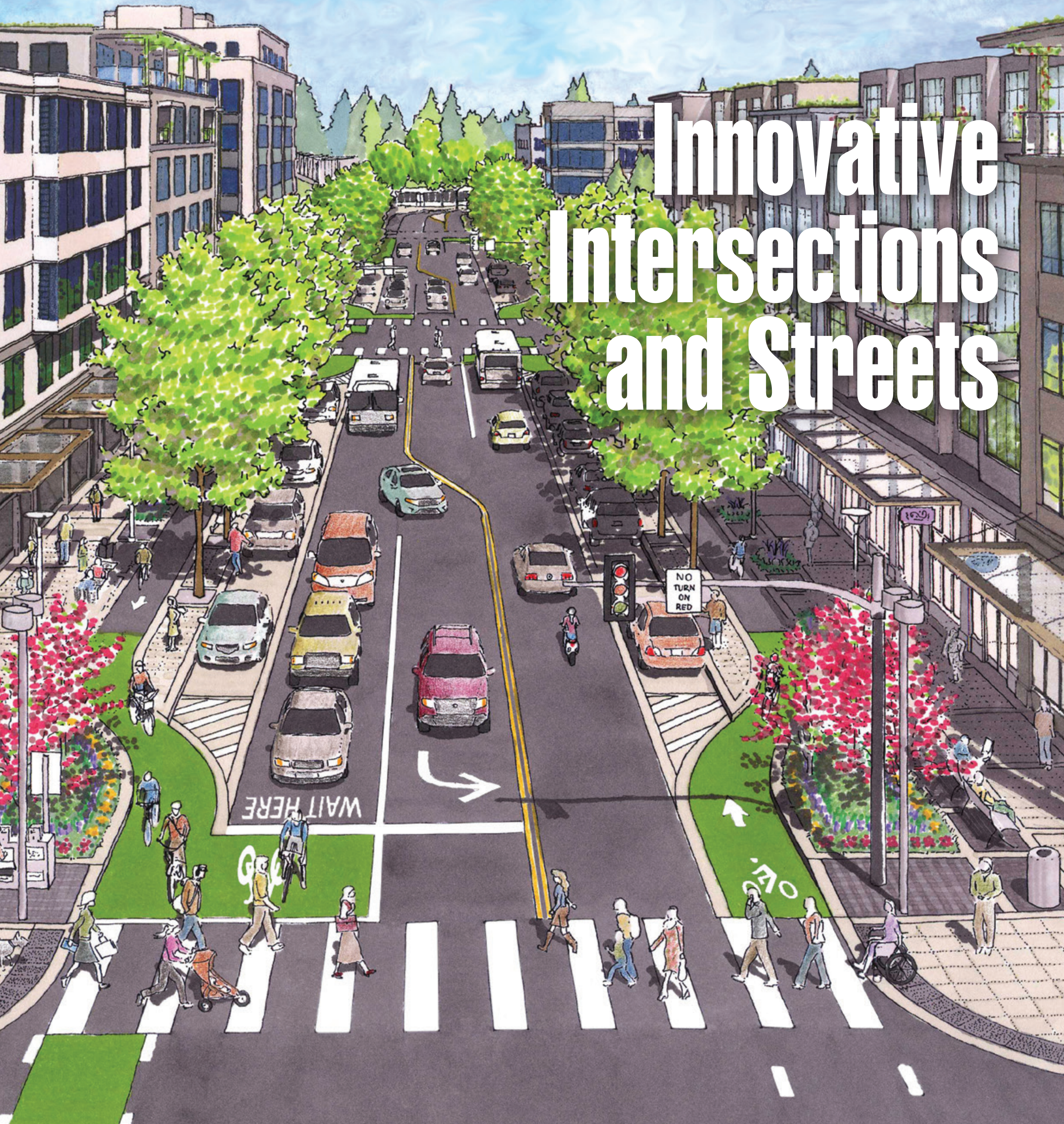
MARCH 2021

ite journal

A COMMUNITY OF TRANSPORTATION PROFESSIONALS

Innovative Intersections and Streets

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Institute of Transportation Engineers
1627 Eye Street, NW, Suite 600, Washington, DC 20006 USA
Telephone: +1 202-785-0060 | Fax: +1 202-785-0609
www.ite.org

Innovating the Organization

ALYSSA A. RODRIGUEZ, P.E., PTOE (F)
ITE International President

A colleague and I recently completed a webinar for city supervisors focused on innovation. The City of Henderson, NV, USA has been working to document employees' efforts during the pandemic, capture successes and lessons learned, and maintain momentum. Necessity prompted a lot of change, not only to adopt technology, but to revamp processes. Possible parallels exist to ITE as an organization, as well as similar potential for innovative transformations. As the world emerges from the pandemic, organizations will not be returning to pre-COVID status quo, and it is possible to harness the crisis-mandated energy and flexibility.

Virtual is likely here to stay. Audiences broaden through digital means to include rural and geographically dispersed members. Time commitments also shrink when no travel is required, and a meeting can be squeezed in between other commitments and deadlines. Each ITE District, Section, and Chapter (D-S-C) adapts the technology to its needs, and can document data on the best platforms, practices, and engagement tools. The challenge will be balancing virtual options with the interpersonal benefits of in-person events.

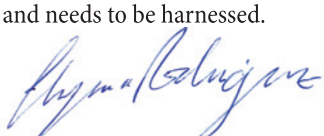
In addition to mixing virtual and in-person meetings, novel variety can be derived through choice of times, days of the week, location, topic, and format. Each iteration may appeal to different participants possibly attracting members from non-traditional fields beyond engineering and planning. Further, variety adds excitement.

Each member brings their whole self to the organization, and experiences outside of ITE may contribute to new and unique event features. My alumni association conducted etiquette training, not to learn manners, but to learn how to make your guests feel comfortable and welcome, and that has contributed to my perspective on inclusion. A colleague applies her experiences as a young mother to conference planning for her District.

With members beyond the leadership developing ideas, it is critical to empower them and delegate. In many D-S-Cs, a single leader is assigned the task of developing the technical program. It may be useful to assign the task to a variety of groups, particularly if they have an idea for a function that has never been tried. Ownership of an event can create affiliation with the organization. As a possibility, a local Student Chapter may plan and facilitate an activity for the professionals.

Documenting lessons learned can improve iteration and facilitate sharing among D-S-Cs. A caution is needed here, though. We shouldn't assume that because an event wasn't successful in the past, that it may not be possible in the future. Malcolm Gladwell offered the following wisdom in his *Revisionist History* podcast—"Principles are a product of past experience." As such, they cannot be unquestioningly applied to future situations.

The first goal under the membership section of the strategic plan states: To be the preferred choice for members from all disciplines and at all stages of their careers. The first task is to develop creative and innovative ways to recruit and retain members, particularly during global events such as COVID-19. I would posit that the potential exists during the pandemic recovery and needs to be harnessed.



Alyssa A. Rodriguez, P.E., PTOE (F)
ITE International President

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Old School, New School

This month, ITE will either be reviving our prior tradition of hosting Spring Technical Conferences or bringing you our first-ever virtual Spring Technical Conference. I guess both are true. For a number of years, ITE regularly convened conferences in the spring, often with a technical focus. They were typically held in Florida or California, USA to provide those from cooler climes the opportunity to enjoy some warmer weather. As District meetings have filled up the spring months, the Spring Technical Conference fell by the wayside. However, the desire for learning among ITE members and the industry remains strong.

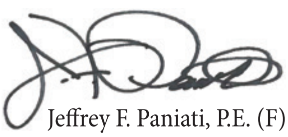
One of the takeaways from our very successful virtual Annual Meeting and Exhibition last year is that our members, particularly those from the public sector, said they valued the opportunity to enhance their technical knowledge, interact with peers from across ITE, and earn PDHs, all in a virtual environment. The relatively low-cost registration fee made the meeting accessible to younger staff and those who might not have the opportunity to travel to an international meeting. With all this in mind, we have decided to create—or recreate—a new learning opportunity with this year's Spring Technical Conference on Innovative Intersections and Streets, taking place March 23-24, 2021.

In forming the program, we tapped ITE's technical engine—our Councils and Standing Committees—to bring forward the content for this two-day event. The program includes 10 technical sessions spread across five timeslots, with topics ranging from Speed Management to Alternative Intersections to Innovative Curbside Management—and much more. Check out the full program and register online at www.itetechconference.org, and see page 29 for more information. I would like to thank Gannet-Fleming for their support as a title sponsor and Miovision for their supporting sponsorship.

Our opening plenary session will be moderated by ITE International President **Alyssa Rodriguez, P.E., PTOE (F)** with a keynote presentation by Ryan Russo, director of the City of Oakland, CA, USA Department of Transportation. Ryan will talk about how he and his staff are bringing new ideas and approaches to their city, the innovative Open Streets program they advanced as a result of COVID-19, and some of the lessons they have learned about transportation equity.

Equity considerations and conversations will be woven throughout the technical sessions. As we seek to advance innovation and bring new ideas forward, we must do so in an equitable way. It is critical that we fully understand the needs of all constituencies, particularly communities of color. We cannot take a one-size-fits-all approach if we are to effectively serve all members of our communities. We must be innovative and equitable in the way we plan, engage, design, and deploy the programs, policies, and technologies that will shape the future of transportation. ITE members can help lead the way.

I hope you will join us for an engaging two days of learning and conversation. The meeting will include a networking session on the evening of March 23 where we will be using a new innovative virtual engagement tool to allow attendees to mix and mingle with one another and have informal discussions on the key topics from the conference. I look forward to seeing you there. As always, reach out to me on the ITE e-Community or on Twitter: @JPaniatiITE.



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

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PEOPLE IN THE PROFESSION

Obituaries

ITE recently learned of the passing of the following members. We recognize them for their contributions to ITE and the profession, and send condolensces to their families.

Dr. Fuad A. Rihani of Cary, NC, USA passed away on June 26, 2020. He was a Life Member of ITE.

Dr. Neilon J. Rowan, P.E. of College Station, TX, USA passed away on January 8, 2021. He was International President of ITE in 1981 and an ITE Honorary Member.

Warner Gordon Derr of Leander, TX, USA passed away on December 27, 2020. **itej**

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.

New Members

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

Canadian
Erin J. Taylor
Kristen Machina
George Jankovic
Antonia Reynolds
Maria Laube

Florida Puerto Rico
Matthew Poppell
Smit Patel
Kerrie Harrell
Erin Martineau
Derwood Sheppard

Great Lakes
Kelly Laabs, P.E.
Collin Webb, P.E.
Art Baumann, P.E.
Dan Brugman, P.E., RSP1
Cory J. Johnson
Graham Heitz
Patrick Sloan
Eric Lauer-Hunt
Jeremy Koonce
Joe Stonesifer
Mallori Linnea Fitzpatrick
Kimberly M. Lask, P.E., PTOE
Jacob Mages
Kristin R. White
Curt Kobilarcsik
Paul Miller
Mitchell Kiecker
Jay DuMontelle
Anthony Norman
Anna Varney
Jerrel Kruschke, P.E.
Jennifer Leech, P.E.
Benjamin Roskoskey, P.E.
Karen Martens, P.E.
Keegan Dole, P.E.

Mid-Colonial
Melissa Anderson
Gunnar Rhone
Cheryl Walker
Amanda L. Purcell, P.E.
George Fekadu Gurara
Zhibo (Brandon) Zhang
Annamaria Furmato
Stephanie Wakeley
Jason Broehm
James Gray
Anyesha Mookherjee
Dale Thompson
Jorismar Torres
Sarah Weissman Pascual
Aimee Zhang

Missouri Valley
Steve Schultz
Scott Komarek
Sara M. Peters, P.E.
Michael E. Kramer
Garrison Brazeal, EIT

Mountain
Julie Luna
Nicole Silva
Brian Kelley
Andrew Focht
Aaron Monks
Solomon Haile
Tomi Oyekan
Jared Clinton Lillywhite
David Allen Klebosky
Matt Barkley

Northeastern
Jonathan D. French, P.E.
Liam Patrick Feeney
Justin Iwinski
Michael Bangert-Drowns
Alan Heredia

Southerrn
Kevin Long
Paul Holzen
Ashley Landis
Walta Brumskine Blackmon
Aaron Brady Cook
Patrick Monroe
Scott Schulman
Tab Anthony Huff
Michael Parker Karpinski
Omojojadavwe Morales
Devin Huston
Asia Smith
Devendra Patel
Bill Greentanner
Mark Odem
Jon Shaben
Anthony Mendez
Eric Lemieux
Kevin Parker
Lynda Jensen

Texas
Bishawjit Saha Sagar
Logan Thomas Williams
Abdullah Sbaiti

Westerrn
Nathan Welch
Nick Fortey
Thomas Check, P.E.
Abbass Vajar, P.E., C.E., T.E.
Adam Driscoll T.E.
Ahmad Khalifeh
Andrew Hall, P.E.
Anthony Modica
Briana Liu
Canyon Trainer, TEA 1
Charles Ly
Daniel Serrano
Eliana Goehring, EIT
Eric Leung
Erick Guillermo
Jayanne Nicole Jimenez
Jimmy Vivar, EIT
Justin Kim
Leslie Michelle Rios
Steven Gaskill
Lila Johnston
Lorraine Delano, EIT
Manuel Anaya, P.E.
Matthew Ly, P.E.
Nahum Alfredo Rivera
Nikolas Osborne, P.E.
Paul Konkirati, P.E.
Remedios Domagas-Fernandez, CEDT
Sara Zaldana
Sheila Ahoraian
Steven Loreto Meraz
Steven Santana, E.I.T.
Tess Chen
Vicki Y. Huang, P.E.
Sharon Cuevas
Charles Meyer
Y-Thao Truong
Shelby Nadin
Daniel Turk
Kevin Kelley

ITE NEWS

ITE Elections – Cast your Vote by March 12!

You can play a role in shaping the future of ITE by casting your vote in the ITE elections. The ballot closes on March 12, 2021 at 12:00 noon ET. The following candidates have been nominated for election as officers in 2022:

International President
Beverly Kuhn, Ph.D., P.E. (F)

International Vice President

Eugene G. Chartier, P.Eng. (F)

Rosana Correa, P.E., PTOE (F)

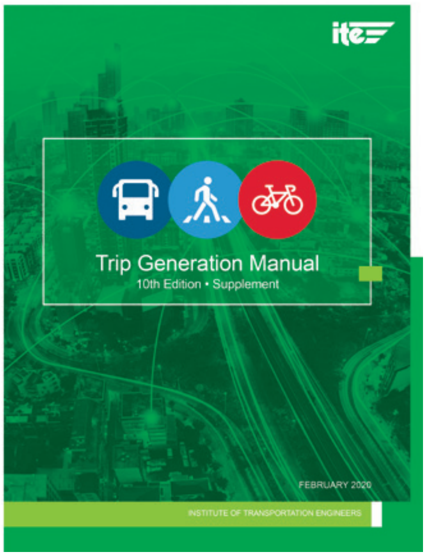
Learn more by visiting www.ite.org/candidates. The ballot opened on February 10, 2021, and a unique link to vote has been sent to eligible members via email. Your vote will remain confidential, and you will receive an email confirmation of your vote.

The election results will be announced on the ITE website the week of March 15, 2021 and in the April 2021 issue of *ITE Journal*.

Call for Data: ITE Trip Generation Manual, 11th Edition

The 11th Edition of the ITE *Trip Generation Manual* will be released in the fall of 2021 along with an updated ITETripGen web app. The 11th Edition will provide guidance on the estimation of post-pandemic site-generated trips. For some combinations of land use type and time period, pre-pandemic (i.e., 2015-2019) data may continue to be appropriate. For other combinations, adjustments will be necessary.

For prior editions, ITE has typically posted a Call for Data that highlighted new or emerging land uses as high priorities. For this edition, ITE requests that its members submit data for any land use for the years 2017 through 2021. In order to develop tools that optimize ITE members' ability to estimate trip generation, ITE needs a robust database with trip generation counts across the entire gamut of conditions (pre-pandemic, mid-pandemic, and post-pandemic).



If you have counted site-generated trips for any land use within the past five years, please consider submitting the data for use in the 11th Edition.

If you have compiled trip generation data collected by others for any land use within the past five years, please consider submitting the data. ITE will track down the source and obtained their permission before using the data.

If you know of any trip generation data collected or compiled by others, let us know the agency or consulting firm (and a potential contact if possible). ITE will track down the source.

You can submit the data by visiting www.itedatasubmission.org, or by contacting Lisa Fontana-Tierney, Traffic Engineering Senior Director at lfontana@ite.org with any questions. The deadline for data submission is **May 1, 2021**. ITE encourages you to start reviewing your files now for potential data.

ITE Talks Transportation Podcast

New from the Thought Leadership Series

AASHTO's Jim Tymon on Transportation and COVID-19, Working with a New Administration, and More

Jim Tymon, Executive Director of the American Association of State Highway and Transportation Officials (AASHTO), discusses the impacts of COVID-19 on the transportation industry over the past year and how state departments of transportation are faring. He also talks about the new U.S. presidential administration and upcoming legislative activities, including what AASHTO hopes to see in terms of congressional investment in infrastructure and transportation, as well as the FAST Act reauthorization.

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

Go Green with ITE Journal

Not in the office to get your mail, or would you like to be more "green"? You can choose to stop the mailed delivery of *ITE Journal* by filling out a quick online survey at http://bit.ly/ITEJGoGreen. You will still get the emailed version of *ITE Journal* that goes out on the first or second of each month and have full access to the digital edition. **itej**

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! **itej**

2021 EVENTS

ITE VIRTUAL TECHNICAL CONFERENCE
March 23-24 | See page 29 for details.

MOVITE SPRING MEETING
April 8 | Virtual Meeting

SDITE ANNUAL MEETING
April 12–16 | Virtual Meeting

MID-COLONIAL DISTRICT ANNUAL MEETING
April 26–28 | Virtual Meeting

NORTHEASTERN DISTRICT ANNUAL MEETING
May 13–14 | Virtual Meeting

INTERMOUNTAIN SECTION ANNUAL MEETING
May 13–15 | Jackson, WY, USA

CITE ANNUAL CONFERENCE
June 8–10 | Virtual Meeting

FLORIDA PUERTO RICO SUMMER MEETING
June 23–25 | Fort Lauderdale Beach, FL, USA

JOINT ITE INTERNATIONAL AND MOUNTAIN AND WESTERN DISTRICTS ANNUAL MEETING AND EXHIBITION
July 18–21 | Portland, OR, USA

GREAT LAKES DISTRICT ANNUAL MEETING
August 30–31 | Columbus, OH, USA

TRANSPO (ITE AND ITS FLORIDA EVENT)
September 27–29 | Bonita Springs, FL, USA

Something for Everyone

Remembering Einah Reza M. Pelaez, P.E.

The Met Section has painfully felt the loss of member Einah Reza M. Pelaez, P.E., who was serving as Section president at the time of her passing on July 22, 2019. She served as deputy traffic section manager and associate at HDR. A member of the ITE Met Section since 1999, Einah was a 2015 graduate of *LeadershipITE*. The Section has named the Einah Reza M. Pelaez Young Professional Award in her honor.

Einah was always full of life, passion, empathy, and above all, always willing to help and mentor others. She was a leader at the workplace, in the industry, and within her local community.

– Luigi Casinelli, P.E., PTOE (M)

Read more of the tribute at http://bit.ly/EinahPelaez.

There's something for everyone when it comes to the ITE Metropolitan Section of New York and New Jersey (Met Section), which has been in existence for more than 40 years. Member engagement is a core strength for the Section, which serves densely populated areas of New York and New Jersey and surrounding regions. Having a large number of volunteers has enabled the creation of a wealth of events and activities that appeal to a wide range of members. For example, Industry Day is a showcase of upcoming technologies and trends in the industry from vendors and manufacturers alike—a re-envisioning of exhibit halls seen at larger events, but in a more focused setting. Half- and all-day technical sessions invite experts to present in panel sessions and share on the latest industry trends. Networking events abound in the Met Section as well. The Start of Summer Networking event is held in a laid back, relaxed setting to help build friendships and connections. Brownbag technical sessions take place during lunch and include informal networking, particularly targeting public agencies.

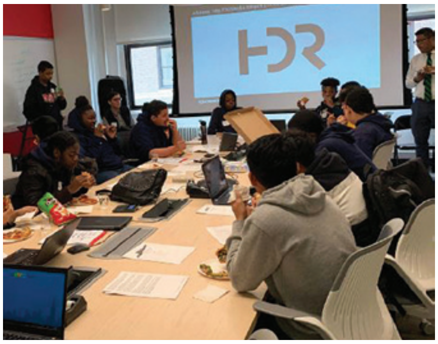
The Met Section has several key committees to help recruit new members and provide opportunities for engagement. The Membership Committee develops incentives to drive recruitment, such as the creation of an annual raffle that awards an iPad to a new member. The Student Outreach Committee is responsible for helping the Met Section maintain strong relationships to its Student Chapters and academic institutions, and is the main group that coordinates Student Chapter activities.

The Young Members Committee is responsible for events and activities geared toward a younger audience. They host happy hours, game nights, park clean-ups, and have held events in conjunction with other professional organizations. The Mentorship Committee has been instrumental in building a path towards guidance and professional growth for younger members. More recently, it launched a year-round mentorship program that includes mentee-mentor pairings, group meetings, and special presenters/speakers who touch on topics like horizontal and vertical career movements.

Focusing on issues of diversity and inclusion, the Section also has the D/M/W/SBE Committee—short for Disadvantaged/Minority/Women/Small Business Enterprise. Formed in 2020, its goal is to help make the Met Section more inclusive for organizations that fall into these categories. The group has brought in a number of D/M/W/SBE firms to participate and created "program guides" that help describe the firms' areas of expertise and backgrounds. The committee also curated a sponsorship package for small businesses, which grants them several sponsorship "perks" and increase their visibility at a significantly reduced cost.

When it comes to professional development, the Met Section is dedicated to ensuring its members grow their careers. It has provided tremendous support to ITE's premiere leadership program *Leadership*ITE (LITE). Two Section members chair the LITE Committee—**Adam Allen, P.E, PTOE, TSOS, IMSA II (F) and Keith Hall, P.E., PTOE, LEED AP, STP, IMSA II (M)**. The

Met Section Committee Volunteers and Executive Board.

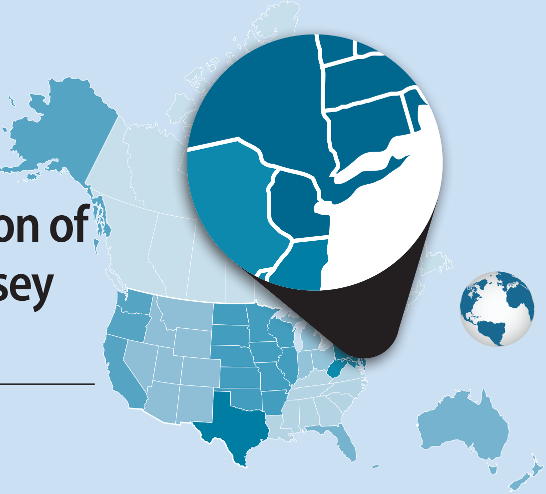


The Met Section holds a STEM outreach event.

Met Section actively encourages members, volunteers, and younger members to apply for the program. Every year a dedicated budget of at least $2,500 is set aside to support members from the Met Section who are selected for *Leadership*ITE. This helps subsidize some of the costs involved with travel, lodging, and tuition, and simply helps make the decision to apply much easier for potential scholars. Many LITE alumni have gone on to take positions on the Section's Executive Board. The Met Section also has a strong track record of supporting K–12 STEM activities in the areas it serves, and has hosted several STEM outreach events engaging local students to help them learn about the transportation industry.

Previously, the Met Section received praise for its efforts reaching its consulting members, but found its events were not resonating enough with its public agency members. Thanks to executive leadership as well as dedicated public agency members serving on committees, the Met Section has undertaken a concerted effort to engage public agencies and encourage more participation from these groups. The Section held several brainstorming sessions to understand the underlying barriers to participation and where changes could be made. It provided a discounted rate to public sector employees, knowing employers do not always subsidize professional development costs for workers. The Section also embraced the idea of lunchtime events, called "brownbag technical sessions," that take place during the lunch hours of public

ITE Metropolitan Section of New York and New Jersey (ITE Met Section)



Northeastern District

Areas Represented: New York City, NY: Westchester, NY; Long Island, NY; New Jersey

Members

880+

Board Members

President – **Marvin Souza, P.E. (M)**
Vice President – **Farukh Ijaz, P.E. (M)**
Secretary – **Tom Pagano, P.E., PTOE (M)**
Treasurer – **Asheque Rahman, ENV SP (M)**
Past President – **Lu Ding, P.E., PTOE (M)**
Jr. Section Director – **Steven Eisenberg, P.E. (F)**
Sr. Section Director – **Andy Kaplan P.E. (M)**

ITE Operations Volunteers

District Board Representative: **Adam Allen, P.E, PTOE, TSOS, IMSA II (F), Steven Eisenberg, P.E. (F), Andy Kaplan, P.E. (M)**; Section Administrator: **Mike Salatti, P.E., PTOE (F)**; Website: **Robert McAvoy, P.E. (M), John DeMarco (M)**; Action Calendar: **Andrew Saracena (M), Brad Miller, P.E., P.P, PTOE, LEED AP (M)**; Membership: **Warren Michelsen, P.E., PTOE (M), Emad Makarious, P.E., PTOE**; Pignataro Awards: **Marvin C. Gersten, P.E. (F), Anthony Mariani, P.E., PTOE, RSP1**; Corporate Partner/Sponsorship: **Warren Michelsen, P.E., PTOE (M), Justin Healey (M), Tyce Herrman, AICP, EIT ,PTP, ENV, STP (M), Jiayu (Jason) Li (S)**; External Coordination: **Paul Eng-Wong, P.E. (F), Doug Das, Andy Kaplan, P.E. (M), Lynn A. LaMunyon, P.E., PTOE, IMSA II (F)**

Committees

Professional Development: **Thomas Arlo, P.E., PTOE (M), Alfred Yeung, P.E. (M), Ray DiBiase, P.E., PTOE, PTP (F), Md Shah Imran, Ph.D., P.E., PTOE (M)**; Mentorship: **Sydney Chan (M), Daniel Quiroga (M), Sofia Duran (M), Sanam Lakhwara (M)**; Young Members: **Ben Yeung (M), John Fang (M), Doug Das, Tyce Herrman, AICP, EIT ,PTP, ENV, STP (M), Jiayu (Jason) Li (S)**; Student Outreach: **Ray Dominguez, P.E. (M), Alyssa Kantor (M), Elizabeth (Liz) Casola (M)**; Technical Projects: **Luigi Casinelli, P.E., PTOE (M), Myra Cabangon, Thomas Isola (M)**; Emerging Trends and Policies: **Emad Makarious, P.E., PTOE (M), Jeevanjot Singh, PMP (M), Marvin Souza, P.E. (M), Amir Rizavi, P.E., ENV SP (M), Justin Healey (M), Chaitanya Pathak**; Industry: **Richard Marsanico, P.E. (M), Rachel Beer, P.E. (M), Najmeh Jami, P.E. (M)**; Disadvantaged/Minority-Owned/Women-Owned/Small Business Enterprises: **Justin Healey (M), Pat Ott, RSP1 (M), Waj Husain, P.E. (M)**; Communications: **Mohammed Masroor Hasan, Carson Qing (M), Krzysztof Lukasik (M), Elaine Du, E.I.T. (M), Sanam Lakhwara (M)**; Media Outreach: **Robert McAvoy, P.E (M), Elaine Du, E.I.T. (M)**; Local Arrangements Chairs: **Hassan Hashmi, P.E., PTOE (M), Pankti Mehta (M), Diane Xiao (M), Lihua (Emily) Zhang (M), Geline Canayon, Raymond Tam (M), Michael C. Briska, P.E., PTOE, Brian Dempsey, P.E., PTOE, RSP1 (F), Michael O'Rourke, P.E., PTOE (F), Krzysztof Lukasik (M), Umer Nadeem, E.I.T., Hasnain Ali Syed (M)**; Webinar and Online Events: **Elaine Du, E.I.T. (M), Raymond Tam (M)**

TransTalk Newsletter

The ITE MET Section's communication volunteers publish a quarterly electronic newsletter called *TransTalk* to convey information on everything from Section events to original articles on trending transportation topics. View the publication at www.ite-metsection.org/transtalk.php.

Special Awards Named for Members

Ivor S. Wisepart Transportation Engineer of the Year Award
Leon Goodman Distinguished Member Award
Louis J. Pignataro Award
Einah Reza M. Pelaez Young Professional Award

Past President's Night

Past Presidents Night is one of the MET Section's most cherished events of the year, where members gather to recount the previous year's accomplishments and hear from a high-profile keynote speaker. Those who've led the Section over the decades stand up one by one and announce their name and year of service in a roll call. This year, the COVID-19 pandemic presented a challenge for the traditional gathering. However, Section volunteers worked diligently to create a well-choreographed webinar event complete with videos, presentations, and a keynote address by the president of the Long Island Railroad, the country's largest commuter rail. The Section even pulled off a virtual roll call in a video montage, allowing past presidents as far away as Florida to participate. View the video at http://bit.ly/METRollCall.

employees and hold the events at the agencies. This helped tackle another barrier of public sector employees having to request additional time off from work to make it to Section events.

To further increase public agency engagement, the Section also formed the Emerging Trends and Policies Committee, focused on developing and organizing programming for public sector members. Public agency members steer the programming by gathering speakers and presenters whose messages resonate with where they see the industry headed. There are still several municipal public agencies in the region that the Section has yet to tap into, but it's actively engaged in discussions for closing these gaps, and is excited to continue engaging public sector members.

While COVID-19 has presented unique challenges for the Section, the difficulties of a global pandemic have also driven unique solutions leading to increased participation. Lockdowns forced the Section to rethink its monthly meetings. Initially, it was a scramble to figure out how to continue to reach membership and provide the valuable services they've come to rely on. At the first virtual meeting, no one knew what to expect, and organizers planned for meetings of about 100 participants. That number quickly hit capacity, and the Section swiftly upgraded its plan to cover up to 1,000 participants for the next event. Now it's seeing above average attendance at all of its events, as well as a significantly reduced cost to hosting them—resulting in savings it can pass on to the membership.

With virtual engagement, the Met Section has been able to reach the farthest parts of its membership, even seeing old members who left reemerge. Virtual meetings have been a great tool during COVID, and the Met Section is looking at opportunities to continue leveraging these platforms long after in-person gatherings are safe again. **itej**

ite Learning HUB

Courses Offered as Part of ITE's Partnership with the Consortium for Innovative Transportation Education at the University of Maryland

ITE members receive a 20% discount by registering through ITE.

Transportation Cybersecurity

April 8 – May 23

Data, technology, and the Internet of Things (IOT) are playing a prominent role in delivering today's transportation services. More public sector agencies and municipalities are being targeted and attacked. Information and operations technology professionals need a practitioner's perspective to vigilantly address these evolving threats. This course is designed to equip participants to know what to do and what to look for in relation to cybersecurity.

Instructors: Murali Rao and Micah Dalton,
Office of Strategic Innovation
Virginia Department of Transportation

Communicating the Value of TSMO: A Three-Part Program to Get the Skills You Need Now

April 8 – May 12

You completed the analysis; you did the research and fine-tuned the engineering. And that's not enough. Successful persuasion requires more than facts and data. Learn the skills you need to be an effective and memorable communicator. Discover tips from neuroscience to enhance audience connection and solidify the relevance of your work to their interests. Through this interactive workshop, you will learn and apply the steps of converting technical material into an interesting, informative, and relevant presentation that resonates with non-technical audiences.

Instructor: Shelley Row,
President and CEO, Blue Fjord Leaders

Upcoming Live Webinars

Traffic Management for Planned, Unplanned, and Emergency Events

March 2

Developed by the ITE Traffic Engineering Council

Tactical Urbanism: Equity, Engagement, and the Opportunities and Challenges of COVID-19

March 4

Developed by the ITE Pedestrian and Bicycle Standing Committee

NaTMEC: Micromobility Data Collection and Processing – Considerations for Policy Regulation and Data Privacy while Using the Data Meaningfully

March 15

Road Safety Fundamentals Webinar Series

Developed by the ITE Safety Council

This 10-part webinar series highlights various aspects of road safety as part of ITE's continued focus on Vision Zero and the goal to reduce and eventually eliminate fatalities.

Individuals may sign up for individual webinars or for the entire series at a discount.

- Safety for All Road Users (Recording available on-demand)
- Partnerships that Create a Lasting Safety Culture (Recording available on-demand)
- Safety Analysis Tools (Recording available on-demand)
- Basic Statistics and Predictive Safety (Recording available on-demand)
- ITS, TSMO, and Safety in Operations (Recording available on-demand)
- Human Factors (Recording available on-demand)
- Road Geometry and Roadside Safety (Recording available on-demand)
- Safety Considerations in Transportation Planning
- Systemic Safety and Network Screening
- Road Safety Audits

From Pen to Practice

Kay Fitzpatrick, Ph.D., P.E., PMP (F)
Senior Research Engineer,
Roadway Design Program
Texas A&M Transportation Institute

Education
Ph.D., Civil Engineering,
Pennsylvania State University
M.S. and B.S., Civil Engineering,
Texas A&M University

ITE Leadership
Chair, Local Arrangement Committee for TexITE District Meeting, 2015
President, Brazos Valley ITE Section, 2014
Chair, Committee on Marking Patterns Used at Pedestrian Crossings, 2009-2011
Chair, Traffic Engineering Council, 1998-2001

Honors and Awards
AASHTO Sweet 16 Project Award, 2020
Transportation Research Board (TRB) Emeritus Member, 2018
Texas A&M University (TAMU) Regents Fellow Service Award, 2015
ITE Burton W. Marsh Award for Distinguished Service, 2014
ITE Coordinating Council Best Product Award, 2011
TRB paper awards: Mickle (2015, 2012), Waller (2010), Burggraf (1995)

Fun Fact
With her youngest in college and facing an empty nest, Kay has begun quilting in earnest. She spent time earlier this year making masks for several groups (pictured right).

***ITE JOURNAL*: You have used your writing to convey your transportation knowledge to other professionals and the greater world. What value do you get from publishing articles and why has this been an important part of advancing your career?**

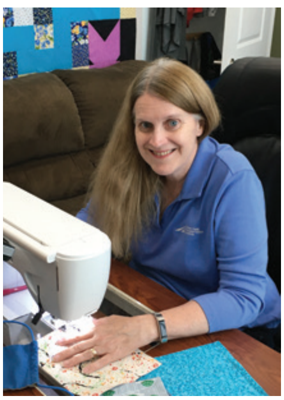
FITZPATRICK: When I decided that research was the transportation engineering career path I wanted to pursue, I knew that technology transfer would be an important part. Research that just sits on a shelf gathering dust does not provide benefits to society. We need to find effective ways to deliver our research findings to those who can implement them. Writing papers for *ITE Journal* and other publications provides the opportunity to communicate important research findings for transportation professionals to use—for example, the use of pedestrian hybrid beacons (see page 23). Even with the various papers I have written, I still struggle with generating sentences and documenting my thoughts. Each of my papers go through multiple versions, sometimes a painful amount; however, it is worth it, as improving conditions for all transportation users has been a fundamental motivation within my career.

***ITEJ*: You have been a trailblazer for women in the transportation field. What advice do you have for young and emerging professionals who may feel intimidated if they don't look, sound, or work like those around them?**

FITZPATRICK: I did not start my career with the intention of being a trailblazer. I just wanted to be able to use my math and science abilities to help others—but in the background. I wanted my work to speak for itself, rather than having the attention focused on me. Along the way, I realized that as a woman in engineering, I can and should help others who may feel it is too difficult, or that they do not fit in. Even having been blessed with a mind that can see patterns and develop solutions, it takes help from others to have a successful career. I have greatly benefited from others—both men and women—who provided encouragement at several points in my career. I have used the skills and encouragement they showed me and applied them when helping others with an interest in transportation engineering. So, those early in your career, and especially to the young ladies in the audience…if someone closes the door in your face, look for another door or perhaps a window. Keep focus on your goals and find a way, recognizing that the path may need to take some unanticipated turns.

***ITEJ*: As a longtime member of ITE, what are some of your most memorable achievements and how have they enhanced your career?**

FITZPATRICK: Like many, ITE was important to me while I was a student. The first ITE office I held was when I was a graduate student at Texas A&M. I enjoyed being able to interact with others who were at the same place in their career, or being able to meet and talk to those who were further along professionally about engineering challenges I was currently addressing. The memorable achievement within ITE that enhanced my career was successfully chairing Committee 5B-28 (*Geometric Design and Operational Considerations for Trucks*). I was rather young at the time, and feeling so as I encouraged the committee members to meet my deadlines. That committee provided me the opportunity to demonstrate my dedication to the profession and my capabilities as a leader. A number of other doors opened with that success. ITE provides multiple opportunities to be engaged at the local, District, Technical Council, and International level—you just need to seek them out. **itej**



Turning Edmonton's Bike Story into Edmonton's Bike Plan

By Daniel Vriend, P.Eng, City of Edmonton, and Dallas Karhut, P.Eng., City of Edmonton

In 2009, Edmonton City Council in Canada approved a Bicycle Transportation Plan which focused on developing an on-street bike network throughout the city. The approach to implementation can be best described as opportunistic, in that it focused on new bike routes located on underused streets as they were being reconstructed. This approach led to bike route implementation in areas with low demand, resulting in a disconnected network. While there was public engagement during the development of the bike plan, not enough effort was made to engage with Edmontonians affected by the changes. For many, it was a rather sudden implementation of bike lanes, which often resulted in the loss of on-street parking or fewer travel lanes, and this created frustration and angst.

Some of the new bike lanes had to be removed, and a new conversation on cycling was needed. The city reset the discussion through the What the B*ke! campaign by issuing a public apology and identifying the need for a new implementation and engagement approach. The disruption that the bike lanes created allowed for necessary conversations between the public, administration, and the city council about how the city should plan and design for bikes in Edmonton. The result was implementation of a comprehensive six-stage public engagement process that gave stakeholders and communities more clarity on the process and ability to influence decisions. The new focus was to build a network of protected bike lanes, starting in the high use, central areas and extending out.

For the key projects that were then moving forward, there was careful engagement along the way. The focus was on high quality engagement and high quality bike facilities. This took time. Over the course of three years, thousands were engaged on the new projects but there was growing concern that not enough was actually being built. In the summer of 2016, the city council directed city staff to plan, design, and build a network of bike routes in our downtown and to do it quickly. A year later, an 8-kilometer (5-mile) network of adaptable, physically separated bike lanes were open.

While there was nothing easy about implementing a downtown bike network in less than a year, the change management required to usher in a new era of bike planning proved to be far more challenging than expected. Developing integrated processes across delivery methods and creating meaningful engagement strategies, while also embracing the continuous evolution of bike planning and design practices, challenged every aspect of city building. The ability of planners, engineers, and designers to embrace these challenges have set the foundation for the next chapter in Edmonton's bike story.

We then turned Edmonton's Bike Story into Edmonton's Bike Plan to guide not only how biking in Edmonton will look and feel in the future, but also how it will be implemented, based on the learnings from the past 10 years. The Bike Plan was shaped by a substantial engagement program, includes a clear narrative for why we pursue cycling as a city, includes clear technical analysis and results in long-term network definition and supportive program areas to pursue.

The Bike Plan is the culmination of two years of engagement with residents of Edmonton. Through 62 public events including workshops, pop-up events, drop-in sessions, surveys and community conversations, just over 11,500 Edmontonians gave us their feedback about biking in Edmonton. We heard from so many people: those who are avid cyclists and those who don't support bike lanes; those who would love to bike more but are nervous; and those who will probably never ride a bike. Edmontonians were clear: biking must be inviting for people of all ages and abilities for all reasons, in all seasons.

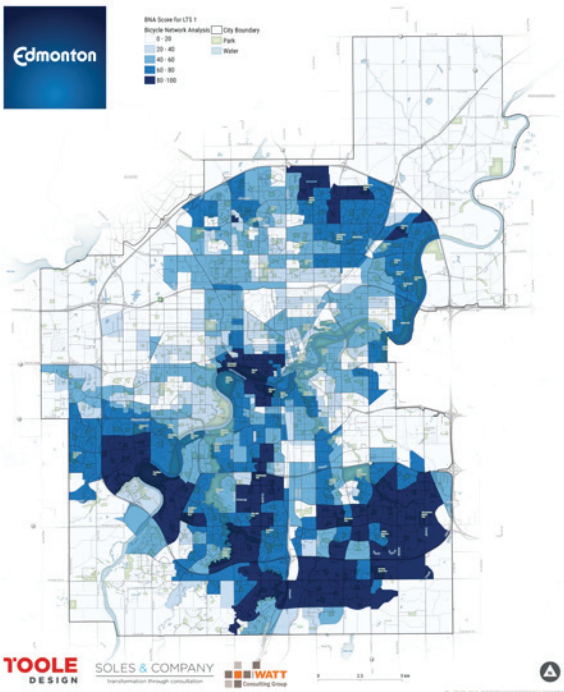
We heard that our future cycling actions have to be guided by values of:

- Fun and functional – Biking enriches the lives of Edmontonians and sparks joy by being a safe, enjoyable and practical way to get around
- Equitable – Biking is a valid and practical option for people of all ages, abilities, backgrounds and walks of life.

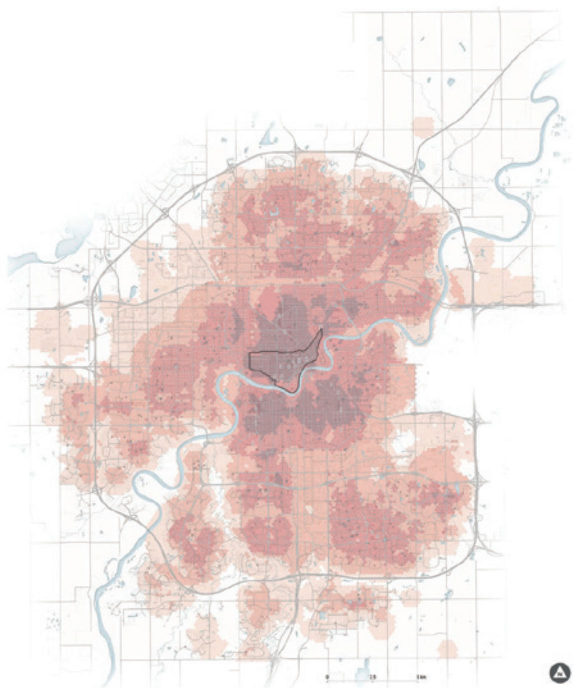
- Urban vibrancy – Weaving biking into building and design makes Edmonton a vibrant, attractive city we can be proud of and that others are drawn to.
- Culture shifting – Biking is a highly valued part of Edmonton's mobility system and is welcomed as an everyday way to move around and enjoy our city.

When understanding what it means to invite people of all ages and abilities, we learned that there are people that have unique needs. The following list of potential users is based on the *Who is the "All Ages & Abilities" User?* developed by the National Association of City Transportation Officials:

- Children – Children face unique risks because they are smaller and less visible to driver's and often have less ability to detect risks or avoid conflicts. Encouraging active travel can help children become more physically active and will encourage active lifestyles.
- Seniors – As a low-impact activity, seniors often see positive impacts from cycling, and are also greatly affected by the quality of cycling infrastructure.
- Women – Women are consistently under-represented as a share of total bicyclists in Edmonton (and other cities). Concerns about personal safety including and beyond traffic stress are often particularly relevant for women.
- Racialized People – Racialized people often face unique barriers to cycling. Studies have shown fear of exposure to theft or assault, fear of traffic collisions, or being a target for enforcement are barriers to bicycling for some visible minority populations. More work is required to understand and address these barriers.
- People with Low-income – An affordable and accessible transportation choice for those who may not have access to an automobile can be provided by building safe and comfortable bicycle facilities for all ages and abilities. Basic cycling infrastructure is often lacking in low-income neighborhoods, increasing safety concerns.
- People with disabilities – People with disabilities may use adaptive bicycles including tricycles and recumbent handcycles. These often operate at lower speeds, are lower to the ground, or are wider than other bicycles.
- People riding bike share or e-scooter share – Riders often use bike share or e-scooter share to link to other transit or make spontaneous one-way trips. Riders that move in this way place a



Bike Network Analysis: Darker shades indicate more destinations connected to low-traffic stress bike network.



Bike Trip Potential: Darker colors indicate greater density of bike trips expected.

premium on comfortable and easily understandable bike infrastructure.

- People moving people, goods or cargo – Bicycles and tricycles outfitted to carry multiple passengers or cargo, or bicycles pulling trailers, increase the types of trips that can be made by bike, and are not well accommodated by bicycle facilities designed to minimal standards.
- Confident cyclists – The small percentage of the bicycling population who are very experienced and comfortable riding in mixed motor vehicle traffic conditions are also accommodated by, and often prefer, All Ages & Abilities facilities, though they may still choose to ride in mixed traffic.

Understanding the needs of Edmontonians coupled with analytical work meant we could describe the network needed to fulfill the bike plan values. Analysis included mapping Edmonton's low-traffic stress (LTS1) network, mapping which neighborhoods have most of their destinations connected to our low-traffic stress network, assessing which areas are likely to generate more cycling trips, bicycle collision mapping, and mapping of demographic information.

All of this helped us to see our city in a new way and will help us prioritize projects through our coming implementation guide, which will further outline high level costs, and prioritize supportive actions.

We recognize that the Bike Plan is not an end in itself. The Bike Plan, through the future bike network plan, strives to provide the "why?" but not necessarily the "how?"—leaving a high degree of flexibility to better understand the local context through engagement, planning, and design in a way that is meaningful to the community while recognizing network implications. That flexibility is powered by coordination and delivery integration, building on the processes that have grown over the past few years.

By sharing Edmonton's bike story and the Bike Plan, we hope the lessons we learned along the way can help other communities in creating their own bike stories. Check out Edmonton's Bike Plan at www.edmonton.ca/bikeplan. **itej**

INDUSTRY NEWS

ITE Signs on to Letter to President Biden Calling for Reduction in Traffic Fatalities

ITE recently joined more than 74 other organizations in signing on to a letter addressed to U.S. President Joseph Biden calling for a commitment to reduce traffic fatalities to zero by 2050.

"We are committed to roadway safety and know what it takes to achieve zero deaths. It will take action at the local, state and federal levels. A commitment by you and your administration to prioritize safety, including adopting the Safe System approach, will provide the leadership needed to save lives," the letter states.

With the recent confirmation of U.S. Secretary of Transportation Pete Buttigieg, these organizations along with individuals are also sending messages with the hashtag #DearSecretaryPete over social media, encouraging him to join in the effort to reduce traffic fatalities and make an ambitious commitment to safety.

The lead organizations on the letter are Families for Safe Streets, Toward Zero Deaths, Road to Zero Coalition, and Vision Zero Network.

AAA Pedestrian Fatality Report

This research from the AAA Foundation for Traffic Safety examines the increase in pedestrian fatalities from 2009 to 2018 through analysis of changes in the presence of certain pedestrian, driver, vehicle, and environmental factors.

From 2009 to 2018, pedestrian fatalities in the United States increased 53 percent, from 4,109 to 6,283, after decreasing for three decades. The proportion of all traffic fatalities that were pedestrians increased from 12 percent to 17 percent over the same time period. Between 2010 and 2017, the United States experienced the largest percentage increase in pedestrian fatalities among 30 countries in the Organization for Economic Co-operation & Development, 24 of which saw decreases in pedestrian fatalities.

Although major risk factors for pedestrian crashes, injuries, and deaths are well documented (i.e., high speeds, large vehicles, poor lighting) and some studies have examined long-term trends in pedestrian fatalities, not much is known about the factors underlying the large increase in pedestrian fatalities in recent years. The main objective of this research was to examine more closely the increase in pedestrian fatalities from 2009 to 2018 through analysis of changes in the presence of certain pedestrian, driver, vehicle, and environmental factors. The outcomes of this analysis are also described in the context of other recent and topical studies. Read more and access the report at www.aaafoundation.org.

NOCoE's Annual Report Available

Access the Annual Report to learn how the National Operations Center of Excellence is a meeting its goals and advancing transportation systems management and operations.

- Learn how transportation systems management and operations (TSMO) continues to expand its role inside agencies.
- Learn which new NOCoE initiatives are accelerating the deployment of TSMO practices.
- Learn about the emerging leaders in the TSMO industry as well as long-standing TSMO champions.

Access the report at www.transportationops.org/annual-report-2020.

ITS America Annual Meeting – Submit Your Proposals

ITS AMERICA 2021
CHARLOTTE, NORTH CAROLINA

Join the Intelligent Transportation Society of America (ITS America) at its 2021 Annual Meeting in Charlotte, N.C., December 7-10, 2021, as we reimagine transportation and discuss how technology is a foundational piece of a new 21st century transportation system. This event will bring together the entire intelligent transportation community for four days of thought-provoking education, networking, technical tours and demonstrations exploring products, emerging technologies and solutions that will enable a better future transformed by intelligent mobility.

Do you have something you'd like to contribute, present, or discuss at the conference? ITS America is now accepting proposals for this year's event until April 12, 2021. For more details and to submit a proposal, visit www.itsamericaevents.com. **itej**

VOTE

ITE Elections – Ballot Closes March 12 at 12:00 noon ET

The ITE Nominating Committee has nominated the following candidates for election as officers in 2022:

International President:

Beverly Kuhn, Ph.D., P.E. (F)

International Vice President:

Eugene G. Chartier, P.Eng. (F)

Rosana Correa, P.E., PTOE (F)

There's Still Time to Get to Know Your Candidates!

Review candidate brochures and listen to their interviews on a number of important topics here: http://bit.ly/Candidates_2022.

Didn't receive a link to the ballot? Email Zach Pleasant at zpleasant@ite.org

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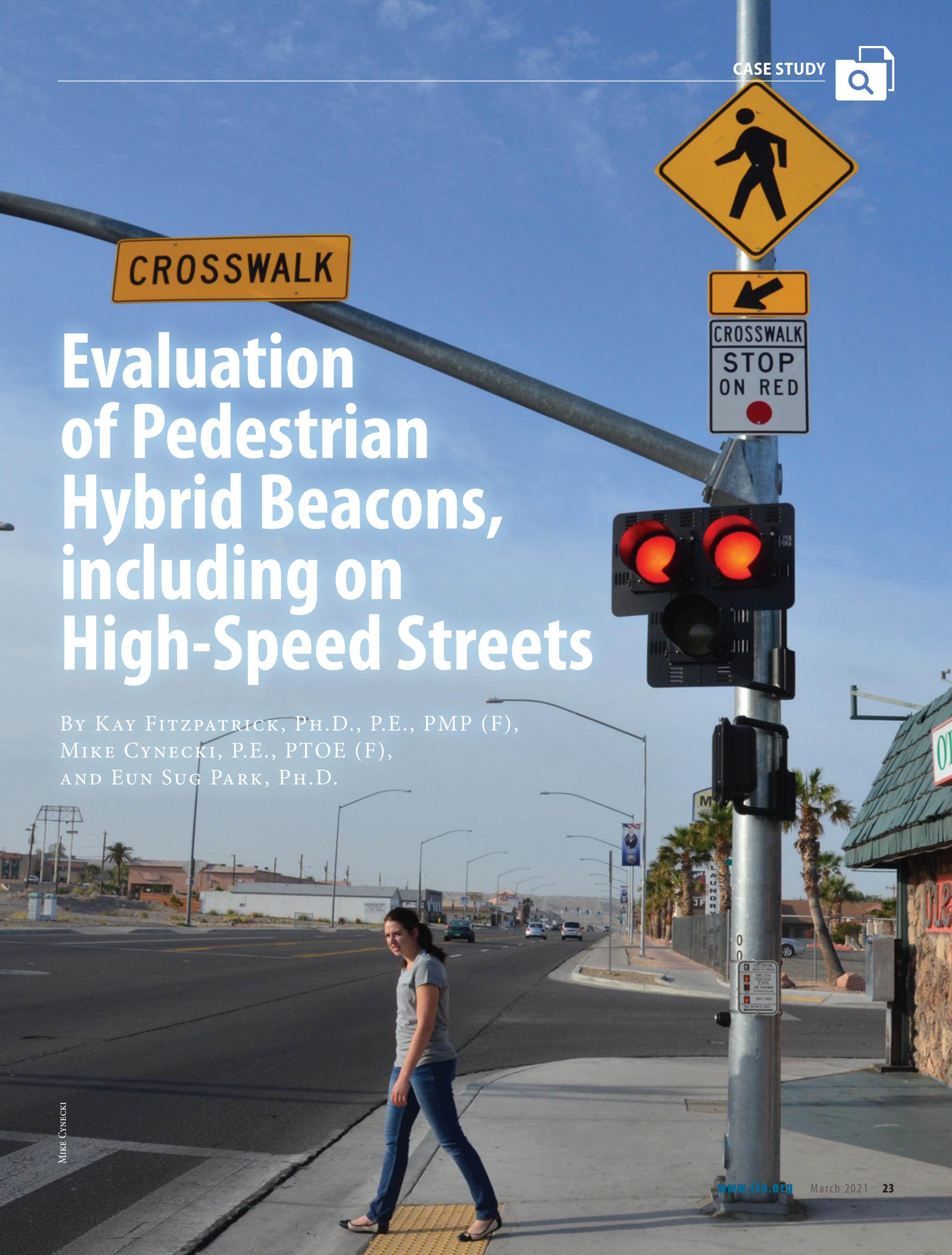
A Community of Transportation Professionals

Evaluation of Pedestrian Hybrid Beacons, including on High-Speed Streets

By Kay Fitzpatrick, Ph.D., P.E., PMP (F), Mike Cynecki, P.E., PTOE (F), and Eun Sug Park, Ph.D.



Mike Cynecki

The pedestrian hybrid beacon (PHB) is a traffic control device used at pedestrian crossings (see example in Figure 1). It was first included in the 2009 *Manual on Uniform Traffic Control Devices* (MUTCD) and was based on the HAWK (**H**igh-intensity **A**ctivated cross**W**al**k**) beacon developed in Tucson, AZ, USA.[1] The device is pedestrian activated and upon activation, drivers see a sequence of indications that start with a flashing yellow, then a steady yellow, followed by two steady red indications, and then alternating flashing red, after which the device goes into the resting dark mode. Pedestrians see the Walk sign when a steady red is displayed to drivers. After the Walk phase ends, pedestrians see the flashing Don't Walk along with a countdown, after which the pedestrian signal head would show the resting steady Don't Walk indication. Additional guidance is available on the Federal Highway Administration (FHWA) and Arizona Department of Transportation (ADOT) websites.[2, 3, 4]

The focus of a recent ADOT research effort was to investigate:[5]

- Operational performance of the PHB on higher-speed local or state-maintained roads.
- Changes in crash frequency, severity, and crash types (e.g., rear-end crashes) due to the PHB presence as well as in crashes involving pedestrians and bicyclists.

The PHB has shown considerable potential for improving pedestrian safety and driver yielding.[6, 7, 8, 9, 10, 11] While previous studies have proven the effectiveness of PHBs, questions on the effect of PHBs on higher-speed roads and on rear-end crashes or severe crashes had not been fully addressed because of limited sample size.

Mike Cynecki

Figure 1. Example of a pedestrian hybrid beacon on SR 95 at 5th Street in Bullhead City, AZ, USA.

Operations

Ten crossing locations in Arizona on streets with higher-operating-speeds (85th-percentile speed ranging between 44 and 54 miles per hour (mph) [70.8 and 87 kilometers per hour (km/hr)] were selected for this study and operations/compliance data were collected in the spring of 2018. Table 1 summarizes the characteristics of the sites used in the operations study. The final dataset reflected about 40 hours of video data and included 1,214 pedestrians or bicyclists crossing at PHBs.

Overall, driver yielding for these 10 sites averaged 97 percent (see Table 2). In a 2016 FHWA study, data were collected at 20 sites where the posted speed limit was typically 35 or 40 mph (56.3 or 64.3 km/hr) with one site at 30 mph (48.2 km/hr) and one site at 45 mph (72.4 km/hr).[11] That study found an overall yield rate of 96 percent with per-site yield rates ranging between 87 percent and 100 percent. The FHWA study included 12 sites in Tucson, AZ, and eight sites in Austin, TX, USA. The average driver-yielding rate for the 12 Arizona sites was 97 percent. The current ADOT study

Table 1. Operational Study Site Characteristics.

Site ID	Posted Speed Limit (mph)	Number of Legs[a]	Number Through Lanes (major)[b]	Distance to Nearest Signal (ft)	Crossing Distance (ft)[d]	Average Daily Traffic (ADT)	Sidewalk Presence (major)[e]	Driveway Density (driveways per mile)[f]	Bike Lane (major)[g]
BH-01	45	4	4	1,263	70 / 75	27,668	2	60	0
GI-03	45	3	4	641	90 / 100	25,200	1	22	1
PH-33	45	3	5	652	73 / 68	20,400	2	16	0
SD-02	50	3	2	5,254	70 / 63	15,250	0	2	0
SD-03	50	4	4	4,892	86 / 90	19,100	0	5	0
SV-01	45	4	4	1,099	78	15,675	1	22	0
TP-01	45	3	4	1,068	82 / 90	25,000	2	25	2
TU-089	40[c]	2	4	1,779	78	24,028	0	28	2
TU-124	45	4	4	2,559	74 / 72	18,366	2	36	2
TU-129	50	4	2	2,335	79 / 65	10,300	0	6	2

Note: [a] 2 legs = midblock, 3 legs = T-intersection, 4 legs = cross intersection.
[b] All sites had a TWLTL or left-turn lane present. A median pedestrian refuge island was not present at any of the sites.
[c] The goal of this project was to consider sites with posted speed limits of 45 mph and above. Initial reviews indicated that this site had a posted speed limit of 45 mph; however, once in the field the Research Team determined that the speed limit was 40 mph. The site was retained in the study because the actual 85th percentile speed was about 10 mph higher than the posted speed limit.
[d] The crossing distance is the approximate distance from the pedestrian pushbutton to the far side edge line or edge of pavement. If the distance varies by direction, the crossing distances are provided as WB/EB or NB/SB.
[e] Sidewalk presence: 0 = No sidewalks, 1 = Sidewalk on one side, 2 = Sidewalk on both sides
[f] The driveway density was calculated by determining the number of driveways on both sides of the major street for a one-mile segment (0.5 mile either side of the PHB).
[g] Sidewalk presence: 0 = No sidewalks, 1 = Sidewalk on one side, 2 = Sidewalk on both sides

Table 2. Speed and Driver Yielding Rates by Site.

Site	Posted Speed Limit (mph)	85th Percentile Speed (mph)	Number of Vehicles[a]	Driver Yield Rate[b]
BH-01	45	47	274	96%
GI-03	45	44	290	93%
PH-33	45	53	265	100%
SD-02	50	53	133	95%
SD-03	50	54	208	93%
SV-01	45	48	199	99%
TP-01	45	Not available	294	99%
TU-089	40	50	295	100%
TU-124	45	48	275	99%
TU-129	50	54	93	100%
All sites			2,326	97%

[a] Number of vehicles = total number of vehicles that approached the crossing pedestrians and bicyclists.
[b] Driver yield rate = percent of approaching drivers who should have yielded and did so.

that focused on higher-speed roads (posted 45 to 50 mph [72.4 km/hr to 80.4 km/hr]) found a similar driver-yielding rate (97 percent) as observed on lower-speed roads (also 97 percent). This finding clearly shows that the PHB also operates well on higher-speed roads.

While drivers are yielding to pedestrians in most cases, they are not as compliant with the traffic control device. Only 90 percent of the drivers stopped and stayed stopped until the end of the steady red indication. During the flashing red indication, about 59 percent of the drivers rolled through the intersection without stopping initially. Most of those rolling stops occurred during the queue discharge after the pedestrian had completed their crossing maneuver. None of these driver actions resulted in a pedestrian/vehicle conflict.

Actual (non-staged) pedestrians and bicyclists were preferred in the data collection efforts, but at sites where pedestrian volumes were low, members of the research team conducted staged crossings to obtain a larger sample of motorist behavior data. A large proportion of the non-staged pedestrians and bicyclists observed activated the PHB or crossed when the device was operational. At a few sites, many pedestrians and bicyclists crossed without activating the PHB. These sites had large gaps in traffic where the pedestrian or bicyclist was able to cross without affecting the major-road traffic. The percent of the non-staged pedestrians and bicyclists observed using the pedestrian pushbutton was only 66 percent, which reflects the large number of pedestrians and bicyclists who preferred to use the large vehicle gaps for their crossings. The 2016 FHWA study found that a greater number of pedestrians activated the device when on 45-mph posted speed limit roads than on 40-mph-or-less roads.[11] That FHWA study also found that when the hourly volume for both approaches was 1,500 vehicles per hour or more, the percent of pedestrians activating the PHB was always 90 percent or more.

Safety

The safety analysis from this study included 343 sites, which consisted of 186 PHB crossings, 56 signalized intersections, and 101 unsignalized intersections. The variables considered in the safety analyses are listed in Table 3. There were 52 PHBs installed between 2011 and 2015 that were identified for use in the before-after empirical Bayes (EB) analysis. PHB installation dates were obtained from the various government agencies. Reference groups consisting of signalized and unsignalized intersections were chosen from intersections in close proximity to the 52 before-after PHB sites and were used in the EB before-after analysis. In all cases, no other major roadway or geometric changes were made other than PHB installation at the PHB sites during the study period. Table 4 summarizes the descriptive statistics for these sites.

Each reference group has potential limitations; therefore, the research team considered three different reference groups:

- Unsignalized intersections
- Signalized intersections
- Both unsignalized and signalized intersections combined

For the signalized and combined unsignalized and signalized intersection groups, all crash types considered showed statistically significant reductions in crash frequency (e.g., total crashes, fatal and injury crashes, rear-end crashes, fatal and injury rear-end crashes, angle crashes, fatal and injury angle crashes, pedestrian-related crashes, and fatal and injury pedestrian-related crashes) as shown in Table 5. Previous studies have also

Table 3. Roadway Variables Considered in Safety Analyses.

Variable	Description
C_Lanes	Cross: total number of lanes on the cross street
Legs	Number of legs at the intersection (2, 3, or 4), 2-legs = midblock crossing
M_Bike_01	Major: is a bike lane present? (1=bike lane on one or both sides, 0=none)
M_Lanes	Major: number of through lanes
M_LTL	Major: is a left-turn lane present on the major street (0=neither approach has a left-turn lane, 1=at least one of the approaches has a left-turn lane)
M_LTL_A	Major: number of approaches with an exclusive left-turn lane (0, 1, or 2)
M_MT	Major: median type (raised, TWLTL, none, flush)
M_MT_R	Major: median type (Raised (0) = raised, Not Raised (1) = all others e.g., flush, TWLTL, none)
M_PK_01	Major: is a parking lane present? (1=parking lane on one or both sides, 0=none)
Ped or PB_Vol_MC	Daily number of pedestrians at the intersection, sum of the pedestrian volume on the major and on the cross street
PSL	Major: posted speed limit (mph)
PSL_group	Major: the posted speed limit for the main street grouped into either 35 mph and below or 40 mph and higher
Sig_Dist	Major: distance between the PHB and the nearest traffic signal in feet
Veh	Major: daily number of vehicles on the major street, also called average daily traffic (ADT)

Table 5. Results of EB before-after safety evaluations based on 52 PHB sites using unsignalized intersections and signalized intersections as a reference group.

Crash Type	Percent Crash Reduction at PHBs
Total	18.2**
Fatal and injury	25.2**
Pedestrian related	45.7**
Fatal and injury pedestrian related	45.0**
Rear end	20.5**
Fatal and injury rear end	28.6**
Angle	22.6**
Fatal and injury angle	24.5*

Statistical level indications:
** Statistically significant results with 90 percent confidence level*
*** Statistically significant results with 95 percent confidence level*

Table 4. Descriptive Statistics for PHB sites used in EB Before-After Evaluations.

Variable[a]	PHB (52 sites)			Unsignalized intersections (101 sites)			Signalized intersections (56 sites)		
	Min	Max	Avg	Min	Max	Avg	Min	Max	Avg
Legs	2	4	3.3	2	4	3.6	3	4	3.9
M_Lanes	2	7	5.0	2	9	5.3	2	10	5.5
M_LTL	0	2	0.9	0	2	1.5	0	2	1.9
M_PK_01	0	1	0.1	0	1	0.1	0	1	0.1
M_Bike_01	0	1	0.6	0	1	0.6	0	1	0.6
C_Lanes	0	3	1.3	0	6	1.6	2	12	6.0
Veh (Period AADT)	5,400	47,627	23,959	4,937	47,627	24,377	5,400	48,512	24,421
PB_Vol_MC	10	1,670	297	10	480	99	30	1,520	308
M_MT_R, Value (# of sites)	Not Raised (33), Raised (19)			Not Raised (69), Raised (32)			Not Raised (35), Raised (21)		

Note: [a] See Table 3 for description of roadway variables.

found a safety benefit with the installation of a PHB, and this study supports those findings.[6, 7]

A cross-sectional study was conducted with a larger number of PHBs crossings to identify relationships between roadway characteristics and crashes at PHB sites, especially with respect to the distance between a traffic control signal (TCS) and a PHB. The cross-sectional study could include more PHB sites because crash data before the installation of the PHB were not needed; therefore, more of the older installations (prior to 2011) could be considered. Crash data between January 1, 2007 to September 30, 2017 were available in this study; therefore, up to 10.75 years of crash data were utilized where appropriate. Table 6 summarizes the descriptive statistics for these sites.

For total crashes, the roadway and geometry variables that have a relationship to crash frequency at PHBs include the number of lanes on the major roadway, median treatment, bike lane presence, and number of lanes on the cross street. These relationships are as expected, with more lanes on either the major or cross street being associated with more crashes, and with the presence of a raised median or pedestrian refuge island being associated with fewer crashes. The presence of a bike lane at the PHB being associated with fewer total crashes is a desirable finding. Several studies have documented the benefit of a raised median/refuge island for pedestrians, and this ADOT study supports that finding. The distance to an adjacent traffic signal variable only remained in the total rear-end and fatal and injury rear-end crash type models where it was significant at the 0.1 level (not the 0.05 level). When reviewing the effect on rear-end crashes, the distance between TCS and PHB is less influential than median presence or speed limit groups (35 mph or less versus 40 mph or more). The study found no significant difference in crashes at PHBs located at intersections versus midblock locations.

Table 6. Descriptive statistics for PHB sites used in cross-sectional analysis.

Variable [a]		PHB (186 sites)		
		Minimum	Maximum	Average
Legs		2	4	3.4
M_Lanes		2	9	4.5
M_LTL		0	2	0.8
M_PK_01		0	1	0.1
M_Bike_01		0	1	0.6
C_Lanes		0	6	1.4
Veh (AADT)		1,385	50,510	23,500
PB_Vol_MC		40	2,130	475
Sig_Dist		277	13,249 [b]	1,548
M_MT_R	Value (# of sites)	Not Raised (119), Raised (67)		
PSL_group	Value (# of sites)	35 or less (97), 40 or more (89)		

Note: [a] See Table 3 for description of roadway variables.
[b] If Sig_Dist was greater than 1,500 ft, the value was set to 1,500 ft. At a certain distance, a traffic control signal would probably not affect the operations or safety of a neighboring intersection. This distance was assumed to be 1,500 ft based on engineering judgment.

This ADOT study permitted the inclusion of a larger number of sites and a larger number of months of before and after data than other studies, which aided in the ability to provide statistically significant results. Crash reductions were found to be significant at the 0.05 significance level for total crashes, fatal and injury crashes, fatal and injury rear-end crashes, and pedestrian-related crashes, regardless of the reference group considered. Other crash types were also associated with significant reductions depending on the reference group being used and statistical significance level being accepted.

Using the Findings

The research team used the study's findings to develop detailed recommendations regarding the design and operation of PHBs on Arizona roadways. A summary of those recommendations follows:

- Section 640 of the ADOT *Traffic Engineering Guidelines and Processes* (TGP 640) provides guidance on the evaluation of candidate locations for installing PHBs. The following are recommended changes to the TGP 640:
  - Add direction to first consult with the FHWA Safe Transportation for Every Pedestrian (STEP) Guide or the Arizona-specific STEP guide when determining if a location is suitable for a PHB or for an alternate crossing treatment.
  - Revise the PHB application consideration based on the posted speed limit by raising the accepted speed limit to 50 mph.
  - Expand the evaluation criteria in Exhibit 640-A for PHB locations.
  - Add information about potential consideration of latent crossing demand as criteria for a PHB.
- To encourage consistency in PHB design, the research team recommended developing a PHB standard drawing and outlined specifics to address.
- Consider two-stage PHB crossings when wide raised medians, sufficient to accommodate expected number of pedestrians, either exist or can be installed.
- Consider developing separate design and guidelines to implement the concept of side-by-side pedestrian/bicyclist crossings at busy multi-use trails crossing state highways.
- To complement the primary standards, guidance, and options for the operation of PHBs contained in the MUTCD and the Arizona Supplement within Sections 4F.02 and 4F.03, the research team suggested adding extensive operational guidance to the TGP 640, making it more useful as a full set of guidelines.

Key Findings

Before-after safety study:

- Crash reductions found to be significant for total crashes, fatal and injury crashes, fatal and injury rear-end crashes, and pedestrian-related crashes regardless of the reference group considered (see Table 5).

Cross sectional safety study:

- PHBs with a raised median or pedestrian refuge island had fewer total crashes.
- There is no significant difference in crashes at PHBs located at intersections versus midblock locations.

Operational study:

- Driver yielding on higher-speed streets (posted 45 to 50 mph) is similar to driver-yielding rates on lower-speed streets (both categories had an average of 97 percent yielding).

Kay Fitzpatrick

Additional Research Needs

The findings from this research identified the following research needs:

- Determine under what circumstances it is desirable to synchronize PHBs with the adjacent traffic signals to avoid unnecessarily stopping motorists at the signal or the PHB crossing; unnecessary stops might cause more red-light violations or rear-end crashes at either the signal or the PHB.
- Determine how to best educate drivers, pedestrians, and bicyclists on the appropriate use of and response to PHBs. **itej**

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Kay Fitzpatrick, Ph.D., P.E., PMP (F) *is a senior research engineer with Texas A&M Transportation Institute (TTI). Kay has been involved with ITE for many years and has served as president of the ITE Brazos Valley Section, chair of a Texas District meeting, and member and chair of the ITE Traffic Engineering Council; has written chapters in the ITE* Traffic Engineering Handbook *and the* Urban Street Geometric Design Handbook *and was one of the assistant editors for the 2000 edition of the ITE* Traffic Control Devices Handbook*; and is the co-author of several ITE Briefing Sheets, ITE Compendium articles, and* ITE Journal *papers. She has been honored with the Burton W. Marsh Award for Distinguished Service to ITE.*

Michael J. Cynecki, P.E., PTOE (F) *is a project manager with Lee Engineering in Phoenix, Arizona. He has 41 years of traffic operations and safety experience, including 26 years with the City of Phoenix Street Transportation Department. Mike installed the first nine Pedestrian Hybrid Beacons in Phoenix, AZ and serves as an instructor for the FHWA Designing for Pedestrian Safety Workshops.*

Eun Sug Park, Ph.D. *is a senior research scientist at the Texas A&M Transportation Institute (TTI). She co-authored a transportation statistics textbook* Transportation Statistics and Microsimulation *as well as numerous papers and research reports. She is Fellow of the American Statistical Association (ASA), Elected Member of the International Statistical Institute (ISI), Member of the TRB Committee on Statistical Methods, and Editor for Statistics of the journal* Chemometrics and Intelligent Laboratory Systems.

Grey Means Go: Colorblindness in Transportation

By Brian Chandler, P.E., PTOE, RSP2IB, PMP (M)

Up to 90 percent of what road users use to navigate is visual, and much of that information is color-specific. Road signs are denoted by color, and pavement markings have different meanings depending on their color. At a traffic signal, red and green provide opposite messages: Red means stop. Green means go.

Shutterstock/Anttoniart

But to a road user with color vision deficiency (typically referred to as "color-blindness"), and even more so to those who are fully colorblind, these colors have little or no meaning.

Grey means stop. Grey means go.

An estimated 4 to 5 percent of the population has some sort of color vision deficiency. The effects of colorblindness in transportation are not well-documented, and transportation professionals have generally ignored or misunderstood the issue. What is known is that colorblindness introduces a disadvantage to some road users, and the lack of mitigation for this issue makes their travel experience less efficient and less safe.

Color Vision Basics

The act of sight starts with rods and cones. Two photoreceptors on the retina take information from the environment, through the eyes, and to the brain. The rods handle light-related information, and the cones handle color. The three cones take certain areas of the spectrum to the brain—red (R), green (G), or blue (B)—like an old "RGB" computer monitor. The combination of these three cones creates color vision.

If any of the cones has a problem, the color absorbed by that cone changes, which affects the RGB combination received by the brain. Because any one of the cones can have a problem (or be missing altogether), the type and severity of color vision deficiency are nuanced. No colorblind person sees the world in exactly the same way as another, which is one reason addressing this issue is complicated.

The most common type of color vision deficiency is Deuteranomaly, a malfunctioning of the green cone. A red cone malfunction, called Protanomaly, is also possible. Rarely, one of these cones may be missing altogether; this is called Deutronopia (green) or Protanopia (red). Rarer still are malfunctioning or missing blue cones, called Tritanomoly and Tritanopia.

The cone problems that cause colorblindness affect more than a single color. Any faulty or missing cone (red, green, or blue) impacts color identification along the entire spectrum. Overall, color perception tends to be lower, increasing color confusion and the ability to "call out the color" when seen. This can have significant effects as travelers navigate the transportation system, as described below.

Color in the MUTCD

The *Manual on Uniform Traffic Control Devices* (MUTCD) is the national standard in the United States that guides the use of traffic control devices, including signs, pavement marking, and traffic signals. The MUTCD requires consistent color nationally to provide uniformity. The manual mentions color more than 300 times, starting on page 1.

Figure 1. Simulation approximating what some colorblind people see.

"Devices should be designed so that features such as size, shape, color, composition, lighting or retroreflection, and contrast are combined to draw attention to the devices; that size, shape, color, and simplicity of message combine to produce a clear meaning…"[1]

The MUTCD then lays out its official "Color Code" that assigns proper usage to each color:

The general meaning of the 13 colors shall be as follows:

a. Black – regulation
b. Blue – road user services guidance, tourist information, and evacuation route
c. Brown – recreational and cultural interest area guidance
d. Coral – unassigned
e. Fluorescent Pink – incident management
f. Fluorescent Yellow-Green – pedestrian warning, bicycle warning, playground warning, school bus and school warning
g. Green – indicated movements permitted, direction guidance
h. Light Blue – unassigned
i. Orange – temporary traffic control
j. Purple – lanes restricted to use only by vehicles with registered electronic toll collection (ETC) accounts
k. Red – stop or prohibition
l. White – regulation
m. Yellow – warning

A review of this list reveals several colorblind-related concerns:

- Red and green are the most confused colors, yet they are used for opposite messages: stop and go.
- Blue is used for evacuation routes, a true emergency. Purple—which colorblind people often confuse with blue—is focused on toll collection, a non-emergency situation.

- Light blue and coral are currently unassigned, but if either is introduced it is likely to cause confusion.
- Fluorescent pink signs, used to warn road users of incidents, test poorly for colorblind people, looking more like faded red, yellow, or grey.

Signing

Traffic engineers use signs to share information with road users, and color is one of the primary aspects of the sign denoting its type. For example, all red or partially-red signs are called “regulatory” signs, warning signs are yellow, work zone signs are orange, and other colors are used for other types of signs as described above.

Speed Limits, Speed Advisories, and Color

One example of sign color confusion is the way traffic engineers post speeds. There are three different types of speed-related signs on the roadway:

Modified from MUTCD

Figure 2. Variety of posted speeds.

- *Regulatory Speed Limit* – These signs provide a speed limit that, if exceeded, could result in a driver receiving a citation.
- *Advisory Speed Limit* – These signs are typically added at the bottom of a warning sign, have a yellow background, and are only a suggestion. Exceeding an advisory speed is not breaking the law.
- *Work Zone Speed Limits and Advisory Speeds* – In some cases, a work zone will have a regulatory work zone speed limit. But a work zone may also have an advisory speed plaque under work zone warning signs (orange background) to denote a recommended speed.

Colorblind drivers may not be able to easily tell whether the speed sign is regulatory or advisory, putting them at a disadvantage since they cannot easily use color as a distinguisher.

Blending in with the Environment

For colorblind road users, it is common for signs (especially green, red, yellow, and orange) to visually blend in with the environment. This is of particular concern in the autumn in many parts of the United States, as the forests change colors to an array of green, red, yellow, and orange—the same color as many highway signs. The problem is exacerbated when the signs fade over time, making them blend in even more with their surroundings. The image below simulates what someone with Deutronopia (green-blind) color vision deficiency may see.

Image from The Bluffton Sun; simulaton via Colbindor

Figure 3. Left: Stop sign with background vegetation. Right: That same image as seen by some colorblind road users.

Pavement Marking

Regarding roadway striping, the MUTCD requires that “Markings shall be yellow, white, red, blue, or purple” and details the purpose of each color:[1]

- White: Separation of traffic in the same direction, right-hand edge of road.
- Yellow: Separation of traffic in opposite directions, left-hand edge of divided highways, one-way streets, and some ramps.
- Red: Truck escape ramps, lanes that should not be entered in the direction from which the markings are visible.
- Blue: Supplement white markings for disabled parking spaces.
- Purple: Supplement other markings in toll plaza areas; designate areas restricted to vehicles with electronic toll plaza accounts.
- Black: Contrast marking, only used in combination with other colors.

Using color alone to differentiate regulations can be problematic for colorblind road users. For instance, colorblind drivers could misidentify <u>yellow</u> skip lines on their left as <u>white</u> skip lines, assuming the lane to their left is in the same direction they themselves are traveling. This momentary mistake can happen quickly and subconsciously, and the result could be a head-on collision.

State of Michigan

Flickr Commons/haljackey

Figure 4. Left: Two-way, two-direction roadway with a yellow skip marking. Right: a multi-freeway with white skip lane marking.

Curb Markings

Section 3B.23 of the MUTCD provides guidance for curb markings. "Local highway agencies may prescribe special colors for curb markings to supplement standard signs for parking regulation."[1]

This opens the potential for using colors that are confusing to colorblind road users, and some cities tend to over-rely on the curb markings to convey parking regulations. The MUTCD requires signs as the primary regulatory device, but sometimes the sign is not in place while the painted curb remains, adding to the confusion.

Faded red curb markings look like faded grey concrete to some colorblind drivers seeking a parking space, yet these same drivers can receive a citation or have their vehicle towed for parking here. For example, signs in Seattle, WA, USA state, "You may not park, even temporarily, in a Tow-Away Zone. Vehicles in a Tow-Away Zone are subject to fines and immediate removal and impound."[2]

Signalized Intersections

At signalized intersections, color alone is used to distinguish between opposing messages.

Red. A circular red indication means STOP. It is typically placed on the top of a 3-colored signal, with yellow in the middle and green at the bottom. Unless it's not.

Yellow. Officially, the amber/yellow indication conveys caution for the upcoming red indication. To some, it results in acceleration through the intersection.

Green. The most complex of the indicators, a green ball sometimes means GO, but it can also mean other things. If you're traveling straight, *Green Means Go*. If you are turning right, *Green Means Yield* to adjacent pedestrians who have a WALK signal at the same time. If you are turning left, green can mean many different things depending on conditions.

Of course, this assumes all drivers can recognize the difference between red and green, or at least know that green is at the bottom location of the signal (unless it's not).

What Colorblind Drivers See

The author's personal experience with traffic signals includes the following issues:

- **White Means Go?** Green signal indications look white to me—the same color as nearby street lights and lighting of nearby homes or businesses. Signals mounted on pedestals at intersection corners (instead of overhead) cause me problems, especially at night and in downtown areas.
- **Yellow Means Go?** Some versions of LED green and yellow indications look very similar to me, and to other colorblind drivers.

Signal Color Standards

The MUTCD provides details about traffic signal colors in Chapter 4:[1]

> *4D.06.05 Each circular signal indication shall emit a single color: red, yellow, or green. 4D.08. Standardization of the number and arrangements of signal sections in vehicular traffic control signal faces enables road users who are color vision deficient to identify the illuminated color by its position relative to other signal sections.*

The manual also standardizes the placement of those red, yellow, and green indications and specifically mentions colorblind road users! It is helpful to know that the red, yellow, and green indications should be in different places—red on top, yellow in the middle, and green on the bottom. As colorblind drivers, we use the movement of the indication (such as the green-to-yellow-to-red phase change occurring up the signal face) as much as the colors themselves.

However, after providing clear standards and reasoning, the MUTCD allows for these exceptions:

Horizontal Signal Placement

> *4D.10 In each horizontally-arranged signal face, all signal sections that display red signal indications shall be located to the left of all signal sections that display yellow and green signal indications.*[1]

Tilemahos Efthimiadis/Flickr Commons

Figure 5. Horizontally-mounted signals.

Horizontally-installed signals can make identifying red, yellow, and green more difficult. The MUTCD requires red to be placed on the left, but there is not 100 percent adherence. Therefore, when approaching a horizontal signal, colorblind users must use additional cues—like other drivers and pedestrians—to make decisions at the intersection.

Two Colors. Same Signal Head.

> *4D.06.06 Each arrow signal indication shall emit a single color: red, yellow, or green* ***except*** *that the alternate display (dual-arrow signal section) of a GREEN ARROW and a YELLOW ARROW signal indication, both pointing in the same direction, shall be permitted, provided that they are not displayed simultaneously.*[1]

The MUTCD allows the green arrow and yellow arrow to be used in the same head location with the only difference being the color. Note that in this case the figures are not showing the difference between regular color vision and color deficiency. These are both normal-color-vision photos of the same signal head, taken a few seconds after the other.

Of every 20 drivers making this left turn, one is colorblind, and he or she will struggle to identify that arrow as yellow or green. Those who are colorblind will make their best guess, and then hope—for their own safety and that of others—that they guessed correctly.

Brian Chandler

Figure 6. Four-section signal head with green indication.

Brian Chandler

Figure 7. Four-section signal head with yellow indication.

Solutions

Addressing the needs of colorblind travelers starts with basic accessibility principles, and continues with specific examples to improve safety and efficiency for colorblind travelers, and in turn, for everyone.

Accessibility Principles

Ian Hamilton, an accessibility specialist in Bristol, England, identifies three key principles related to colorblindness that I've adapted to transportation planning, design, and operations.

1. *Don't use color difference alone to communicate or differential information.*
2. *Check with a simulator to pick up on contrast issues.*
3. *Run by colorblind folk, but use that as a way to pick up on issues you've missed, not was a way to verify accessibility.*[3]

Don't Use Color Difference Alone to Communicate or Differentiate Information. As shown below, the London Underground subway map color lines can be problematic for colorblind travelers.

Transport for London, 2020

Figure 8. Excerpt of London Underground Map.

To help colorblind users, several smartphone apps and websites provide colorblind-friendly versions of the map. As seen below, this image displays a normal map view on the left, what some colorblind viewers see in the middle, and then a double-coded map on the right that includes a mix of colors and patterns for an aesthetically pleasing, colorblind-friendly map.

Check with a Simulator to Pick up on Issues. For any situation where a colorblind perspective is needed, software tools can give anyone a starting point to approximate what some colorblind users may see. COBLIS is a browser-based simulator that allows users to upload an image from their computer and simulate a variety of color vision deficiencies. At DKS Associates, a consulting firm focused on transportation solutions, the creative services team uses Color Oracle, a free plug-in for Mac and Windows that simulates color vision deficiency. DKS created a color palette for transportation-related mapping projects that is optimized for colorblind viewers.

Brilliant Maps/Transport for London

Figure 9. Left: Normal-vision map. Center: Simulated colorblind-vision map. Right: Double-coded map to aid colorblind users.

DKS Associates

Figure 10. Guide for optimizing maps for colorblind viewers.

Run by Colorblind Folk to Identify Other Issues You've Missed. Colorblind people are often willing to share their experiences to help make their products and experiences more accessible. Be sure to note, however, that color vision deficiency varies widely by type and degree, so something one colorblind person can see clearly could still be problematic for someone else.

Colorblind-Friendly Solutions

Designing and operating for colorblind users starts with awareness. On the roadway, designers and traffic engineers have several tools in the toolbox to aid colorblind travelers. One key element of colorblind accessibility is that helping color vision deficient users also helps everyone else navigate the system safer and more efficiently.

Signing Solutions. It is common for some signs to blend into the natural environment, especially in late summer and early autumn as leaves change to colors that match the red, yellow, and brown signs. Fortunately, signs can be enhanced to stand out against their background.

Doubled-up signs on the left and right side of the road provide additional opportunity to be seen. Reflective strips on signposts provide more color and help "tie the sign to the ground" visually. And flashers—including beacons above the signs and LED lights around the edge—add another element that can make the sign stand out.

Minnesota DOT

Figure 11. Stop sign with LED enhancement.

Striping Solutions. In many European countries, white pavement marking is used for all routine lane markings. For example, in Germany engineers use patterns instead of colors to communicate with motorists.[4]

Figure 12. German pavement marking patterns.

1. ***No passing in one direction.*** You may pass only if you have a broken line on your side; you may not cross a solid line on your side to pass.
2. ***No passing.*** You may not cross the solid center line to pass.
3. ***Lane separation line.*** Short broken lines between opposing traffic lanes indicate that the passing zone is ending.
4. ***Lane separation line.*** Long broken lines between opposing traffic lanes indicate passing is allowed (unless prohibited by a sign). This marking is also used to separate traffic lanes traveling in the same direction.

Signal Solutions. Engineers following the MUTCD's primary guidance that "Each circular signal indication shall emit a single color" is a good start, and that basic standard can be enhanced with a few other strategies.[1]

Reflective Backplates. One helpful treatment at traffic signals is the retroreflective backplate—a strip of material placed around the signal that provides a detailed indication of its location and the signal indicators. This is one of many examples where improving a traffic control device for colorblind road users also provides a safety benefit to all users, as indicated by research showing a 15 percent reduction in all crashes at urban intersections with this treatment.

Kentucky Transportation Center

Figure 13. Signalized intersection with reflective backplates.

Dual Red Lights. The application depicted in Figure 13 in Kentucky, USA creates a "Red T" at the top of the signal head. Its main purpose is to double the visibility of the red light, and it provides a backup in the case of a burned-out LED or other failure. For colorblind drivers, it provides additional clarity that it is—in fact—the red indication.

Kentucky Transportation Center

Figure 14. Dual red light signal indications.

In Quebec, the signal has two red indications, one on each side. All other indications (green and yellow balls, and any arrows) have a single indication. This could introduce some confusion regarding the yellow and green phases, as users might not know where to expect each to show up.

Kentucky Transportation Center

Figure 15. Dual red indications in Quebec, Canada.

Conclusion

Approximately 4 to 5 percent of all road users navigate the transportation system with color vision deficiency. As an industry, the needs of the colorblind have largely been ignored or not acknowledged, using color as a single indicator of important traffic control information. There are numerous ways to make the system more accessible for colorblind travelers. By doing so, we can make transportation safer and more efficient for all users. **itej**

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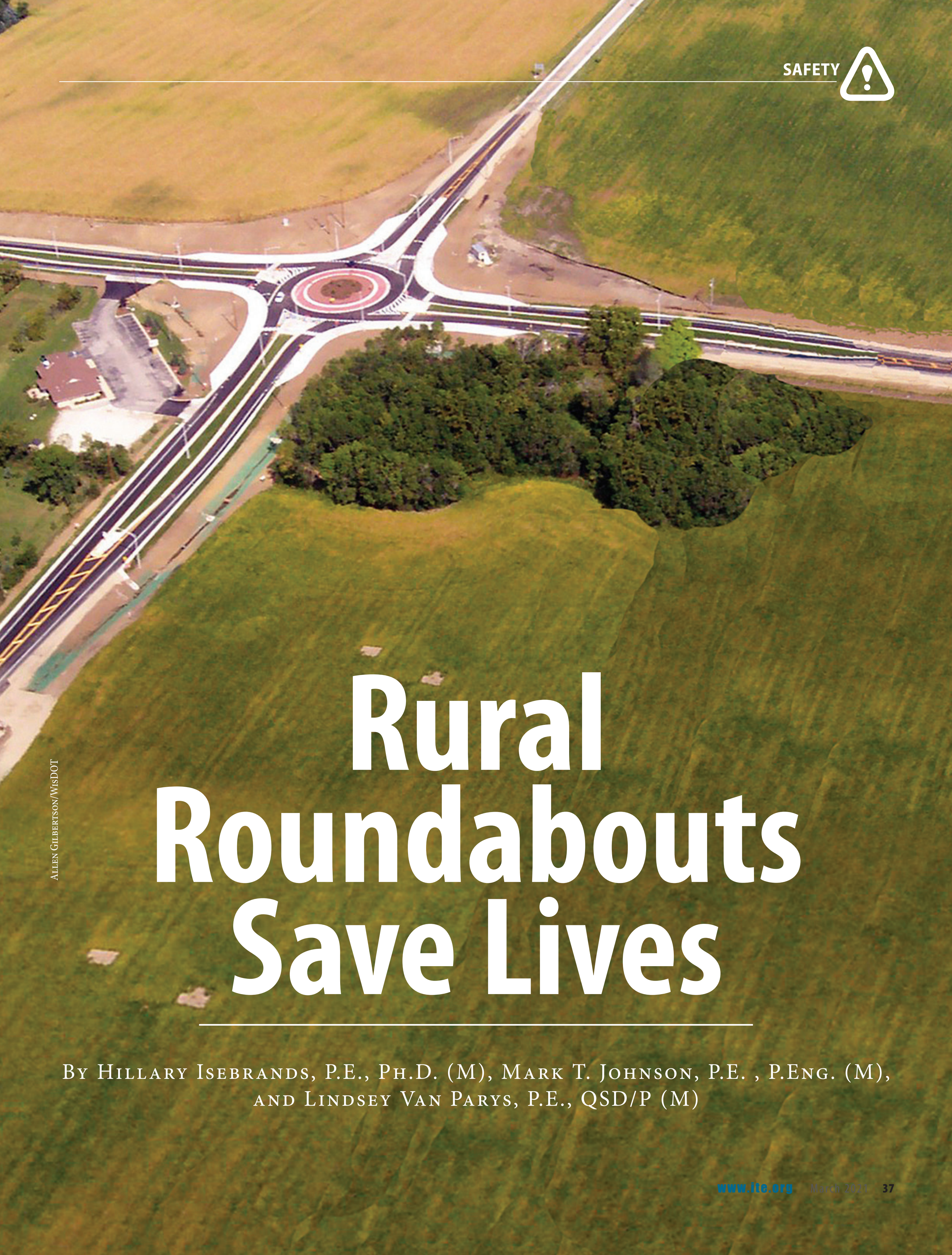
Brian Chandler, PE, PTOE, RSP2IB (M) *is the national director for Transportation Safety at DKS Associates in Seattle, WA, USA. He serves nationally on the ITE Transportation Safety Council Executive Committee and locally on the ITE Washington Section Safety Committee. Brian's original* Grey Means Go *article series provides additional details and more examples. It can be accessed at www.linkedin.com/in/brianchandler.*



Allen Gilbertson/WisDOT

Rural Roundabouts Save Lives

By Hillary Isebrands, P.E., Ph.D. (M), Mark T. Johnson, P.E. , P.Eng. (M), and Lindsey Van Parys, P.E., QSD/P (M)

Annually, nearly 9 percent of all roadway deaths in the United States occur at rural intersections.[1] Modern roundabouts are a Federal Highway Administration (FHWA) Proven Safety Countermeasure—one good reason why is that rural intersections converted from stop-controlled intersections to modern roundabouts have resulted in an 87-percent reduction in fatal and serious injury crashes.[2, 3] The roundabouts' slower speeds, reduced conflict points, and attention to driver expectancy principles create a safe intersection. These safety results have been consistent throughout the last three decades in the United States and are in line with the historical experience on international roadways.

Rural roadway environments typically include higher speeds (45 miles per hour [72.4 kilometers per hour]+), large trucks, and infrequent intersections and stops. Roundabout designs in rural context applications that promote conspicuity allow drivers to recognize the intersection ahead and react to changing conditions—including the readiness to slow down and awareness of turning vehicles—and have impressive safety records when applied to intersections with safety issues or risks associated with severe crashes.

Myths of Rural Roundabouts

Despite the documented safety performance of roundabouts at rural intersections, the public, practitioners, and decision makers may still have reservations about implementing roundabouts on high-speed roadways. Contrary to their concerns about the safety of roundabouts—including the ability of drivers to recognize the intersection and slow down—roundabouts save lives. Other myths include that roundabouts take up too much right of way and are expensive. A "right-sized" roundabout accounts for design vehicles and other common vehicles, and is not overdesigned with unnecessary re-alignments and extensive features that do not add safety or operational value. Simply put, a rural roundabout can be context-appropriate and consistent with the intersection environment. The evaluation of project costs needs to address numerous performance measures, including safety, operations, maintenance, and environmental impacts for all users for the life of a project. Often times, preventing just one severe crash at a rural intersection with numerous safety risks pays dividends towards a benefit-cost analysis.

Truths about Rural Roundabouts

Knowing the facts about how rural roundabouts perform is important when helping an agency decide about safe and efficient intersection alternatives. The faster we drive, the narrower our cone of vision is, so on high-speed roadways, it is critical that drivers "see" the roundabout design features and do not inadvertently "look past" the roundabout. Addressing driver expectancy is aimed at ensuring drivers will not fail to notice that there is a changed condition ahead. This is accomplished in a number of ways, including geometric approach alignment that allows approaching drivers to see the central island and promotes visual conspicuity. Longer splitter islands (than in lower speed environments) can provide early indication of changing conditions ahead via channelization principles on higher speed roadways.

Safety. Numerous roundabout safety research reports published over the last 20 years cite the persistent reduction in fatal and injury crashes at rural intersections with the installation of a roundabout.[4, 5, 6, 7] There are several U.S. states that lead the way with implementation of rural roundabouts at some of their highest crash locations on high-speed rural roadways. Kansas, Maryland, Minnesota, Washington, and Wisconsin were all leaders in the deployment of rural roundabouts in the late 1990s and early 2000s. For example, rural roundabout projects in Duvall, Spokane, and Whatcom County, WA, USA—as well as dozen more that came afterward—have maintained significant reductions in fatal and severe crashes. Of those original seven rural roundabouts in Washington State, a simple

Courtesy Hillary Isebrands.

SR 206/Bruce Rd Intersection, 2005 Roundabout Construction, Washington State.

before-and-after comparison of crash data showed in the six years before the roundabouts were constructed, two fatalities and nine suspected serious injuries occurred. In the 11 years after the rural roundabouts were constructed, there were no fatalities and seven suspected severe crashes. This is a 66 percent reduction in fatal and severe crashes at these rural roundabouts.[8]

Splitter Island Lengths. Splitter island designs can be extended approximately to a point where drivers might be expected to decelerate. A 1993 Austroads guide, referenced in NCHRP 672 *Roundabouts: An Informational Guide*, suggests a minimum of 200 feet (ft.) (61 meters [m]) for high-speed roadways.[9,10] Furthermore, NCHRP Report 672 states that good design encourages drivers to slow prior to the roundabout and suggests designing a comfortable deceleration with a minimum of 100 ft. (30.5 m) splitter island and 200 ft. or more desirable splitter island length is desirable for higher speed roadways. Some agencies have adopted a speed-based splitter island design length approach based on comfortable stopping distance for the prevailing approach speeds.

Even with this guidance, it is noted that prevailing speeds, the context, and horizontal and vertical alignments of the specific location must be taken into consideration in determining appropriate splitter island lengths to assist with addressing driver expectancy, versus relying on standardized or specific lengths for all applications. It's also noted that appropriate horizontal geometric shifts (aka "slight" chicane) on approaches can be useful to assist in addressing driver expectancy on higher speed roadways. However, similar to splitter islands lengths it is not recommended to implement the horizontal shift (chicane) in all conditions and applications, as this can restrict the ability to find the best fit and optimized safety for a specific location. Both tangential/flared/taper (shown in Exhibit 6-69 in NCHRP 672) approaches and successive curve approach designs on approaches have a similar safety performance record in the United States.

The project shown in Figure 1 is an example of context for splitter island length. The east leg of the roundabout has a splitter island of 250 ft. (76.2 m), where the west leg has a splitter island of just 100 ft. The reason for the difference in splitter island lengths on the two approaches of the same road is context. Drivers approaching from the east (traveling westbound) are approaching

Courtesy Hillary Isebrands.

A 2006 Florence, KS, USA rural roundabout US 50/US 77 with a 160 ft.-long splitter island.

at a higher rate of speed and coming from a rural roadway where the closest adjacent intersection is almost 4 miles (6.4 kilometers) further east. Additionally, the approach to the intersection is on a horizontal and vertical curve. Therefore, the longer splitter is needed to alert the driver to the change in condition and provide that visual and physical queue that the roadway is changing ahead. For the west leg (traveling eastbound), drivers are approaching from a slower and more open environment with businesses and uncontrolled intersections along the way. Additionally, there are business access points on both the north and south side of the intersection. Based on this criteria, the shorter splitter island was warranted.

Courtesy CalTrans and the City through GHD.

Figure 1. State Route 49 /Main Street, Plymouth, CA, USA.

Conspicuity on Approach. Approach splitter island/median landscaping along with central island features such as mounding, and appropriate selection of landscape vegetation design features can assist drivers in recognizing the need to reduce their speed and navigate the intersection safely. The project shown in Figure 2 is an

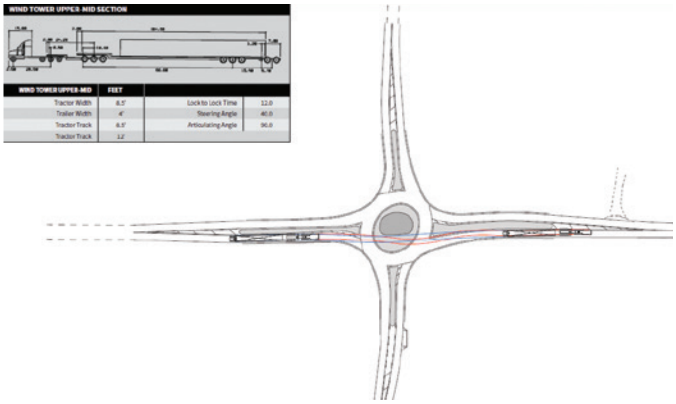
Courtesy MTJ Roundabout Engineering.

Figure 2. USH 18 at Bennett Road Dodgeville WI, USA.

example showing application of landscaping the splitter island as well as the central island to address the driver expectancy of this high speed context divided highway application.

Accommodating Large Vehicles. The ability to design a roundabout for typical design vehicles (WB-62 or WB-67) as well as oversized over weight (OSOW) trucks or farming equipment is essential to the success of a project. Not only are there tools available to assist with simulating the larger vehicles, there are also flexibilities in design features such as truck apron width and shape, outside curbing design and location, as well as modifications to the splitter island noses and curbing. This is often where experience in applying engineering principles for both roadway and roundabout specific applications come into play to achieve desired accommodations without reducing overall safety. There are physical limitations of large vehicles to make particular turns maneuvers—even with skilled and professional drivers—in addition to the roundabout design features that are needed for speed control and consistency. How those elements come together is part of the problem solving and creativity of roundabout design. The project examples shown in Figure 3 show an elliptical center islands and raised features modified to accommodate the large, yet likely infrequent, trucks traversing the intersection. Lastly, it is important to engage the trucking and freight community in conversations early on regarding the use (i.e., what are the predominant movements through the intersection?).

Divided Highways. Rural divided highways are found across the tranpsortation landscape. Like rural two-lane roadways, there are decisions and conflicts at these higher volume rural intersections. High speeds are expected, and gaps in high-speed traffic can be a challenge to find during portions of the day. A roundabout is a viable design alternative to other intersection options. Even with unbalanced flows between the major route and minor route, a roundabout can provide safety benefits to both mainline and side street traffic as they navigate turning movements. The safety project



Courtesy MTJ Roundabout Engineering.

Figure 3. OSOW Wind Tower AutoTurn Turning Template and Envelopes.

shown in Figure 4 evaluated a roundabout, grade separation, and a signal to replace a two-way stop control intersection with a very poor safety record. During the evaluation stage of the project, the roundabout was shown to substantially outperform the other two alternatives with respect to benefits and cost, and it fit the community's goals of providing a gateway. It was constructed in 2006 and has had an exemplary safety record, which is attributed to its high level of design features that addressed the driver expectancy requirements of this high-speed roadway.

Lighting. Intersection lighting is very common at roundabouts and is a requirement for many states, several of which have roundabout lighting guidance. Intersection lighting is one feature that contributes to the visibility of the intersection as drivers approach the rural intersection. The number and location of light poles—and therefore, luminance—typically varies based on roadway traffic volumes, adjacent land use, pedestrian and bicyclist use, length of splitter islands, and other intersection signage. According to a 2016 publication, highway lighting can

Courtesy GHD.

Jaye Street/Montgomery Avenue, Porterville, CA, USA.

Courtesy MTJ Roundabout Engineering.

Figure 4. Divided highway in Dodgeville, WI US Hwy 18 at Bennett Rd Intersection.

be expensive in rural areas and cost can impact the decision to install a roundabout. Gblogah's international literature search found that many countries around the world do not illuminate rural roundabouts, and that partial illumination can provide up to 80 percent of benefits of full lighting at roundabouts.[11] Lighting of rural intersections continues to be a topic of continued research considering benefits and costs to installation and maintenance.

Conclusion

Safety data tell us that people are less likely to be involved in a serious crash at a roundabout than many other intersection types. With hundreds of rural roundabouts operating across the United States, it is safe to say that lives have been saved at these intersections. The versatility of rural roundabouts provide flexibility and opportunity, in application from two-lane roads to divided roadways and both balanced and unbalanced traffic flows at the intersections. With purposeful consideration for design features that reduce approach speeds and provide conspicuity without over-design and excessive costs, a rural roundabout may be our next opportunity to save a life. **itej**

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Hillary Isebrands, P.E., Ph.D. (M) *has 24 years of experience. She focuses on improving the design and safety of roadways by providing technical assistance, training, and technology deployment of proven safety countermeasures. Hillary is a safety engineer with the Federal Highway Administration, Resource Center and is a Professional Engineer, a NHI Certified Instructor, and has her bachelor's, master's, and Ph.D. in Civil Engineering.*

Mark T. Johnson, P.E., P.Eng. (M) *founded MTJ Roundabout Engineering in 2005, after 12 years of public- and private-sector traffic and transportation engineering experience in Colorado and with the Wisconsin Departments of Transportation. Mark works as a subject area expert on project teams aimed at maximizing community benefits and delivering successful, well-received roundabouts across North America.*

Lindsey Van Parys, P.E., QSD/P (M) *has been delivering roundabout projects since 2008. She is currently an associate and project manager at GHD overseeing daily project operations. She has expertise in delivering projects from the conceptual stage through to construction. She is the chair of the ITE Roundabout Committee.*

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Evaluation of a Low-Cost Countermeasure to Prevent Incorrect Turns at Highway-Rail Grade Crossings

By Zhenyu Wang, Ph.D. (M) Pei-Sung Lin, P.E., PTOE (F), Abhijit Vasili, Rui Guo, and Runan Yang

Vehicle incursion onto rail tracks is a significant safety issue at highway-rail at-grade crossings. Rail track incursion incidents are observed primarily at these crossings adjacent to roadway facilities at which turning movements are expected (i.e., intersections, driveways, ramps, etc.). Figure 1a presents a scenario involving an incorrect turn onto railroad tracks near an on-ramp. Drivers unfamiliar with the area or distracted may enter the turning lane and make a wrong decision at the apparent turning point. Once the driver passes the shoulder and the lateral concrete slab, the vehicle will likely get stuck on the railroad tracks, leading to a hazardous situation.

A systematic review identified five major contributing causes of incorrect turns onto railroad tracks: 1) potentially misleading signs and pavement markings near highway-rail crossings, 2) darkness and low visibility near or at highway-rail crossings, 3) following inaccurate turn instructions from a GPS device onto railroad tracks, 4) skewed highway-rail grade crossings, and 5) driver distraction.[1] Misleading signs and pavement markings, as shown in Figure 1b, are widely applied on exclusive turning lanes in the upstream of highway-rail grade crossings. Drivers who intend to make a turn at the downstream turning point (intersection leg, on-ramp, or driveway) on an exclusive turning lane may be confused by the design of continuous right-turn arrows plus "ONLY" in advance of the crossings, and "MUST TURN" signs exacerbate the issue. Drivers are likely to make the turn at the first curb edge opening (rail tracks) and then hesitate near the rail tracks. This issue is more serious for unfamiliar or distracted drivers in a low-visibility environment.[2]

To help road users more clearly understand where a turn is to be made, even under adverse conditions, the National Committee on Uniform Traffic Control Devices (NCUTCD) (2009) Technical Committee recommended the following (It is worth noting this recommendation has not yet been included in the *Manual on Uniform Traffic Control Devices*, 2009 Edition):

Proposed Section 8B.23 Arrow Markings

Standard – Arrow pavement markings for turn lanes shall not be placed between the stop line for the highway-rail grade crossing and the tracks.

*Guidance – Arrow pavement markings, if used, should be placed a minimum of 100 ft. in advance of the stop line for the highway-rail grade crossing when sufficient turn lane storage length exists. Arrow pavement markings, if used, should be placed no less than 20 ft. beyond the far rail.**

* The proposed changes approved by the NCUTCD are submitted to the Federal Highway Administration (FHWA) for consideration for a future revision to the MUTCD. Approval by the NCUTCD does not constitute official rulemaking or acceptance of these changes by the FHWA. The FHWA evaluates each proposal and determines whether to include in a future rulemaking to amend the MUTCD, along with recommended changes submitted by other organizations, agencies, and individuals, as well as any changes that the FHWA develops directly.

Based on this proposed recommendation, this study developed cost-effective countermeasures, as shown in Figure 2, to prevent incorrect turns onto tracks caused by driver misinterpretation of the curb edge opening at railroad crossings at a location at which they were to turn. First, continuous right-turn arrow markings on exclusive turn lanes are removed from the zone in advance of rail tracks; the clearance range is beyond 100 feet (ft.) (30.5 meters [m]) for forming a consistent pavement-marking pattern promoting path continuation. Second, several combinations of route/interstate shield, cardinal direction, and straight arrow are repainted on the upstream of the grade crossing on exclusive lanes. This design of straight arrow, plus guidance information in the upstream of the rail tracks, could guide drivers to keep a straight path until passing the grade crossing and, consequently, avoid incorrect turns onto tracks.

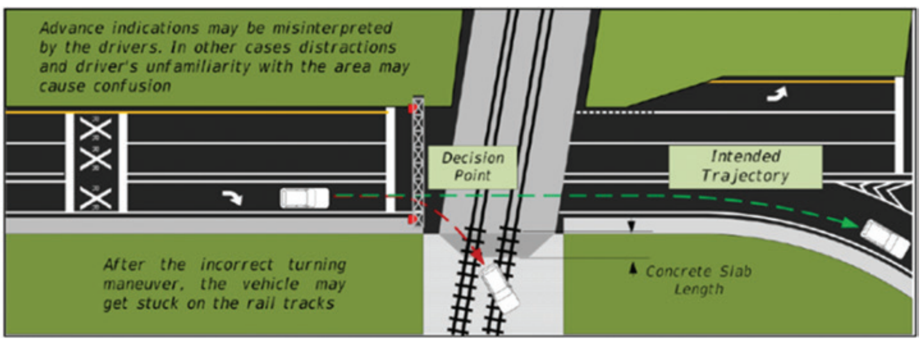
Similar countermeasures of pavement markings have been successfully implemented to prevent wrong-way driving behaviors.[2, 3, 4, 5, 6] However, the effectiveness of these countermeasures in preventing incorrect turns at highway-rail grade crossings has not been investigated. The research objective of this study was to conduct pilot studies in Florida, USA and evaluate the effectiveness of proposed low-cost countermeasures in preventing incorrect turns at highway rail crossings.

Hesitation Behavior

It is difficult to observe actual incorrect turning behaviors during a short period of time because 1) incorrect turns onto tracks are rare and random events, 2) few incidents of turning onto railroad tracks are reported if no stuck vehicles or collisions occurred, and 3) surveillance devices (i.e., CCTVs) that monitor incorrect turn events are available at only a few grade crossings.

Drivers who are confused about a turning point near a railroad crossing tend to present hesitation behavior that causes a significant lowering of speed to allow searching for target turning points and making decisions—the more hesitation behavior occurs, the higher the incorrect turn risk. Since hesitation behaviors are related to slower speed, this study measured the speed of approaching vehicles on

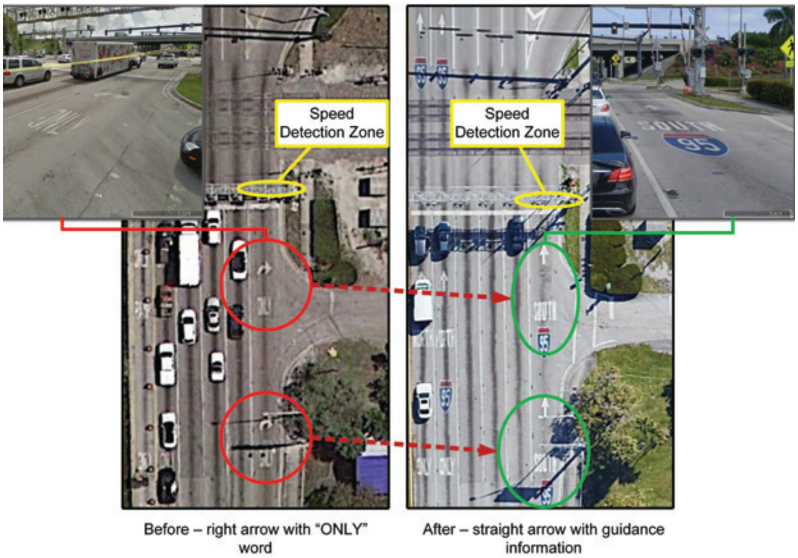
Figure 1. Illustration of incorrect turning maneuvers at highway-rail grade crossings.



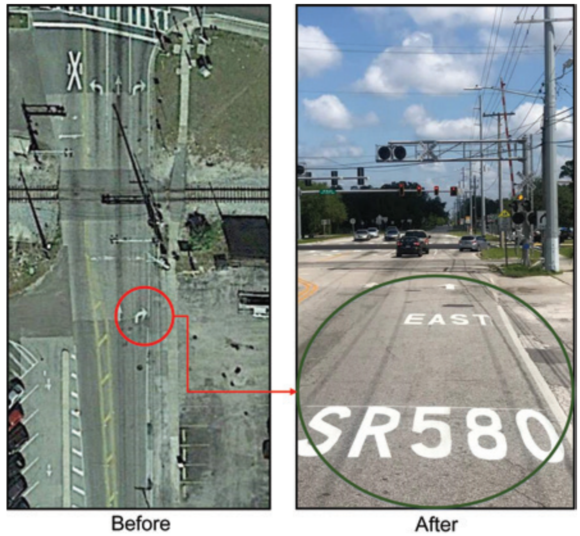
a. Scenario of incorrect turns at highway-rail grade crossings.

b. Misleading pavement markings and signage.

Figure 2. Illustration of proposed countermeasures at highway-rail crossings.



a. Proposed countermeasures for connecting interstate on-ramps.



b. Proposed countermeasures for connecting side street.

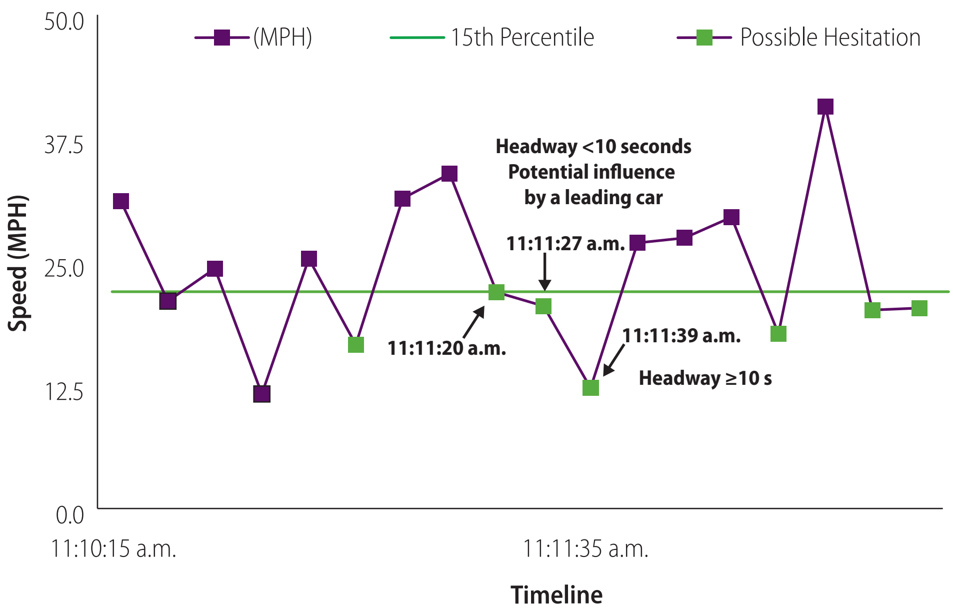
exclusive turning lanes near railroad tracks and identified hesitation behaviors based on the following criteria (as shown in Figure 3):

- Speeds of approaching vehicles are lower than the 15th percentile of the collected sample within a data collection period at a highway-rail crossing; these vehicles exhibit abnormal speed.
- Headways of vehicles with abnormal speeds are equal or greater than 10 seconds; a long headway was used to exclude the influence of leading cars on speed.
- Other factors influencing low speed, such as a red signal, incidents, or lane closure, were excluded from the observations.

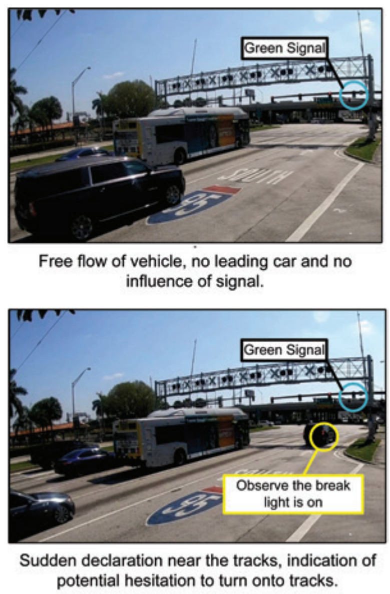
Study Sites and Data Collection

Pilot studies were conducted at six sites in Florida, as shown in Table 1. These sites, including a railway grade crossing adjacent to a signalized intersection and an exclusive turning lane connecting an interstate on-ramp or a principal arterial road, have historical

Figure 3. Identification of hesitation behaviors.



a. Filter vehicles by speed.



b. Second review to exclude unnecessary influencing factors.

records of incidents of vehicles running onto tracks or potential risk of incorrect turns identified by traffic agencies. At each site, data collection was conducted twice—before and after implementation of the proposed countermeasures (Table 2). The research team collected speed data on exclusive turning lanes near highway-rail grade crossings, as shown in Figure 2b, for 3-4 hours in both daytime and nighttime. The hesitation behaviors were identified by applying hesitation identification criteria on the collected speed data. Videos were used to exclude any "fake" hesitations, such as very low speed due to a red traffic signal, a queue, and unnecessary factors. The hesitation rates, which are defined as the quotient of the count of hesitation events divided by the count of vehicles on the exclusive lane, were compared before and after the implementation. The hesitation rate reduction due to the implementation was calculated to evaluate the safety performance of the proposed countermeasures in reducing the risk of incorrect turns onto rail tracks at highway-rail grade crossings. Hypothesis testing was applied to determine if the reduction of hesitation rate due to the proposed countermeasures was significant at a confidence level of 90 percent or higher.[7]

Table 1. Characteristics of study sites

	Forest Hill Blvd.	Pembroke Rd.	Commercial Blvd.	Hollywood Blvd.	Hallandale Beach Blvd.	N. Boulevard
Functional classification	Urban principle arterial					
Intersecting road	I-95					Busch Blvd (SR-580)
City	Lake Clarke Shores	Pembroke Park	Oakland Park	Hollywood		Tampa
Through/right-turn lanes	2/1	3/1	3/1	3/1	3/1	1/1
Right-turn lane length before tracks	525 ft.	90 ft.	300 ft.	140 ft.	130 ft.	140 ft.
Downstream access point	On-ramp					Intersection
Speed limit	35 mph	40 mph	45 mph	35 mph	35 mph	30 mph
Driveway/side street closed to rail tracks in upstream	No	No	No	Yes	Yes	No
AADT	47,500	48,500	62,500	49,000	45,500	23,000

Table 2. Treatments and data collection

	Forest Hill Blvd.	Pembroke Rd.	Commercial Blvd.	Hollywood Blvd.	Hallandale Beach Blvd.	N. Boulevard
Pavement markings on right-turn lane in "before" stage	3 right-turn arrows with "ONLY" wording + 4 right-turn arrows	No pavement markings	3 right-turn arrows with "ONLY" wording	2 right-turn arrows with "ONLY" wording	No pavement markings	1 right-turn arrow
Pavement markings on right-turn lane in after stage	4 straight arrows with guidance information and I-95 shield	1 straight arrow with guidance information and I-95 shield	2 straight arrows with guidance information and I-95 shield	2 straight arrows with guidance information and I-95 shield	1 straight arrow with guidance information and I-95 shield	1 straight arrow with guidance information and SR-580
Additional treatment			Dynamic Envelope			
Before data collection						
Time of day (day)	9:50 a.m.–3:00 p.m.	9:55 a.m.–2:59 p.m.	9:53 a.m.–3:00 p.m.	9:58 a.m.–2:59 p.m.	9:52 a.m.–3:45 p.m.	10:04 a.m.–2:00 p.m.
Time of day (night)	7:55 p.m.–12:22 a.m.	8:01–11:56 p.m.	7:40–11:59 p.m.	7:45–11:58 p.m.	7:56–11:54 p.m.	7:49–11:45 p.m.
Weather	Clear					
After data collection						
Time of day (day)	10:12 a.m.–1:27 p.m.	9:12 a.m.–12:20 p.m.	10:54 a.m.–1:01 p.m.	9:03 a.m.–12:21 p.m.	10:18 a.m.–1:13 p.m.	10:07 a.m.–12:56 p.m.
Time of day (night)	8:37–11:38 p.m.	7:54–11:27 p.m.	7:27–11:02 p.m.	7:23–11:25 p.m.	7:47–11:02 p.m.	8:09–10:56 p.m.
Weather	Clear					

Results and Discussion

Figure 4 presents the relative hesitation reduction obtained from the before-after study. Three sites (Forest Hill Blvd., Pembroke Blvd., and N. Boulevard) experienced a significant hesitation rate reduction after implementing the proposed implementation, at a confidence level of 99 percent, in both daytime and nighttime. Forest Hill Blvd. and Pembroke Blvd. have an exclusive right-turn lane connecting to an on-ramp of I-95. An interstate shield on pavement was used provide guidance information (Figure 2a). The exclusive right-turn lane on N. Boulevard connects to a surface road (SR-580/Busch Blvd). Text pavement markings were used to provide guidance information, as shown in Figure 2b. The length of exclusive lane varies across sites, from 525 ft. (160 m) (Forest Hill Blvd) to 90 ft. (27.4 m) (N. Boulevard). With different conditions, the proposed countermeasures present effectiveness in preventing incorrect turns onto tracks.

On Hallandale Beach Blvd., relative reductions were 100 percent for both daytime and nighttime. On Hollywood Blvd., hesitation rate reductions were 61 percent and 91 percent during daytime and nighttime, respectively. However, only nighttime experienced significant reductions at the two sites (at a confidence level of 99 percent). At the two sites, a side street (driveway) in the upstream is very close to rail tracks (30 ft. [9.1 m] and 60 ft. [18.3 m] from the side street to the first rail track edge for W. Hallandale Beach Blvd. and Hollywood Blvd., respectively); drivers may hesitate at the side street (driveway) and detect rail tracks before reaching the speed detection zone in a good-visibility environment. Drivers may not present hesitation (significantly low) speed at the speed detection zone due to the influence of the upstream side street (driveway) in the "before" stage. During nighttime, drivers may hesitate twice at the upstream side street and rail track. Thus, the speed-based hesitation measures used in this study may underestimate the effectiveness of the countermeasure in reducing hesitation rates at rail tracks in daytime at the two sites.

- On Commercial Blvd., the relative reductions in hesitation rate were 67 percent (daytime) and 91 percent (nighttime). Only the nighttime reduction was significant at a confidence level of 99 percent. Before this study, a dynamic envelope pavement marking that indicates rail track areas was applied on Commercial Blvd. to reduce stopping behaviors in track areas.[8] A bright yellow dynamic envelope outlined by white hash marks is effective in making drivers aware of highway-rail grade crossings and reducing hesitation. Consequently, a reduction in hesitation rates on Commercial Blvd. was insignificant during daytime due to the existing dynamic envelope markings. At night, the proposed countermeasures presented significant effectiveness in reducing driver hesitation even with the dynamic envelope treatment.
- Overall, hesitation rates are more likely to be reduced by 89 percent and 97 percent on average at the six sites with the proposed countermeasure during daytime and nighttime, respectively, and both hesitation reductions were significant at a confidence level of 99 percent.

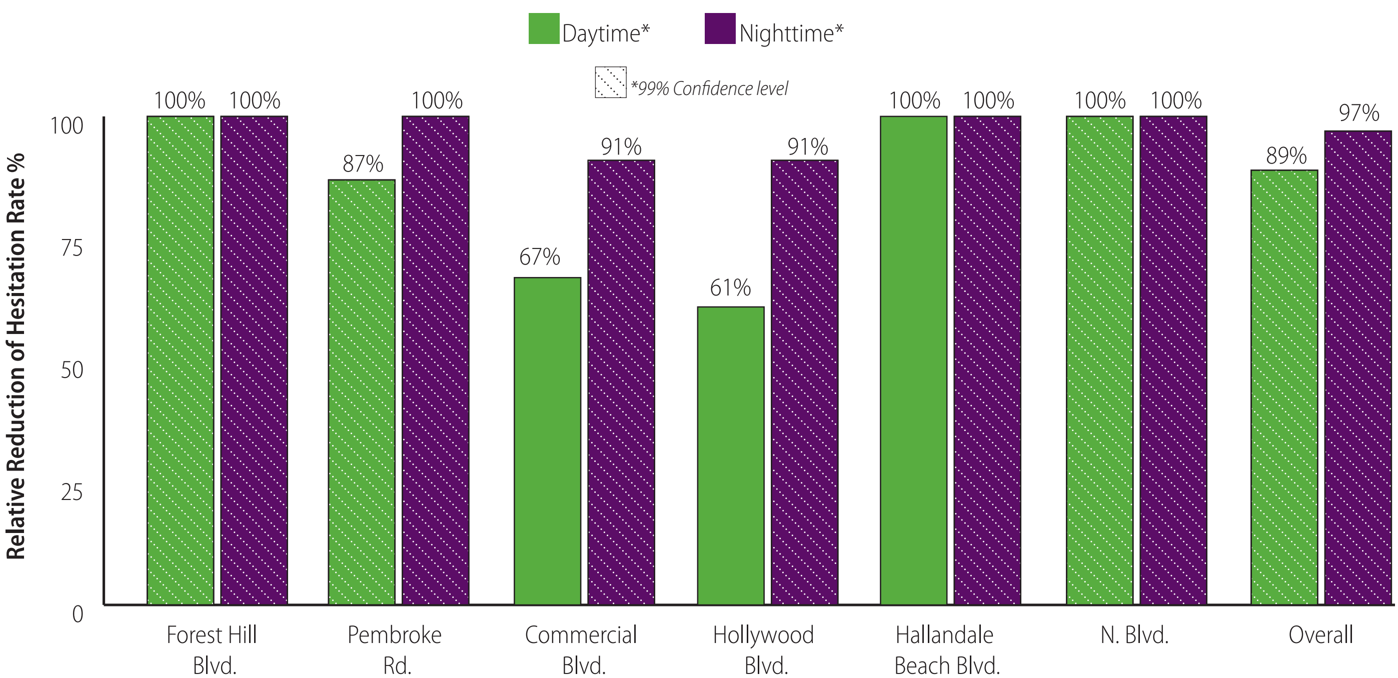


Figure 4. Relative reduction in hesitation rates caused by proposed countermeasures.

Conclusions

Incorrect turns at highway-rail grade railroad crossings are a serious issue in traffic safety management. This study conducted before-after studies at selected highway-rail crossings in Florida to evaluate a cost-effective countermeasure that replaces continuous right-turn or left-turn arrows with straight arrows before at-grade crossings in conjunction with guidance information to reduce driver confusion in selecting proper turning points as they approach at-grade crossings. Based on the before-after comparisons of hesitation rates, the following conclusions were obtained:

Replacement of continuous right-turn arrows with straight arrows plus guidance information on pavement upstream of railroad grade crossings can effectively prevent incorrect right-turns onto railroad tracks.

The effectiveness of straight arrows plus guidance information on pavement at highway-rail grade crossings is more significant in a low-visibility environment (i.e., nighttime) and are more likely to avoid frequent incorrect turns onto rail tracks.

Overall, the proposed countermeasures can significantly reduce hesitation rates of drivers at at-grade crossings by 85 percent in daytime and 97 percent in nighttime at a confidence level of 99.9 percent.

To implement the treatment, engineers need to ensure enough longitudinal space on turning lanes to paint straight arrows and guidance messages. On some crossing with short turning lanes (less than 53 ft. [16.2 m]), a straight arrow without guidance information could be considered. **itej**

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Zhenyu Wang, Ph.D. (M) *is a senior research faculty of Center for Urban Transportation Research (CUTR) at University of South Florida with 15 years of research experience in traffic safety, crash modeling, naturalistic driving studies, and traffic simulation. He has conducted and managed 30+ research projects through grants funded by the Florida Department of Transportation (FDOT), U.S. Department of Transportation (USDOT), and the National Cooperative Highway Research Program (NCHRP).*

Pei-Sung Lin, P.E., PTOE (F) *is a program director at CUTR at the University of South Florida. He is also the director of the Florida LTAP Center. His research interests include traffic signal systems, pedestrian and bicycle safety, railroad safety, railroad trespasser fatality mitigation, wrong-way driving prevention, work zone safety, congestion management, and automated and connected vehicle research.*

Abhijit Vasili *is a graduate research assistant in the CUTR at the University of South Florida. He is a doctoral candidate pursuing a Ph.D. in Electrical Engineering at University of South Florida, Tampa, FL, USA. His primary areas of research are connected vehicles, systems engineering, and data science. He is currently working on the THEA (Tampa Hillsborough Expressway Authority) Connected Vehicles Pilot project.*

Rui Guo *is a lecturer of the Department of Engineering Education in the UF Herbert Wertheim College of Engineering. Her research interests include multimodal traffic safety, sustainable transportation, air transportation and engineering education. She has conducted 10+ funded research projects from state departments of transportations as well as national agencies, presented her studies in core conferences, and published research papers in major peer-reviewed journals.*

Runan Yang *is a graduate research assistant in CUTR at University of South Florida (USF). Her research interests include statistic modeling in transportation safety, lighting data visualization, and analysis. She earned her bachelor's degree from Chang'An University, China and is pursuing her doctoral degree in Civil Engineering in University of South Florida. Runan serves as a board member of the ITE USF Student Chapter.*

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Providing drivers with visual information along their route enables airport visitors to make timelier, and often safer, decisions. OPTIPARK Wayfinding enables data to be posted on variable message signs along the route to the airport, as well as share parking information digitally via websites or smart phone apps. Utilizing OPTIPARK central software, parking facility operators can remotely monitor VMS, detectors, and car park information from one central system. The easy-to-use interface and accessibility via a web browser make OPTIPARK a simple and effective way to manage traffic. As with other McCain solutions, OPTIPARK is scalable and can operate independently or be fully integrated into a community-wide traffic system.

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Answer to "Where in the World?" on page 10 "Headed to Arizona Snowbowl," US-180 West/North near Flagstaff, AZ, USA. Photo submitted by Kohinoor Kar, P.E., PTOE, Ph.D. (M).

2021 Vision Zero Sandbox Competition

The goal of this challenge is to think beyond the traditional ways of assessing crash data based on historic information and move towards a more proactive approach by leveraging new near-miss data analytics and technology.

Teams are challenged to demonstrate how automated conflict data being collected through innovative technologies can be used to gain new insights into safety problems and the selection of low-cost countermeasures at intersections.

Sponsored by the ITE Consultants Council

There will be separate professional and student categories.

Submission deadline: April 15

For more information: www.ite.org/sandboxcompetition

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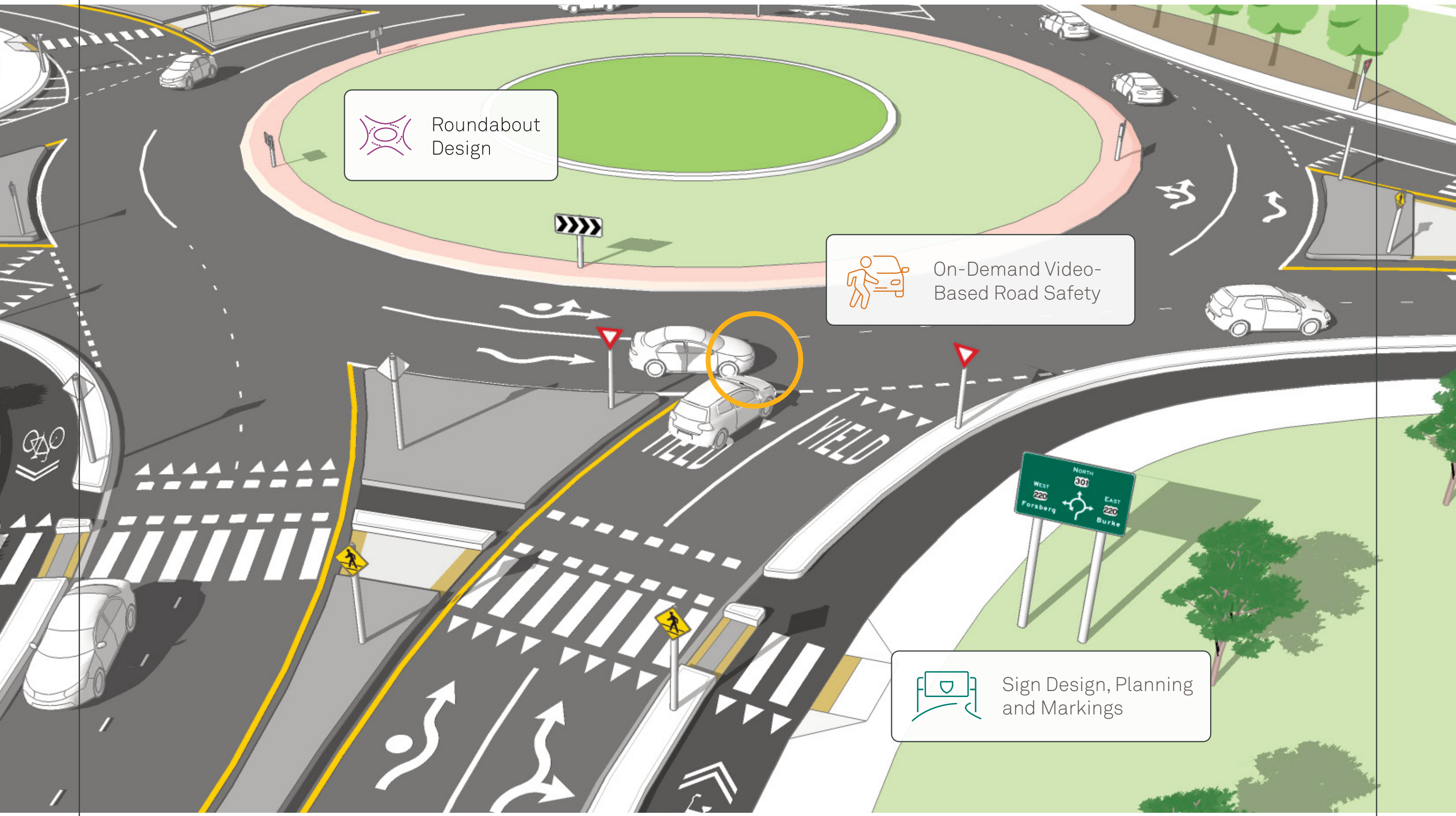

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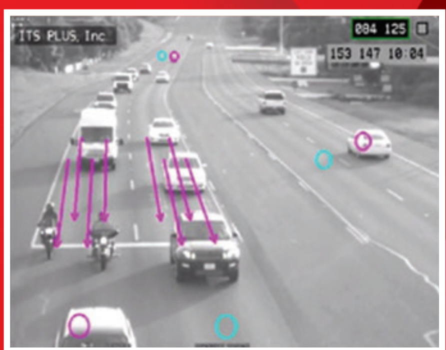
- *BIKE AND PED DETECTION*



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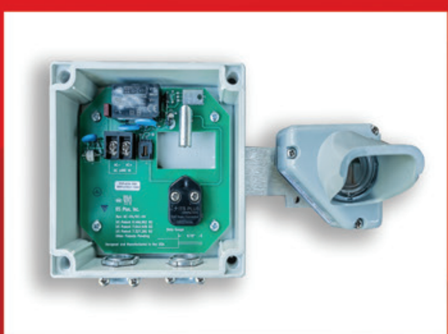

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