

- The CAV Steering Committee met at the Transportation Research Board Annual Meeting in Washington, DC, USA on January 14, 2020. The committee drafted the plan for this year and assigned the responsibilities to respective members for undertaking the tasks. The committee intends to build focus on legislation, policy, and regulation-related CAV programs.
- The committee developed a white paper on CAV deployments, which can be found on page 31. The white paper includes the best practices on how to create a CAV deployment program from planning to implementation, funding aspects, policy issues, developing business cases for CAV technologies, lessons learned from deployed projects, and the way forward to achieve safety and mobility goals using CAV technologies.

In addition to the above, several other initiatives by the CAV Steering Committee are underway, including organizing four webinars this year on current pressing issues. The Steering Committee will also continue the outreach effort by the Outreach Subgroup; create inventories of lessons learned from CAV projects nationwide; and encourage student engagement efforts through ITE Student Chapters.

Guidelines for Determining Traffic Signal Change and Clearance Intervals

ITE has published guidance on yellow change and red clearance intervals for signalized intersections. The goal of this guidance is to create a consensus methodology for calculating and evaluating traffic signal change intervals that can be consistently implemented by transportation agencies. The recommendations presented should yield reasonable times for the yellow change and red clearance intervals for traffic signals, assisting transportation professionals in enhancing intersection safety, maintaining reasonable traffic flow, and providing for movement of vehicles, bicycles, and pedestrians.

Purchase Information:
Electronic Format: Member $75 | Non-Member $150
Print Format - price of electronic format plus $20 shipping and handling
ITE Journal | member to member

Young ITE-ANZ Program

ITE’s Australia-New Zealand Section (ITE-ANZ) has a Young Members of ITE (YITE) program that encourages leadership among students and young professionals. Matthew Bennett (M), current president of the group, tells ITE Journal more about how he became involved and what upcoming activities YITE has planned.

ITE Journal: Can you share more about your path to becoming the current leader of YITE?
Bennett: My path to YITE leadership started with the 2018 Student Leadership Summit (SLS) Organizing Committee under the fantastic leadership of Laura Aston (S). Building off the event’s momentum, Laura put out a call for volunteers to form a committee for young members of ITE. We held a couple of workshops to find out what people would want in such a group, then an election was held. I knew I wanted to contribute to the best of my abilities towards the formation of a strong community of young transport professionals and students within Melbourne, all while connecting with similar groups both interstate and internationally to be part of a wider transportation community. From the preliminary work done before the election, it was clear that whoever became president of YITE would receive support from a great team of other young and enthusiastic transport professionals and students. I cannot thank the YITE committee enough for putting up with me bumbling about while trying to figure out what the role of president looks like. Overall, ITE has played a major role in the first couple of years of my professional life, and being a member of the ITE community has allowed me to build up connections that extend far beyond my own team and graduate cohort at Aurecon.

ITE Journal: Tell us a little more about the opportunities offered to young members by YITE.
Bennett: At this stage, YITE has been focusing on building our strength, and determining what our offering should be to the younger members of ITE. As a committee, we have bonded well, often going out for dinner after our meetings, sometimes bringing snacks into the meetings themselves. In terms of events that we have held, we have been primarily supporting the ITE-ANZ board through filming, helping to organize, and sharing seminars through social media.

ITE Journal: What are some of the up and coming activities planned by YITE that you’re excited by?
Bennett: We have a couple of social events lined up aimed at young professionals and students. The first is an Amazing Race-style event, where teams will race through the streets of Melbourne, using clues to navigate to their next destination. We are also co-hosting a trivia night with a group called Young Transport Professionals, who mostly work in the rail industry—it should be a great for meeting people who may otherwise not attend too many ITE events! We eventually plan to host a competition similar to the ITE Micromobility Competition, aimed specifically at university students. We would also like to help facilitate SLSs both in Australia and New Zealand, and potentially send Australian and/or New Zealand teams to compete in the North American ITE Traffic Bowl!
Communicating Technical Topics to Non-Technical Audiences

An ITE Online Interactive Workshop powered by Shelley Row, P.E., CSP (F)

There’s a lot at stake. You must effectively communicate your work to a client, prospective clients, elected officials, executives, or the public who have little time and less background in your subject area. You get one chance and it needs to go well.

Impactful and memorable communications are an essential part of being successful and advancing your career. What are the secrets to creating and delivering powerful communication that connects with your audience in a meaningful way?

To assist you with enhancing your skills in this area, ITE has partnered with Shelley Row, P.E., CSP to provide this intensive, interactive online 3-part workshop. This workshop is the practical solution transportation professionals are looking for to build confidence in communicating with non-technical audiences.

As part of this webinar workshop series, you will:

• Learn how to analyze the audience and design a presentation that is laser-focused on their real issues;
• Practice and develop proficiency in asking powerful questions designed to connect to the audience; and
• Create powerful and memorable presentations with stories that stick.

Know Your Audience: Who Are They Really and What Do They Care About
Wednesday, May 13, 2020

Asking Powerful Questions and Listening for the Answers that Really Matter
Thursday, July 16, 2020

Design Impactful, Brain-Friendly Presentations That Stick
Thursday, September 17, 2020

Upcoming Blended Learning Courses from the Consortium for Innovative Transportation Education
ITE members receive significant discounts on registration for this course:

Managing a Corridor
Friday, May 15, 2020 - Saturday, June 20

Upcoming Live Webinars

Design Fundamentals for Complete Streets 1.5 PDH Credits
Tuesday, April 7, 2020, 2:00 - 3:30 PM ET

Applying Surrogate Safety Techniques to Assess Protected Bike Lanes 1.5 PDH Credits
Wednesday, April 8, 2020, 1:30 - 3:00 PM ET
(Sponsored by the Industry Council and presented by Transoft Solutions)

Case Studies on Curbside Management from San Francisco, Toronto, and Washington, DC 1.5 PDH Credits
Wednesday, April 15, 2020, 1:00 - 2:30 PM ET

Smart City Webinar Series
In partnership with the City of Columbus Smart Columbus Program Management Office, ITE is hosting a webinar series on various Smart City-related topics. These webinars are free to all attendees and offer PDH credits.

FREE! Human Use Approval Summary 1.5 PDH Credits
Thursday, April 2, 2020, 1:30–3:00 p.m. ET
Previously held webinars are available on-demand via the ITE Topics include:
• Demonstration Site Map & Installation Schedule
• Safety Management Plan Final Plan, Smart Mobility Hubs Interface Control and System Design Documents
• Presentation of the Linden AV Shuttle Deployment
• Safety Management Plan Final Plan
• Connected Vehicle Environment Webinar on System Design and Interface Control Document Review

Visit http://bit.ly/ITEwebinars for more information on how to access and stream these webinars.
Flexibility is Needed on the Long, Winding Road to an Automated Vehicle Future

By Yassmin Gramian, Acting Secretary, Pennsylvania Department of Transportation

When considering the far-reaching benefits to our transportation system and the broader society that automated vehicles offer the future, it’s not difficult to understand why so many transportation planners and engineers—including me—enthusiastically embrace vehicle automation. The vision of vastly safer movement of people and goods, expanding mobility options for the traveling public, shrinking logistics costs to the economy, and optimizing operational efficiency to reduce congestion and its consequent pollution is nothing short of a transportation utopia.

Alas, like most utopian visions, an array of complicated problems must be resolved, and unintended effects addressed before we will get to enjoy the promised milk and honey.

To put the spotlight on just a couple of the more ornery issues: first, public opinion has grown increasingly concerned about the growing role of smart technology in our lives, and in survey after survey displays particular skepticism about the notion of safe vehicular automation; second, the initial over-the-top hype about how soon automated vehicle technology would be ready for general use has given way to a more realistic recognition of just how far automated driving systems currently are from mastering the myriad challenges.

In short, these factors suggest we are in for a long, winding, and bumpy journey of transition in which conventional and automated vehicles will be sharing all or parts of the roadway, and the driving environment will be distinguished by an unprecedented and unpredictable mix of human and machine operators interacting with each other.

In order to overcome these obstacles and reach our goals, it’s natural to want to accelerate the progress of automation as swiftly as possible. After all, we are talking about the potential to all but erase the 35,000-plus crash fatalities per year, not to mention the untold misery to and costs of care for the millions of crash survivors who are seriously injured and disabled.

Yet it’s equally important that development of automated and vehicle (AV) technologies advance prudently, mindful of the first requirement to ensure the safety of the traveling public, be they self-driving evangelists or techno-phobic nay-sayers.

The Role of the States

As stewards of the transportation system, state DOTs, along with our federal government counterparts, are tasked with the responsibility of striking that fine balance between safety and innovation.

Thus far, several different approaches are being tried by various states—and in a few cases by cities—and no consensus has yet emerged as to the best governing model. Some jurisdictions, notably California, prefer a relatively robust regulatory structure, while others like Florida and Michigan have undertaken a more permissive approach.

In Pennsylvania, where our second largest city—Pittsburgh—is not only the cradle of vehicle automation, but also one of the global epicenters of its ongoing research and development, Pennsylvania Department of Transportation’s (PennDOT) approach to AV governance can best be described in one word: flexible.

Unlike our sister jurisdictions that are also leaders in AV development, PennDOT’s safety requirements for automated vehicle testers set firm guidelines, but they can be readily changed—whether they need to be fine-tuned or revised wholesale—by an ongoing, collaborative process that enlists the stakeholders from all sides of the matter to find common-ground solutions.

In Pennsylvania, where our second largest city—Pittsburgh—is not only the cradle of vehicle automation, but also one of the global epicenters of its ongoing research and development, Pennsylvania Department of Transportation’s (PennDOT) approach to AV governance can best be described in one word: flexible.

A National Review of Testing Safety

As part of its investigation of the 2018 crash in Tempe, AZ, USA, in which a test vehicle operating in autonomous mode killed a pedestrian crossing the roadway, the National Transportation Safety Board reviewed various state AV safety regimes and told us of their favorable assessment of Pennsylvania’s “common-sense” approach. Some elements of our Guidance even informed the recommendations that the NTSB team offered in their report.
It bears noting that some of the key features of Pennsylvania’s AV governance approach happened not by preconceived design, but by adjusting and adapting plans to developing circumstances, with the benefit of iterative feedback from our stakeholders. These mid-course pivots seemed perfectly appropriate to the task of developing a governance response to emerging technology whose future trajectory could only be imagined, but not fully anticipated.

As AV testing began to take off on the streets of Pittsburgh, we intended to ask our legislature to authorize driverless testing and use of automated vehicles with PennDOT empowered to oversee safety exercised by the flexible mechanism of policy, rather than the more cumbersome use of regulation. (By its silence on AVs, existing Pennsylvania law allows an Automated Driving System to operate the vehicle, but a licensed driver must be at the wheel and effectively in control).

The safety policies that were drafted were subjected to intensive review and revision from our AV Task Force, comprised of diverse stakeholders and voices. But the General Assembly had not reached a clear conviction regarding the lawmaking direction it should take, and general AV legislation has not been enacted, though specific uses cases for truck platooning and driverless work-zone vehicles were authorized by new law.

Meanwhile, in response to the Tempe fatality, public opinion in Pennsylvania demanded that PennDOT take appropriate safety measures, notwithstanding the gray area of legal authority that existed.

We responded—with the flexibility that the situation demanded—by reconvening our AV Task Force to help the department strengthen the Testing Guidance and then calling on the testers—in truth, letting them know that we expected them—to comply voluntarily by submitting a detailed Notice of Testing, subject to PennDOT review and approval, that delineates the operational and locational details of their testing activities.

It has been gratifying that the testing community has been uniformly supportive and willing participants in the process. This winter and spring, PennDOT has been working with them to update the Guidance—a needed review in light of two years of further technological progress since the document was first issued.

Equity, Workforce, and Public Engagement

This collaborative, flexible approach to roadway safety has been a cornerstone of Pennsylvania’s governance of vehicle automation, but not the only one. Other key aspects include:

A focus on ensuring that the costs and benefits of this and other emerging transportation technologies are shared fairly across the state’s diverse population and communities.

Close attention to the complex effects of automation on the workforce, both to mitigate the potential for disruptive job loss and to invest in skills training to give Pennsylvanians opportunities for the new, more sophisticated jobs that will emerge.

A relentless commitment to engage Pennsylvanians in a frank and ongoing public discussion about AV technology, so citizens can have a hand in shaping tomorrow’s transportation system, and do so with an
understanding of the benefits of AV technology as well as the complex issues that will arise.

A Debate at Many Levels

Many voices in the AV discussion across the nation have urged the federal government to step in and set nationwide ground-rules for AV testing and operation in order to avoid a state-by-state regulatory patchwork. Clearly, the endgame will demand a uniform, national system of governance.

But there’s a reason that Congress (as of this writing) has not made great progress toward enactment of AV legislation, and that USDOT has thus far taken a light hand in promoting AV safety without exercising its considerable existing regulatory authority.

There has not yet emerged a clear recognition of the appropriate governing structure that will maintain the fine balance between innovation and safety, and with the flexibility required to adapt to fast-moving progress. A single national approach that proves to be premature or wrong could slow progress, stifle promising innovations, or just be ineffectual.

Meanwhile, in keeping with their role as the "laboratories of democracy," the states are trying various approaches, sharing their findings and perspectives. Out of these efforts are likely to come a range of empirically tested options for governing AV technology as it develops.

The good news is that we are just getting started, so there is a reason to be experimental, and time to do it. But not forever. It took just 65 years—shorter than an average lifetime—to get from the Wright Brothers first flight in Kitty Hawk, NC, to humans standing on the moon.

Fully automated vehicles may be some ways down the road for general purpose use, but they are surely coming. Best we exercise our flexibility to get ready.

References


Yassmin Gramian, P.E., serves as the acting secretary of the Pennsylvania Department of Transportation (PennDOT) where she oversees programs and policies affecting highways, urban and rural public transportation, airports, railroads, ports, and waterways. Yassmin is a professional engineer in Pennsylvania, Delaware, New Jersey and Florida, and has more than 30 years of experience in operations, design, and management of transportation infrastructure systems, including highway, tolling, bridge, and railroad projects. Prior to joining PennDOT she served as a senior vice president and business development director for a leading international engineering firm. She earned master’s and bachelor’s degrees in civil engineering from the University of Michigan and completed the Tuck Management Training Program at Dartmouth College.
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Pushing the Limits of Transportation Infrastructure
Georgia DOT Partners for Safety and Mobility with Connected Vehicles

By Andrew Heath, P.E. (M)

The transportation industry is on the verge of the largest disruption since the invention of the automobile. Across the country, human error accounts for 94 percent of serious crashes. But up to 80 percent of non-impaired collisions could be prevented with enhanced vehicle connectivity, according to the National Highway Traffic Safety Administration.1, 2

Of the 370,000 annual roadway motor vehicle crashes we see in Georgia, 52 percent are rear-end and sideswipe same direction.* With just the most basic connected vehicle (CV) application, it may be possible to mitigate almost half of those crashes. And if we include lane and roadway departure applications, we could address another 22 percent or more than 80,000 crashes annually. In total, it is reasonable to assume the potential for CV and lane departure technology to eliminate an average of 680 (55 percent) fatality crashes and 23,732 (63 percent) injury crashes annually.

Safety Plays an Intrinsic Role in Transportation. At the Georgia Department of Transportation (GDOT), safety is not only a part of our mission, it’s also one of our strategic goals. And the investments made in intelligent transportation systems (ITS) have improved traffic management and made for safer driving. Promising new technologies for everything from on-road communications to data analysis will dramatically change how vehicles operate and provide information, resulting in even more substantial improvements in real-time traffic management and safety. But these can only occur if the necessary transportation network infrastructure is in place.

What Comes First – the Vehicle or the Infrastructure? Broad deployment of CV technology requires a coalition of the transportation industry—both public and private sectors—to come to the table to work together. Building the transportation infrastructure needed for connected vehicles is a bit of a chicken and egg conversation. Do the DOTs wait for automakers to create cars capable of V2I? Or do DOTs proactively create the infrastructure ahead of the enabled vehicles?

Georgia DOT is taking the latter approach. As CV technology and CV-enabled vehicles become more widespread, there is real potential that the transportation community will get closer to the goal of zero deaths—something that has been discussed for decades. In Georgia, the state DOT takes that challenge seriously. In the metro Atlanta region, Georgia DOT is already implementing one of the largest connected vehicle deployments in the United States through installing Roadside Units (RSUs) at 1,600 locations within metro Atlanta, including 400 in operation now.

Additionally, through a partnership with the Atlanta Regional Commission (ARC), GDOT is embarking on a request for proposal (RFP) to deploy another 1,000 RSUs at contiguous signalized intersections across the region.

And we aren’t stopping there. Through a partnership with Panasonic, the Federal Highway Administration (FHWA), and The Ray on I-85—an 18-mile (12.8 kilometer) rural stretch of interstate in West Point, GA that is a proving ground for evolving ideas and infrastructure technologies—we are testing CV applications at six locations.

Talking Directly to Vehicles. Georgia’s regional connected vehicle program is not a pilot. Deployment of CV roadside units (RSUs) throughout metro Atlanta began in 2018 and has continued ever since. The technology consists of roadside equipment and software systems that connect equipped vehicles directly to the infrastructure. The ability for the infrastructure to talk directly to vehicles is what makes Georgia’s program so unique. It is direct point-to-point communication.

The infrastructure assists with both mobility and safety by collecting information on traffic and road conditions and subsequently providing that information to vehicles. Specific applications can then be developed including red light warnings; recommended speed to pass through the next traffic signal on green; a countdown to green; and preemption or priority phasing for specific vehicles.

* Based on 2013-2018 data using Numeric crash data platform from Georgia Electronic Accident Reporting System (GEARS)
The technology is scalable too. Georgia DOT has designed the system to work in an interoperable standards-based environment that uses non-proprietary technology through the 5.9 GHz safety spectrum. Whether the mission is to establish transit priority, freight priority or signal preemption, or to alert about road weather conditions or work zones, the system needs to function properly. The long-term goal is to enable a baseline level of connectivity of our infrastructure throughout the state, in conjunction with local and private partners, to improve safety and mobility.

**Affordable Option for Safety.** GDOT is funding the full deployment of the initial regional program (1,600 signals), in coordination with an awarded federal Advanced Transportation and Congestion Management Grant, at a total investment level of approximately $7 million USD. That money goes towards deploying and developing the whole spectrum of connected vehicle infrastructure to support equitable access to data and applications to support connected vehicles.

**Part of the Bigger Picture.** Connected vehicle technology is just part of the larger transportation infrastructure. GDOT’s connected vehicle program is housed within the Regional Traffic Operations Program (RTOP), a multi-jurisdictional, cutting-edge signal timing program. The goal of RTOP is to improve traffic flow and reduce vehicle emissions through improved signal timing. Georgia DOT provides signal timing experts focused solely on Atlanta’s busiest arterial roadways. RTOP also assists local jurisdictions to quickly find and repair problems.

GDOT views the deployment of connected vehicle technology as the continued evolution of our infrastructure. Combining the deployment of CV technology with RTOP allows the Department to leverage already existing resources and be efficient in pushing regionally scaled programs.

**In Partnership with Local Governments.** To diversify and to expand off the RTOP network, Georgia DOT’s Regional Connected Vehicle partnership with the ARC provides for necessary infrastructure configuration, deployment, and support over several years with numerous participating local governments in a multi-phase arrangement. The intention is for future deployments as participation and funds allow.

The GDOT-ARC program targets an additional 1,000 connected vehicle locations across the metro Atlanta region to add to the initial 1,600.

This subsequent program will use both the proven DSRC technology, as well as cellular vehicle-to-everything-communication (C-V2X) all within the 5.9 GHz safety spectrum. Like the original deployment, this program has regional and national interoperability. It will be pursued through a competitive procurement process.

Though the list of possible applications from connected vehicle technologies is long, the GDOT-ARC vehicle-to-infrastructure application targets these priorities: signal phasing and timing broadcast (SpaT), map data (MAP) message broadcast, emergency vehicle preemption, transit signal priority, freight signal priority and non-intersection-based applications such as traveler information messages.

**Innovation on The Ray on I-85.** Finally, one of GDOT’s most innovative partnerships is a pilot project on I-85 with Panasonic, the Federal Highway Administration, and The Ray, a living transportation laboratory. On the Ray’s 18-mile stretch of rural interstate in West Point, GA are six roadside units broadcasting through C-V2X technology. As part of the project, four demo vehicles are equipped with on-board units to broadcast basic safety messages. This project along a rural interstate corridor enables various connected vehicle applications such as queue alerts and road weather alerts. GDOT also utilizes Panasonic’s CIRRUS data platform to ingest and act upon data collected from suitably-equipped vehicles.

**Goal to Ultimately Connect All of Georgia with CV Technology.** Georgia DOT has been a leader in connected technology infrastructure (CTI) for almost two years with the goal to positively impact safety and mobility on all Georgia roads. Through a combination of self-funded initiatives, multiple department and jurisdictional programs and innovative pilot projects, GDOT is deploying the best technology for today, while constantly preparing for whatever the future may bring. It’s not just about implementing new technology, but about connecting what we already have through a diverse, flexible, and scalable technology that is designed to work in an interoperable environment.

Andrew Heath, P.E. (M) is Georgia Department of Transportation’s state traffic engineer. He leads the Office of Traffic Operations, where he focuses on addressing congestion and reducing roadway fatalities. He has been with GDOT for 12 years. Heath has a bachelor’s and a master’s in civil engineering from Auburn University. He is a licensed professional engineer in Georgia.

**References**


Great Lakes District Administrator

Patrick O’Connor, P.E., PTOE (M)
Project Manager, American Structurepoint, Inc.

Education
Bachelor of Science in Civil Engineering, Purdue University
Professional Affiliations/Certifications
A member of IMSA, he also holds the Traffic Signal Level 3 Senior Field Technician certification.

Awards
Patrick was awarded Young Engineer of the Year in 2011 by ITE’s Florida Section. The award recognizes outstanding contributions to the Section and to the transportation profession.

ITE Service
Great Lakes District Administrator
2020 Midwest + Great Lakes Joint Annual Meeting Local Arrangements Committee
“New” Great Lakes Transition Team

In celebration of its 90th anniversary, ITE is recognizing each of its District Administrators throughout the year in a series of profiles. Each month this column will also feature historical facts and figures on the various Districts, including important dates and people throughout their history.

Since graduating from Purdue in 2002, Patrick O’Connor, P.E., PTOE (M) has lived and worked in Dallas, TX, USA and Tampa, FL, USA. When his wife, Alicia, had the opportunity to move to Indianapolis, IN, USA a few years ago, Patrick was thrilled to be going “back home again” and is currently a project manager for American Structurepoint, Inc., specializing in traffic operations.

O’Connor was appointed to the role of ITE Great Lakes District Administrator (DA) in 2015 by Hardik Shah (M) who was serving as the Great Lakes District Chair and International Director at the time. He succeeded fellow Indiana Section member Tony Jones (M).

“My path isn’t unlike that of many of my colleagues,” O’Connor says. “I was good in math and science, and took an Engineering 101 class where different professionals came in each week and talked about the kind of engineering they did. I thought I might like civil engineering if I could be outside and around construction. After my sophomore year I interned at—a basically—one-man shop, and that’s where I got my real education—baptism by fire, as they say. And I realized that I really did want to be an engineer—dirt and water don’t interest me, but if I can be around cars, I am happy.”

Since graduation, O’Connor has served various client types throughout a wide range of specialties as the market and his job required. “The latter portion of my career I have focused on traffic operations where I really enjoy problem solving in real time,” he says. “There is nothing like an upset motorist honking and sharing their sometimes-explicit thoughts with you while fine-tuning signal timings in a cabinet to motivate you to find a safe solution!”

O’Connor’s role as District Administrator (DA) is different from the other DAs throughout ITE. Great Lakes’ District leadership is “lean and mean” as they do not have elected officers. The District board is comprised of current elected Section presidents and past presidents who, in addition to their Section duties, also serve on the District board. Furthermore, Scott Knebel (M) is the only International Director that also serves as International District Director/Chair, keeping him extremely busy with his ITE responsibilities. O’Connor says he spends a lot of time communicating with Board/Section leadership and committee chairs. “At the end of the day our current structure gives us a lot of freedom of movement to get things done and serve our members and District efficiently,” he notes.

Patrick shares a Great Lakes District update at the February Indiana Section Technical Lunch at the Rathskeller Restaurant in Indianapolis, IN.
Getting to Know
ITE’s Great Lakes District

Sections
Indiana
Michigan
Ohio

Members
As of 2020, the Great Lakes District has approximately 900 members, including 250 student members in what is currently ITE’s smallest (non-international) district. Big changes are happening, however, in terms of the Great Lakes’ footprint and membership size: As part of the ONE ITE initiative, the current Great Lakes District is merging with ITE’s Illinois, North Central, and Wisconsin Sections to form a “new” Great Lakes District.

Student Chapters: 10

District Board Leadership
Chair and International Director – Scott Knebel, P.E. (M)
Vice-Chair – Carissa McQuiston, P.E. (M)
Treasurer – Jared Love, P.E., PTOE, PMP (M)
Secretary – Rich Zielinski, P.E. (M)
Member – Neal Underwood, P.E., PTOE (M)
Member – Laura Slusher, P.E. (M)
Member – Lia Michaels, P.E., RSP1, PTOE (M)

Of note: Michigan Section past President and Great Lakes District Vice-Chair Carissa McQuiston also serves as the Midwest District Secretary to ensure a smooth transition into 2021.

Did You Know?

• The Great Lakes District Board is comprised of two officers from each of the three Sections’ leadership (president and past president) for a two-year term plus the District Chair and International Director, a position filled by an individual for a three-year term (it rotates amongst the three sections). As they transition to the “new” Great Lakes District, they will adopt a more typical structure.

• Traffic Bowl is Serious Business! Great Lakes Traffic Bowl stats:
  • Ten years of District Traffic Bowls in eight different cities: Indianapolis, IN; Columbus, OH; Lexington, KY; Grand Rapids, MI; Dayton, OH; Chicago, IL; Ann Arbor, MI; and Ft. Wayne, IN.
  • Four winning schools (Purdue, Ohio State University, Wayne State, and Trine University)
  • Four schools represented at the international level (Purdue, Western Michigan University, Wayne State, and Trine)
  • Purdue has won the event 7 times, including 5 consecutive wins (2014-2018)
  • Eight different schools have participated

Historical Perspective

• The Ohio Section of the Institute of Transportation Engineers was founded in 1956 with 11 charter members.
• Paul Robinette was a charter member of the Ohio Section, and became City Traffic Engineer of Toledo, OH in 1936. He is believed to be the first person to hold that title in an Ohio city.
• Roger L. Morrison, the fourth president of ITE, was a native of Illinois. He became an associate professor and the professor of highway engineering and transportation at the University of Michigan in 1924. At the time of his election, he was the first mid-westerner to serve as President of ITE. He was also a founder of ITE in 1930 and a vice president for two years, 1934 to 1936. He was a director from 1931 to 1933. He was named an ITE Honorary Member posthumously in 1952.

O’Connor joined ITE as young member in 2004 and was active in the Dallas Section of Texas ITE. He says that staying active in ITE truly yields great benefits and, although he’s moved multiple times, the friendships and professional contacts he’s developed over the years through ITE are still dynamic and growing. Additionally, serving the Tampa Bay Chapter as Board President was a great opportunity for exposure to the full gamut of leadership within ITE, from interactions with our members to working and being involved with the District leadership.

“Become active! You’ll never be turned away, as we always need help,” he offers as advice to ITE members looking to become more involved. “If you see an opportunity to contribute or where you could benefit, speak up. There is never the right time, or the right amount of experience before being comfortable raising your hand to volunteer. Take the smallest opportunity to dip your toe in, or jump in with both feet.”

He adds, “As long as you are willing to listen, take direction and ask for help, you will be successful and benefit ITE. Also, take advantage of the ITE Young Member discounted dues if your company or agency doesn’t support you—it’s worth the investment in yourself.”

Students from Trine University (Indiana) receiving the Great Lakes District Traffic Bowl winners plaque at the 2019 GLD Annual Meeting in Indianapolis, IN.

Roger L. Morrison
In celebration of ITE’s 90th anniversary, throughout 2020 ITE Journal will feature a monthly snapshot of the transportation industry by decade, beginning with the turn of the 20th century through present day. These are the technologies, events, and key players that transformed transportation to bring us where we are today.

1950s
The 1950s saw the authorization of a multibillion-dollar package for an interstate highway system in the United States, the largest public works project in America at that time. As the road system grew, freight trucking presented competition for railroads—by the early 1950s, trucks carried 17 percent of all freight ton-miles (today, truck freight accounts for more than 57 percent).¹

Major Deegan expressway outside New York City, NY, USA had six lanes to accommodate increasing suburban commuter traffic in 1957.

Highway Capacity Manual – January 1, 1950

National system of interstate and defense highways as of June 1958.
Traffic Signs and Signals

1954 MUTCD Revision

Though no new editions of the Manual on Uniform Traffic Control Devices (MUTCD) were published the 1950s, a revision to the 1948 MUTCD was released in September 1954. Significant changes:

- Stop sign color went from black on yellow to white on red.
- Prohibited the use of secondary messages on stop signs (a common practice before the revision).
- The yield sign was first introduced, in the form of a yellow triangle with a black “yield right of way” legend.3

Before the 1950s, the U.S. stop sign was black on yellow.

The triangle yield sign appeared in the 1954 MUTCD revision.

AASHO Interstate Manual

In the 1950s, Traffic engineers felt that current MUTCD standards did not adequately address the needs of the high-speed, controlled access nature of the new interstate highways. To fill the gap, AASHO published the first edition of the Manual for Signing and Pavement Marking of the National System of Interstate and Defense Highways in February 1958.1

New features:

- White on green guide signs
- Lowercase letters
- Green on white service signs
- Utilized larger sign sizes

ITE Presidents – 1950s

Harry E. Neal
1950–1951

Nathan Cherniack
1951–1952

F. Bruce Crandall
1952–1953

Donald M. McNeil
1953–1954

Harry Porter Jr.
1954–1955
September 25, 1950 – ITE Board of Direction forms first “Technical Council”

The Board of the Institute of Traffic Engineers directed the formation of a “Technical Council” to make recommendations to them on technical matters. The Technical Council organization consisted of six technical committees, each with their own set of subcommittees and projects.


ITE published a 1950 edition of the Traffic Engineering Handbook (the first edition appeared in 1941). For more than 70 years, ITE has continued to publish the Traffic Engineering Handbook. Now in its seventh edition, the manual has maintained its reputation as the go-to source of essential traffic engineering solutions.

AASHO Road Test – January 1, 1955

The Bureau of Public Roads endorses the American Association of State Highway Officials (AASHO) Road Test. The test, a $27 million USD investment, studies the performance of highway pavement structures of known thickness under moving loads.

Federal Aid Highway Act – June 29, 1956

President Eisenhower signed the Federal-Aid Highway Act, authorizing $25 billion USD for the construction of 41,000 miles (66,000 kilometers) of the Interstate Highway System.

ITE Headquarters Relocates to Washington, DC – 1956

ITE moves its headquarters from Strathcona Hall at Yale University in New Haven, CT, USA to 2029 K Street NW, Washington, DC, USA.

ITE Presidents – 1950s

- Charles W. Prisk: 1955-1956
- J. Carl McMonagle: 1956-1957
- Joseph E. Havenner: 1957-1958
- Matthew C. Sielski: 1958-1959

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Leveraging Connected and Automated Vehicle (CAV) Technology Initiatives to Advance Safety and Mobility

By Raj Ponnaluri, P.E., PTOE, Ph.D., PMP (M)
As a part of its mandate to serve its membership, ITE is advancing knowledge, providing guidance, and instilling the spirit of workforce development in all aspects of transportation technology advancements. As part of ITE’s Connected and Automated Vehicle (CAV) Institute Initiative, a joint Steering Committee on CAV was formed. Some of the objectives of this CAV Steering Committee include: advocating for the policy and governance elements; providing guidance on technology deployments; documenting the lessons learned; discussing topics of interest to the practitioners; and speaking for the membership on policy, education, outreach, national standards, rule-making, and more.

The ITE CAV Steering Committee’s activities are aimed at stakeholders such as the following:
- The Federal Highway Administration (FHWA);
- Infrastructure Owner Operators (IOO) such as the state Departments of Transportation (DOTs), local agencies, and Metropolitan Planning Organizations (MPOs);
- The transportation consulting industry;
- Technology equipment vendors and industry partners including auto manufacturers often referred to as Original Equipment Manufacturers (OEMs);
- Academia and researchers; and
- Standards development organizations such as the Society of Automotive Engineers (SAE) and the Institute of Electrical and Electronics Engineers (IEEE).

The ITE CAV Steering Committee includes members from all core ITE Technical Councils, as well as members who serve on other significant national groups such as the American Association of State Highway and Transportation Officials (AASHTO), Transportation Research Board (TRB), ITS America, National Operations Center of Excellence (NOCoE), and the National Electrical Manufacturers Association (NEMA); while also coordinating with international entities such as the ERTICO, ITS Asia-Pacific, AustRoads, etc., as necessary.

This white paper synthesizes topics of immediate relevance to the ITE membership and the transportation community at large. It is timely because several IOOs are deploying CAV programs with synergistic projects, or are considering emerging technologies with the primary objective of significantly reducing traffic crashes and improving mobility for all road users. These safety and mobility benefits are to be gained during both recurring and non-recurring congestion, on freeways and arterials, in urban and rural areas, within the United States and around the world.

Emerging technologies within the transportation context, and an understanding of good project management practices and innovative procurement methods, are essential for implementing CAV programs. Strategic planning should also recognize user needs, avoiding technology deployments just because they are “cool.” A typical project management lifecycle requires systematic and systems level planning, but with a goal to quickly deploy projects to immediately realizing the benefit of current technologies. Practitioners experience challenges with seeking funding to deploy CAV projects, especially because estimating benefit-to-cost ratios or return on investment is difficult. This is partly because few methodologies exist to quantify the safety and mobility benefits of these emerging technologies.

AASHTO and USDOT are credited with their milestone announcements on the Signal Phasing and Timing (SPaT) Challenge and the USDOT Joint Program Office (JPO) connected vehicle (CV) Pilot projects, which have both radically transformed emerging technologies deployments and the active utilization of the 5.9 GHz safety spectrum.

**Intelligent Transportation Systems**

Traditional traffic engineering has been in development for several decades before the advent of the Intelligent Vehicle Highway Systems (IVHS) during the 1990s, which led to the creation of a well-defined, actively discussed, and comprehensively collaborated intelligent transportation systems (ITS) framework. Today, practically every transportation entity, public or private, includes ITS, and leverages ITS technologies with real-time traffic data monitoring capabilities. IOOs also include...
statewide and Regional Transportation Management Centers (RTMCs) whose primary purpose is to collect, analyze, maintain, and disseminate data and information with the express intent to serve the safety and mobility needs of all road users in real-time. While CAV may be considered nascent, emerging technologies have always evolved. The difference is that ITS systems are now being fully utilized, thereby providing a significant impetus to the CAV programs.

The emphasis of TSMO strategies has recently advanced the discussion on the emerging transportation technologies even further, as TSMO mainstreams ITS by extending it from the systems and policy planning stage through project development and environment (PD&E), design, construction, operations, and maintenance. However, the need for developing a sustainable funding program is less discussed but equally important, helping formulate, identify, and prioritize funding availability. When juxtaposed with the ITS maintenance and operations funding allocations, programs become institutionalized and lead to sustainable initiatives that can last beyond the pilot phase of any project. ITS used to be typically associated with only the freeway systems. The more recent significant advancements with traffic signal systems, arterial network, and multimodalism have expanded the role of ITS to include the active management of arterial corridors, integrated corridor management (ICM), transit signal priority (TSP), and freight signal priority (FSP). The fiber network of the ITS systems is the key component to enable technology platforms and is thus an important element of CAV deployments, especially when large volumes of disparate data need to be transmitted to a central system through a back haul. Even though the typical CAV equipment such as the road side units (RSU) and on-board units (OBU) can be distinguished from the standard ITS equipment such as dynamic message signs (DMSs), closed-circuit televisions (CCTVs), highway advisory radios (HARs), etc., at some point in the future the CAV equipment will be treated on par with ITS infrastructure.

ITS systems provide ground truthing in real-time, and are at the forefront in collecting data and information by utilizing the ITS detectors in the field, the microwave vehicle detection systems (MVDS), CCTVs, radar systems, and many other sensors. Even though standards are being developed for the CAV devices and associated data structures, the existence of adopted standards for ITS infrastructure help to jump-start any CAV program. For instance, the 511 programs in various states collect information that is disseminated to the general public and can be readily integrated into a potential vehicle-to-everything (V2X) data platform (vehicular technology that allows a car to communicate with other cars and infrastructure around it) as is being pioneered at a few agencies.

RTMCs are an important component of ITS systems and will play a crucial role in realizing the full benefits of CAV deployments, which in turn depend on strong ITS networks. Any CAV program should be seen as being integral to ITS systems at the agency, and therefore the need for CAV to reside within the traffic engineering and operations divisions which is also where the operations-led TSMO and ITS programs are housed. TSMO and ITS focus on freeway and arterial operations, including traffic incident management, managed lanes, commercial vehicle operations, and the traditional traffic engineering practices. Thus, CAV stands to gain from institutionalization, infrastructure readiness, innovation, implementation, and ingenuity perspective.

Institutionalization
An empirical review of the transportation practice, particularly at public agencies and even more so within the operations divisions, shows the significant role played by individuals who—over time—may have developed rigorous programs. These champions pioneer concepts of immediate importance to the agency and the stakeholders with a goal directly or indirectly linked to safety and mobility of the transportation network. Over time, the efforts of such individual champions develop into solutions-oriented approaches with seemingly streamlined programs yet with visible gaps in intra-departmental collaboration and inter-departmental coordination. Such gaps provide an indication and are symptomatic of program individualization. Over time, this forms silos and creates barriers for interested stakeholders to enter and support such systems.

Agency leadership should recognize individualization and implement preventive practices such as the development of a second-layer leadership to address the silo effect, failing which the organization could remain dependent on the champion. These individuals are also often the technical experts who take up the role of administrators and managers, an aspect that could either spur or stifle innovation. Such champions fully embrace technology, provide space for stakeholders, invite the industry, encourage research, develop a strong vision, seek and obtain funding, set the program in motion, develop and implement projects, achieve the organizational objectives, monitor progress, and develop performance-oriented systems.

On the other hand, a skeptical individual may impede exploring the utility of emerging technologies, let alone implement the same to address the safety and mobility concerns. Such professionals in managerial roles cause a ripple effect by impacting the entire divisions, departments, and organizations, in at least three aspects:

Safety and Mobility. Not adopting the transportation technologies is counterproductive especially when successful deployments by other entities do in fact yield quantifiable reductions in traffic crashes and congestion.
Opportunity Costs. Not adopting the transportation technologies could set the organization behind both in time and innovation. The organization may face significant challenges in the future with higher costs and a need for significant infrastructure upgrades.

Workforce Development. The new and incoming professional staff are not only interested in but are also able to incorporate technological advancements into their day-to-day job functions. Not adopting the transportation technologies could discourage the younger workforce from proposing any innovative ideas and over a period of time, the organization could lose competitiveness and residual capabilities.

Forward-thinking leaders keenly observe their organizations top-down and bottom-up, identify the champions, provide them the necessary resources and support, encourage ideation and technology adoption spurred by these champions, innovate with the industry recognized by the champions, and begin institutionalizing such thought leadership.

Institutionalization, just as with individualization, has its own set of strengths and weaknesses. In particular, this leads to sustainability and building strong technology organizations, which last beyond the tenures of the leaders and the said champions. Technology adoption, especially with many IOOIs seeking to leverage it for the safety and mobility gains, needs to continue un-impeded, for which a long-term perspective is essential.

Institutionalization, as opposed to individualization, is about the only way to provide confidence to the industry for partaking in discussions to consider advancements, adopt technologies, conceptualize programs, and deploy projects to fulfill the organization’s vision, mission, and objectives. It is worth observing that good institutions in fact emerge from established champions.

Innovative Portfolio Development
Capturing the vision of an organization and translating its mission into an implementable portfolio of programs and projects, with a feasible work breakdown structure that incorporates transportation technologies, is essential to developing sustainable safety- and mobility-centric CAV programs. Several organizations, IOOIs for example, have embarked on developing strategic plans for their TSMO programs. Pivotal to success are garnering financial support; mainstreaming the programs across disciplines and divisions internal and external to the organization; and designing, developing, and deploying TSMO and ITS initiatives. Organizations may repeat this process to launch their emerging technology portfolio of CAV programs and projects. Entities that have already been participating in the AASHTO SPaT challenge, deploying the USDOT JPO and projects, and implementing their respective state and local funded projects have all developed ingenious ways that are specific to their respective organizations. In Florida, USA for instance, the SPaT-only deployment in Tallahassee was followed by the Gainesville SPaT project which included other CAV applications such as motorist-to-pedestrian communication, passenger collision warning, emergency vehicle preemption, etc. This was followed by incorporating RSUs with both dedicated short range communications (DSRC) (an open-source protocol for wireless communications) and cellular-vehicle-to-everything (C-V2X) (which uses cellular connectivity to facilitate communication to and from vehicles) capabilities in Pinellas County, FL. Ingenuity could extend in several directions including technical elements and process orientation. While the DSRC alongside C-V2X communication modes were considered in the Pinellas County SPaT project, the Gainesville experience showed that innovative procurement approaches should be explored despite the legacy procurement protocols at public agencies.

Engaging with the transportation industry is a crucial factor for a successful implementation of CAV applications. IOOIs exist to serve the people and all road users, and are therefore intimately familiar with the functional needs of any technology system. Industry, on the other hand, develops commercial solutions and contributes the technical know-how and the intellectual capital with equipment and sensor capabilities to realize the safety and mobility goals of the public entities. Therefore, the emerging technology portfolio development strategies should consider several stakeholders including the industry and the research community to fully capitalize the public-private process, program, and project partnerships with connectivity; yet, such connectivity among infrastructure, vehicles, and all modes should remain seamless because the real required outcome is the reduction in traffic crashes, relief in traffic congestion, promoting commerce, and improving the environment.

Development of the vision, mission, and objectives by the agency leadership followed by program development by the senior executives and a well-defined array of projects by technical experts eventually leads to a structured project management implementation framework. While several standard approaches exist, the 10 knowledge areas and the five process groups proposed by the Project Management Institute (PMI) in the Project Management Body of Knowledge (PMBOK) can help the practitioner to conceptualize CAV initiatives from concept to concrete. Given that the shelf-life of technology in the modern era is extremely short, and new market players emerge or purge all the time, the project management lifecycle should be agile. The project manager should strive to expedite the development and delivery of the CAV program goals while striking a balance between resources, budget, time, and any other considerations. Both systems engineering and agile approaches can help achieve this. Ingenious portfolio development should also account for the leadership to be keenly aware of the challenges faced by the CAV program staff and
implementing stakeholders. If the goal is to realize the safety and mobility outcomes with available technologies, their primary task is to remove hurdles.

**Infrastructure Readiness**

In empirical terms, only a small percentage of the signalized intersections in the United States use advanced transportation controllers (ATCs). ATC units have modern processors and memory and they are also designed to be updated in the future should further processing power be necessary. An even smaller percentage of these ATC units are running ATC API software. The API software allows multiple applications to run concurrently on a single ATC unit and these applications may be provided by different vendors. It is this type of infrastructure that gives IOOs the most choices in deploying CAV as well as any potential field deployed applications whether they be traffic related, smart city applications, multimodal applications, security, and many others. For instance, the function of the RSU could be performed by an application program on an ATC unit with API software instead of a separate box in the cabinet. While it is conceivable that late pre-ATC transportation controllers could be enhanced to perform SPaT messaging, it is unlikely that manufacturers will modify pre-ATC software to perform this function.

Multiple modes, especially non-motorized, are present on arterials and at both signalized and unsignalized intersections; hence the need to evaluate infrastructure and its capabilities. Organizations wanting to implement their CAV programs should consider readiness studies with a specific intent to evaluate their roadway assets including the make, model, and version of their traffic signal controllers and the firmware on the arterial network. As discussed earlier, the ITS infrastructure on the freeway network provides an important readiness-framework for CAV projects. However, gaps exist, particularly in municipalities, and should be considered as a part of the infrastructure-readiness evaluation.

An often-discussed item of interest to the IOOs and the industry, in particular the OEMs, is signing and pavement markings (S&PM). While the concept of barcodes and radio frequency identification (RFID) is being explored for machine readability of traffic signs, a greater interest lies in recognizing the pavement markings and the contrast features as good or better than the human eye from a machine readability standpoint. These aspects are typically categorized under automated driving system (ADS), and need significant collaboration among IOOs, OEMs, data brokers, S&PM innovators, and scientists, and researchers. The interdisciplinary and cross-functional nature of this work requires a full-scale understanding of the assets in place and the use of associated technologies such as light detection and ranging (LiDAR), radio detection and ranging (RADAR), global positioning system (GPS), etc. While deployments are primarily implementation-centric, the infrastructure-readiness exercise should not ignore the future systems and policy planning objectives of an organization. For instance, the medium- and large-scale green projects, both in terms of budget and scale, should include the latest technology elements to maximize vehicle throughput (i.e., capacity), and safety benefits.

Infrastructure-readiness is also intricately connected to program funding. Traffic signal controller upgrades alone, for example, can cost an agency millions of dollars. Furthermore, other direct costs constitute the provision for a security credential management system (SCMS) and ancillary software and firmware upgrades. Indirect costs such as those for training and workforce development should also be factored in. Adding CAV devices such as the RSUs may not require structural recalculations or adjustments to the mast arms or span wires, but will require an in-depth understanding if more devices are added to the physical infrastructure. Similarly, the available space within a controller cabinet and the firmware upgrade provisions should be considered. Many other such aspects related to the various ITS field devices and design features should also be evaluated.

The concern at this time is that known infrastructure improvements necessary for CAV readiness are not being addressed. New requirements and specifications should be developed at the planning levels of local and regional agencies. Otherwise, agencies will continue to purchase what they have always purchased. In the United States today, the majority of agencies are still buying new traffic controller units based on decades-old technology.

**Implementation**

The pinnacle of any program is the realization of safety and mobility benefits, neither of which can be accomplished without field implementation and maintenance of projects, emerging technologies, and CAV applications. Agencies may develop comprehensive programs based on sound planning, resource provisions, and sustainable funding approaches. If the implementation mechanism is not streamlined or if it is not timely, the organizational and project objectives will not be met. Therefore, the implementation of emerging technologies requires the involvement and commitment of senior leadership just as the need for technical capabilities of implementation staff and the relevant consultant support. Branding CAV programs for public knowledge and acceptability and for funding justification to expand the technology platform require that the IOOs partner with the industry and key stakeholders such as local agencies. Program and project implementation alone is the way to learn the lessons from the deployed projects and to build a road map with subsequent projects that add value to the previous initiatives or to modify them as necessary. Some IOOs found much success in pursuing research and development avenues not only with academic
projects but also field implementation initiatives. Implementation effort requires a full-scale understanding of the interdisciplinary functions within an organization such as:

- The need to evaluate if the proposed CAV program is consistent with the organizational policy;
- The need to determine if the proposed CAV program matches the system-level objectives of the IOO;
- The possibility of including all possible technology alternatives within the PD&E studies;
- The availability of guidelines, specifications, and standards during the design phase;
- The potential to supplement construction contracts with emerging technologies in Smart Work Zones (SWZ), etc.;
- The in-depth profile of benefits to be gained from CAV applications in traffic operations;
- The utility of advancements such as autonomous truck mounted attenuators (ATMA) with routine maintenance or construction activities, etc.

**Conclusion**

The ITE CAV Steering Committee is aggressively working to support the ITE membership by serving as a knowledge center on all CAV aspects including policy formulation, planning consideration, implementation readiness, deployment challenges, education and outreach strategies, and lessons learned from ongoing efforts. The Steering Committee thanks ITE leadership for providing a forum to discuss the topics of interest and to develop guidance on institutionalization, innovation, infrastructure-readiness, and implementation of CAV programs. 

Raj Ponnaluri, P.E., PTOE, Ph.D., PMP (M) chairs the ITE CAV Steering Committee, and serves as the state connected vehicle and arterial management engineer at the Florida Department of Transportation. He leads the state’s CAV, arterial management, and wrong-way driving programs. He also assists with developing and implementing TSMO in Florida.
Preserving the Safety Spectrum

By Holly Gilbert Stowell
In 1999, the U.S. Federal Communications Commission (FCC) set aside 75 megahertz (MHz) of bandwidth in the 5.9-gigahertz (GHz) spectrum for dedicated short-range communications services (DSRC). The spectrum was exclusively reserved for road safety and its use enables vehicle-to-everything (V2X) communication. V2X technologies rely on communication between cars and the outside world—everything from roadside sensors to pedestrian signals to electronic parking, and much more—even helping enhancing the safety benefits of automated vehicles.

Use of the safety spectrum to enable V2X safety applications has the potential to save lives and prevent serious injuries on our nation’s roads. Data from the National Highway Traffic Safety Administration (NHTSA) of the U.S. Department of Transportation (USDOT) showed that 36,750 people died in motor vehicle crashes in 2018. The Department has consistently supported preserving the safety spectrum for transportation safety communications. In fact, the NHTSA estimated that full adoption of only two V2X safety applications would prevent about half a million crashes and save about 1,000 lives a year.1, 2

However, in late 2019, the FCC proposed opening up the lower 45 MHz of the safety spectrum for unlicensed, non-safety uses, potentially disrupting critical, high-speed V2X communications that can prevent crashes and resulting injuries and fatalities.

In response to the FCC’s announcement, there has been strong opposition from transportation organizations including ITE, AASHTO, ITS America, and state and local departments of transportation (DOTs) calling for the preservation of the spectrum for exclusive transportation use. In a letter to FCC Chairman Ajit Pai, USDOT Secretary Elaine Chao stated that the agency had “significant concerns with the Commission’s proposal, which represents a major shift in the FCC’s regulation of the 5.9 GHz Band and jeopardizes the significant transportation safety benefits that the allocation of this Band was meant to foster.”3 Those concerns were recently reiterated in a letter from 38 members of the House Committee on Transportation and Infrastructure.4

The following is a look at current uses of the safety spectrum, background on the FCC’s proposal, and advocacy being carried out by organizations such as ITE in support of preserving the spectrum.

**Uses of the Spectrum**

Since the 5.9 GHz band was set aside for safety communications, transportation experts on both the vehicle and infrastructure side have collaborated on developing service rules for the band, carrying out critical safety proof-of-concept tests, and conducting pilot deployments to gain knowledge in key issues critical to future large-scale deployment. Several applications for the spectrum have emerged, and there are examples throughout the country that point to both successes and potential for further growth. (For more uses of the spectrum, see sidebar on page 40.)

DSRC emerged as an early technology of choice to enable V2X communications that industry dictated would be necessary for safety-related applications. DSRC is a high-speed low-latency communications medium that enables vehicles to exchange data with other vehicles, infrastructure, and other devices to prevent crashes, enhance mobility, and reduce vehicle emissions. Based on the IEEE 802.11p standard (a variation of Wi-Fi), DSRC has been designed for highly secure, high-speed wireless communication between and among vehicles, as well as with the infrastructure. More recently, a group of companies and organizations began also exploring the use of cellular protocols for secure high-speed wireless communication. From that effort, long term evolution (LTE), a 4th generation (4G) cellular network protocol, was identified as a potential alternative to DSRC and is generally referred to as cellular-vehicle-to-everything (C-V2X).

Many automakers indicated that they were adopting or planning to adopt V2X communication technologies in newly manufactured vehicles to enable such communication. However, comments by the FCC in 2019 referring to the spectrum as “lying fallow” and a “promise unfulfilled” stalled production, and many automakers have since announced they would pause the roll-out of such technology for the time being.5, 6, 7

**Current Deployments**

There are several uses of the spectrum throughout the United States. According to the USDOT, “There are currently 123 planned or operational connected vehicle deployment locations in the United States, all of which use the Safety Band. More than 18,000 vehicles
are deployed with aftermarket V2X communications devices.\textsuperscript{8} USDOT adds that more than 6,000 infrastructure V2X devices have been installed at the roadside in 25 states, as shown in the graphic put together by the USDOT Volpe National Transportation Center (Figure 1). For example, a Safety Pilot Model Deployment program in Ann Arbor, MI, USA in 2012 used CAV technology in more than 2,800 vehicles at 29 infrastructure sites to test the effectiveness of CAV crash avoidance systems. After the success of this program, the USDOT proposed rulemaking to require vehicle-to-vehicle (V2V) communication capability for all light vehicles and set the minimum performance requirements and the standard features used on the interface required to establish interoperability for V2V Safety Awareness communications. The project in Ann Arbor continues by the University of Michigan Transportation Research Institute and its partners, which have expanded the infrastructure footprint from Northeast Ann Arbor to the entire 27 square miles (44 square kilometers) of the city, and increased the number of RSUs from 25 to 75.\textsuperscript{9} More than 2,500 CAVs have been equipped with DSRC, paving the way for federal funding from the USDOT for three test sites: Wyoming; New York City, NY; and Tampa, FL.\textsuperscript{10}

**SPaT Challenge.** DSRC pilot deployments are also being encouraged by the Signal Phase and Timing (SPaT) Challenge, an effort led by ITE, AASHTO, and ITS America. Working together through the Cooperative Automated Transportation Coalition, the initiative challenges transportation infrastructure owners and operators to deploy a V2X communications infrastructure with SPaT broadcasts in at least one corridor in each of the 50 U.S. states. A SPaT message defines the current intersection signal phases; the current state of all lanes at the intersection are provided, as well as any active pre-emption or priority.\textsuperscript{11}

Twenty-six states have committed to the SPaT Challenge, with more than 2,000 signals planned. This challenge encourages the continued development and deployment of V2X technologies, helping these communication methods keep pace with the other rapidly developing features of automated vehicles. The challenge is critical, as there is no government-based requirement to develop such technologies. Furthermore, participation in the SPaT Challenge shows a commitment to DSRC infrastructure to auto manufacturers and applications developers.

**FCC Proposal**

The official Notice of Proposed Rulemaking (NPRM) to change the safety spectrum was issued by the FCC on February 6, 2020—but long before that, the FCC indicated it was considering making changes to the spectrum. One of FCC’s commissioners, Jessica Rosenworcel, stated in 2018 that the DSRC has not reached its full

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**Figure 1.** Map of V2X deployed by state and local governments throughout the United States.
Then in May 2019 at the Wi-Fi World Congress, FCC Chairman Pai made the initial announcement that the agency was considering changing the use of the safety spectrum. He stated that the FCC would propose opening-up the lower 45 MHz of the 5.9 GHz band for unlicensed operations to support high-throughput broadband applications, such as Wi-Fi. The upper 20 MHz would be allocated for C-V2X automotive communications technology. With the remaining 10 MHz, the FCC would seek comment on whether to retain it for DSRC or dedicate the segment to C-V2X. 5

Support for the Spectrum. For more than two years, organizations including ITE have repeatedly called on the FCC to protect the ability for the transportation community to utilize the safety spectrum for transportation safety applications without the probability of interference by allowing unlicensed Wi-Fi devices in the lower portion of the band.

“At a time when connected and automated vehicle technologies are just emerging into the marketplace…removing or compromising the 5.9 GHz spectrum set-aside for transportation safety purposes could hinder the development of safety applications and hamper our ability to save lives,” wrote Jeff Paniati, ITE CEO and executive director, in a press release. This is in line with ITE’s position on connected and automated vehicles that includes support for fully protecting the currently designated 5.9 GHz safety spectrum for use by CAV applications and services.

AASHTO executive director Jim Tymon reiterated that sentiment. “The 5.9 GHz band has been part of the spectrum that has been reserved for use for life-saving transportation technologies…at a time when we are trying to get to zero traffic fatalities, the FCC should stay the course and not give up the spectrum that the transportation community has been counting on, and has already made considerable investments in, to help save lives.”14

In addition, leaders of all 50 state DOTs, the District of Columbia, and Puerto Rico signed a letter sent to the Federal Communications Commission on August 20, 2019 in favor of preserving the 5.9 GHz safety band.15

After FCC Chairman Pai’s announcement of the draft proposal at a speech in November 2019, ITE joined organizations including AASHTO, the Insurance Institute for Highway Safety, International Association of Fire Chiefs, and others calling on the FCC to reconsider giving up a large portion of the spectrum.6

“Connected vehicle technologies have been identified by the National Highway Traffic Safety Administration as having the potential to save tens of thousands of lives each year—but only if these technologies are given the certainty of a safety spectrum that is free from signal interference,” ITE stated in a press release dated November 21, 2019.16 “States and cities across the country have

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**Uses of the Safety Spectrum**

**V2V: “Vehicle-to Vehicle”**
Messages are broadcast rapidly from each vehicle (as often as 10 times per second). Vehicles receiving the messages use this information to predict potential collisions and warn the driver to take action (or eventually initiate action with automated driver assist functions).

**V2I: “Vehicle-to-Infrastructure”**
V2I technology at the roadside can enable wireless notification of traffic signal information; work zone locations; lane closures; and other possible roadway interference to enhance safety and reduce congestion. There are several uses for the 5.9 GHz safety spectrum for V2I communications, including but not limited to:
- Emergency vehicle preemption of traffic signals
- Traffic congestion detection
- Red-light violation warnings
- Reduced speed zone warnings
- Curve speed warnings
- Spot weather-impact warnings
- Automatic toll collection
- Other safety-critical applications

**V2X: “Vehicle-to-Everything” – The collective of V2V, V2I, and connections with other transportation system users such as pedestrians**

There are numerous possible future uses of V2X for automated driving systems (ADS) which would greatly enhance mobility and safety, paving the way for fully autonomous driving. Some possible uses of V2X include:
- Commercial Vehicle Platooning
- Coordinated Intersection Movement Assist
- Notify ADS vehicles of approaching police and emergency vehicles
- Send wireless notifications of traffic signal and other roadside messages to enhance situational awareness for automated vehicles
- And other new and innovative features and applications

Source: U.S. Department of Transportation, https://www.transportation.gov/content/safety-band
began to deploy these technologies. Reallocation of the majority of the dedicated safety spectrum will likely slow or even halt these deployment activities.”

DOT conducted a preliminary technical assessment in December which found that opening up the spectrum “defers accident reduction for another 5 years, given time to develop, standardize, and deploy equipment—either existing concepts in different spectrum or new concepts in existing spectrum.”

Though the voices of the transportation industry and DOT leaders were resoundingly clear in favor of preserving the spectrum, in December, the FCC voted to move forward with a draft proposal. Chairman Pai said that the spectrum has largely gone unused, and that the proposed split “maximizes the value of the band for the American people. And it would do far more for both automotive safety and Wi-Fi than the status quo.”

FCC NPRM. When the official NPRM went out, the FCC opened a 30-day public comment window on the matter. (As of press time, the 30-day public comment window has closed.) ITE issued a Call to Action, encouraging members to respond to the FCC in support of saving the entire spectrum. “Reallocating this spectrum may halt the development of safety-oriented V2X applications. “State DOTs who have actively pursued pilot and long-term deployments will be forced to reassess ‘what is possible’ under a new environment…And potential automotive and private sector partners may disappear in a constricted spectrum scenario, which could shift the burden of development costs more onto the state DOTs.”

The safety communication applications that do exist on the spectrum may be unreliable if the band is compressed by unlicensed traffic, and states which have allocated funding toward CAV deployment may see those dollars deferred if the spectrum is reallocated. In addition, a decade of momentum in the 5.9 GHz spectrum may be lost, and automated vehicles might continue to develop without the critical “systems approach” of V2X connectivity.

ITE continues to stand with its partner organizations, USDOT, local and state DOTs, and industry leaders on the case for preserving the safety spectrum. ITE sent its public response to the FCC’s NPRM on March 6, 2020, reiterating its position that the safety spectrum must not be compromised in order to continue developing and deploying lifesaving communications technologies. (See sidebar on page 42.)

Ultimately, adding possible interference to the spectrum could come down to life or death on our nation’s roads. As Diana Furchtgott-Roth, USDOT deputy assistant secretary, said during a presentation at the 2020 Transportation Research Board annual meeting in Washington, DC, USA, “these new technologies depend on clear wireless signals that can help cars avoid accidents in the smallest fraction of a second. Sometimes even a fraction of a second wait means the difference between life and death, or between safety and harm.”

Acknowledgement

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References

ITE’s Response to FCC NPRM

In our March 6 letter to the FCC, ITE President Randy McCourt and Executive Director Jeff Paniati expressed our disappointment in the proposal to reallocate spectrum that has been set aside for life-saving communications between vehicles and other users. We dispute the premise that unlicensed applications can operate in 45 MHz of the existing spectrum without negatively impacting the safety applications. We believe realigning the spectrum against the judgment of transportation safety professionals and the recommendations of the Secretary of the U.S. Department of Transportation misses a significant opportunity to save lives.

As a founding member of the Road to Zero Coalition, ITE supports the acceleration of advanced technologies, including connected and automated vehicles (CAV), as a key strategy in achieving Vision Zero.

In our view the FCC proposal to reallocate more than half of the 5.9 GHz safety spectrum for unlicensed uses, at a time when more than 36,000 people are dying on our nation’s highways each year, and more than 1.8 million are injured, is short-sighted.

Connected vehicle technologies have been identified by the National Highway Traffic Safety Administration (NHTSA) as having the potential to save tens of thousands of lives each year—but only if these technologies are given the certainty of a safety spectrum that is free from signal interference.

In our response we highlighted research published by the United States Department of Transportation (USDOT) this past December that indicated signal interference “will occur, raising the question of the reliability of vehicle-to-everything (V2X) communications in this configuration. Without a high level of reliability, transportation safety will be impacted.”

Our full letter to the FCC can be found at http://bit.ly/ITE_FCC.


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Although uncertainty remains about the benefits and risks of automated vehicle (AV) technology, advocates of AVs tout increased safety for roadway users as an anticipated benefit of the technology. Exploring the potential for highly automated vehicles, or HAVs*, to complement existing efforts to increase safety for pedestrians and bicyclists is especially relevant in the context of recent trends in roadway safety.¹ Roadway deaths for vulnerable road users (VRUs) have been on the rise in recent years, with increasing rates of pedestrian and bicyclist fatalities resulting from collisions with motor vehicles.² Figure 1 shows trends in traffic-related pedestrian deaths from 2000 to 2016, and data from the National Highway Traffic Safety Administration (NHTSA) indicates that speeding-related deaths comprise a large portion of traffic-related fatalities, accounting for more than a quarter of all traffic-related fatalities in the U.S. in 2018.²

* For the purposes of this paper HAVs are defined as vehicles under the operation of Society of Automotive Engineers (SAE) definition of Level 4 or 5 vehicle automation. Level 4 vehicles can still be driven by an occupant whereas Level 5 vehicles do not have a steering wheel, gas pedal, or brake pedal.
to reducing the number and severity of collisions, especially those involving VRUs.6 This article focuses on how an approach to regulate HAV vehicle speed and reaction time could help reduce collision frequency and severity in an HAV future. HAVs have the potential to bolster current policies and programs that support Safe Systems, but transportation professionals need to work with policymakers and vehicle companies toward policy, legislation, and vehicle and software design that create safe HAVs and safe streets to operate them on.9 This article discusses both technology-side and street design strategies that may be necessary in an HAV future.

While VRUs are the focus of the discussion presented here, speed and reaction time are important considerations for all collisions and roadway users, which give the findings broader relevance for multimodal safety.

**Speeds, Reaction Time, and Roadway Safety**

As shown in Figure 2, the likelihood of a VRU fatality increases substantially the faster a motor vehicle is moving at the time of collision. Because higher vehicle speeds are linked to an increased likelihood of fatality or serious injury for VRUs during a collision, multimodal arterials—characterized by high volumes of fast-moving vehicles traveling alongside VRUs—have become one of the most challenging roadway types to improve safety outcomes.10
requiring a stop to the moment the brakes are applied. To from the moment the driver sees an object in the roadway brake reaction time and distance, the distance a vehicle travels when designing roadways is stopping sight distance. This is often defined as the minimum sight distance required for a vehicle to come to a stop when traveling at the roadway’s design speed. However, designing roadways in this way can be problematic to the degree it encourages faster speeds despite discouragement by the posted speed limit.

An important safety factor transportation engineers consider when designing roadways is stopping sight distance. This is often defined as the minimum sight distance required for a vehicle to come to a stop when traveling at the roadway’s design speed. One of the main factors that affects stopping sight distance is brake reaction time and distance, the distance a vehicle travels from the moment the driver sees an object in the roadway requiring a stop to the moment the brakes are applied. To calculate brake reaction distance, a brake reaction time of 2.5 seconds is typically assumed, but recent evidence suggests this assumption may be inadequate and average reaction times may be longer due to increased instances of “distracted driving.” With current infrastructure designed for a 2.5 second reaction time, drivers may be unable to see a VRU or object, react and brake, and reach a complete stop in time to avoid a collision. As a result, it is increasingly important to supplement strategies to reduce distracted driving with strategies to reduce vehicle speeds, which help give drivers more time to react to situations on the road.

Since speed and reaction time are such important factors in determining collision outcomes—and in light of the rise of traffic-related fatalities among VRUs, the number of speed-related collisions, and increasing driver reaction times related to distracted driving—standardizing HAV speeds and reaction times will be important for safety in the future. The pending commercialization of HAVs provides us with a window to meaningfully impact future roadway safety outcomes, particularly for VRUs.

**Figure 2. Relationship between vehicle speed and likelihood of VRU fatality.**

In the United States, it is common practice for the design speed of a roadway to be greater than the posted speed limit. Doing so provides a buffer for driver reaction or correction if drivers exceed the posted speed limit but do not exceed the roadway’s design speed. However, designing roadways in this way can be problematic to the degree it encourages faster speeds despite discouragement by the posted speed limit.

How Might HAVs Influence Safety?

While HAVs have the potential to improve collision rates and safety in the future, they could also introduce new safety risks, and many questions remain as to how HAV will be used and regulated in the future. Advocates often point to HAVs’ potential to reduce human errors by removing the need for a human driver, given that human error is a factor in more than 90 percent of collisions. With automated driving systems (ADS), collision types related to distracted driving and driving under the influence of alcohol could be reduced. Further, the ability to manage vehicle speeds through automated technologies based on roadway classification, surrounding land use, or other factors (i.e., areas with VRUs) could reduce speeding, which is a key contributor to collision frequency and severity.

HAVs could also have better awareness of their surroundings than human operators by using sensors with wide spectrum visibility to “see” 360 degrees around the vehicle. However, reaction time for ADS varies from humans based on differences in recognition and processing time. In particular, HAVs’ ability to detect and predict the movement of pedestrians and bicyclists across contexts is currently limited and represents a key challenge area for HAV safety. For example, in the fatal AV-pedestrian crash in Tempe, AZ, USA in 2018, the pedestrian was detected as an object—not a pedestrian—5.6 seconds before impact. It took the ADS 4.4 seconds to calculate that a collision would occur, making it too late in this case to avoid a collision without human driver intervention. This illustrates that HAV reaction time can be longer than that of a human operator, depending on the circumstance.

There are also larger questions about how general HAV use should be regulated in the future to maximize potential societal benefits while decreasing potential downsides, like negative effects on traffic congestion, emissions, and the design and function of cities. So far, cities and states have taken different approaches to policies around AV testing, and no national legislation has been passed. Many factors will influence AV safety impacts such as:

- How vehicles are designed (similar to today, larger and heavier vehicles—and those with higher bumpers—would result in more severe injuries).
- How vehicles are programmed (i.e., to maximize mobility and take more risk in unpredictable situations, or to maximize safety and drive slower and more cautiously).
- Whether HAVs increase or reduce total vehicle travel, which will depend on public policy and level of vehicle sharing and ride-pooling. To the degree vehicle miles traveled (VMT) increases, vehicle exposure and collision risk for VRUs would increase.
- How human drivers and VRUs will respond to and interact with HAVs as they are phased in.
- How the right of way is adapted (i.e., lane widths could be reduced to accommodate additional lanes, which would increase throughput, but also reduce the margin for error).
• What local, state, and national policies are enacted to require safety standards and reporting.

Technology Safety Strategies for an HAV Future
Strategies focused on moderating speed and reaction time in HAVs would result in tangible safety benefits. These strategies could also offer a compelling, systemic safety alternative, especially for challenging roadway types, such as multimodal arterials that serve high volumes of higher-speed vehicles often alongside VRUs.

Reaction time thresholds. HAVs programmed and regulated to operate with a reaction time of 2.5 seconds or less would improve safety outcomes compared to the average human driver. This requirement could be tracked through performance reporting. Absent regulation of HAV speeds, optimizing reaction times could improve brake reaction distance and moderate risk faced by VRUs, at a minimum.

Speed regulation. Another safety-related opportunity is the standardization of speed limits for HAVs. HAVs can be programmed to not exceed a speed limit (i.e., posted speed limit), regardless of the roadway’s design speed, which would reduce the risk posed by these vehicles to VRUs. HAVs can also be programmed to travel at a specified margin below the posted speed limit in adverse conditions, such as when visibility is low, when reduced pavement friction precludes safe operation at the posted speed limit, in environments with high pedestrian and bicyclist activity, or near specific populations such as communities of older adults. Implementing these strategies would require HAVs to use information provided by roadway infrastructure (i.e., vehicle-to-infrastructure [V2I] environment) or their own vision, sensor, and/or mapping systems to detect posted speed limits and other environmental elements. It is still unclear how human drivers in a mixed fleet might interact with HAVs, and average fleet speeds could slow down if HAVs cannot exceed certain speeds, or human drivers react by speeding to overtake slower moving HAVs.

Street Safety Strategies for an HAV Future
Several built environment factors and considerations could help mitigate safety risks posed by HAVs, particularly in environments with VRUs, and are discussed below. Many of these factors would also help improve safety for all road users, both today and in an HAV future.

Speed Reduction Design Countermeasures. In addition to regulating HAV speeds and reaction times, many existing speed reduction strategies can and should continue to be implemented in an HAV future. This is especially relevant as a portion of the vehicle fleet will remain human-operated for many years. ITE has identified speed management countermeasures as part of its Safe Systems work today that will continue to be relevant with HAVs. These strategies include measures to separate roadway users in space and time, increase attentiveness and awareness, reduce speeds, and reduce impact forces (i.e., cycle tracks and protected intersections, pedestrian scrambles, road diets, and traffic calming measures).

Technology applications related to speed management such as speed feedback, variable speed limits, and automated speed enforcement will also continue to be important.

Pedestrian Scale Lighting. Pedestrian scale lighting on sidewalks and near crosswalks illuminates people walking/biking for approaching motorists. Enhanced visibility improves the safety of these crossings and the security and comfort of VRUs. To the extent HAVs continue to use cameras as part of their detection systems, lighting can help these vehicles detect VRUs. Adaptive lighting with occupancy sensors and/or crossing warning devices also offer an opportunity to provide infrastructure-based cues to HAVs. Pedestrian scale lighting will also be important with regard to equity, to offset biases HAV detection software may have with respect to darker skin tones.

Shared Streets vs. Protected Facilities. In settings with low vehicle volumes and high VRU activity, shared streets may be an attractive option if HAV speeds are software-controlled. However, separated facilities for people walking/biking may be preferred if vehicle speeds and volumes are higher to reduce exposure and risk, and increase comfort and perception of safety for VRUs. In recent years, separated facilities such as protected bike lanes and protected intersections have gained traction as strategies to make non-motorized modes safer, and more comfortable and attractive for people of different ages and abilities. Protected facilities may be even more important and effective in an HAV future, especially to address potential safety issues related to poor detection of people walking/biking, or comfort levels of people walking/biking next to HAVs.

Roadway Design, Materials, and Quick Build. In order to operate safely across contexts, HAVs must be able to detect many elements of the roadway environment. This means street elements must be designed, built, and maintained in a way that’s legible to HAVs. This will impact cities’ responsibility for maintaining traffic control devices as well as attention to proper implementation of temporary traffic controls during construction. Similarly, roadway legibility should be considered for quick build projects and experimental treatments, which often allow complete streets and safety-related projects to be installed more quickly using lower-cost materials. HAV developers will need to collaborate with transportation engineers to ensure legibility across a variety of street design elements.

Transition Period Considerations. For all of these strategies, it’s important to consider that a fully automated transportation system will develop slowly over time, if at all. Some researchers predict that it will take until the 2050s for AVs to constitute the majority of the operating fleet, and they...
may never make up 100 percent of the vehicle fleet. Given that the safety and predictability of HAVs will be uncertain in a mixed-fleet context—and over an extended period—cities, policymakers, and vehicle companies need to work together to implement both technology and street design strategies in order to mitigate safety risks for all road users during this long transition period. Where possible, cities should seek to maintain flexibility in street design so that iterative adaptations are possible, and expensive overhauls are avoided.

Conclusion

Though questions remain regarding how HAVs might transform our cities and influence roadway safety, this article highlights how transportation engineers and planners can design roadways taking “evergreen” safety principles into account, including knowledge of physics and reaction times needed by people and machines—both today and in the future. Given the recent trends in traffic-related pedestrian deaths and speeding-related collisions, it is even more important to implement both technology and street design strategies to moderate vehicle speeds and shorten reaction times for both human drivers and HAVs. Vehicle companies, policymakers, and transportation engineers and planners will need work together to build a transportation system that is safe and legible with the introduction of HAVs—especially, during the long transition period where there are mixed fleets on the road. 

References

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