In each issue, the INCITER features an article coordinated by one of NCITE’s technical committees. This article is a contribution from the Geometric Design Committee.

Continuous Green T Intersections in Minnesota

Tom Dumont, PE | MnDOT District 3 & Vic Lund, PE | St Louis County, MN & Jim McCarthy, PE | FHWA MN & Will Stein, PE | FHWA MN

On both state and local highways, Minnesota has become a national leader in using a broad range of intersection types to solve problems. This advance in intersection design is an important part of performance based practical design—a shift in design philosophy to find better and more cost-effective design solutions. Roundabouts, mini-roundabouts, and restricted crossing u-turn intersections (RCUT) are all commonly used throughout the State. Where they have been deployed, driver familiarity and public support has increased.

Another intersection type, the Continuous Green T, is lesser known but has also demonstrated early success, when used in appropriate locations. As shown in Figure 1, a rural intersection is signalized, with one direction of the major road given a continuously green indication. This new intersection type improves mobility and safety over a standard signalized intersection by providing a free-flow movement for one direction of the major road. Left-turning traffic from the minor road is channelized so that it merges with the traffic moving in the continuous direction. This geometry replaces a crossing conflict for this minor road left-turn with a merging conflict, reducing the risk of a severe high-angle crash. It also eliminates rear-end crashes on the free-flow mainline movement.

Two Continuous Green T intersections have been constructed in Minnesota with a third to be built in 2019.

Figure 1: Continuous Green T Intersection (click to enlarge image)

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www.nc-ite.org
Welcome to 2019! I hope everyone had a great holiday season and survived the January deep freeze. NCITE is looking to start the year by continuing the momentum from a successful 2018, which included the MWITE/GLITE/ITE Annual Meeting, Student Leadership Summit at the University of Minnesota, a professional development ethics training, a regular slate of Section Meetings, and numerous Committee Meetings.

So far in 2019, activities are already moving. The Board has met twice, the January Section Meeting was a success with a great topic and large turnout, and multiple Committees have already scheduled meetings. Please check out the NCITE webpage [www.nc-ite.org](http://www.nc-ite.org), or LinkedIn page for current information on upcoming events.

I’m excited to share that NCITE has added a fourth student chapter. The Board would like to welcome student members from the Duluth Transportation Student Organization (DTSO) at the University of Minnesota – Duluth. The Board has been working with the Department of Civil Engineering and a motivated group of students and look forward to their participation in meetings and activities. One opportunity the Board is already looking at is providing an opportunity for the student chapter to host a Section Meeting. Like the previous Fargo meeting, a companion meeting would be planned for networking and local participation in the Twin Cities. Stay tuned for further details.

Section membership will continue to see changes from ITE International in 2019. During the past two years, the International Board of Direction has initiated some significant changes through the adoption of its current Strategic Plan. Most notably, adopting a new direction for ITE which includes five Strategic Initiatives – Vision Zero, Smart Communities, Connected and Automated Vehicles, Mobility as a Service, and Transportation and Health. As Agencies and Professionals deal with these issues on a local level, look to ITE for new tools and resources.

Another key element outlined in the Strategic Plan is addressing diversity and inclusion within the membership. This initiative is looking at ways to better include the diverse working professionals within the ever-changing transportation industry. The goal is to find ways for ITE at all levels to deliver information and provide opportunities to network, learn, and collaborate. At the Section level, we continue to look for ways to carry this forward by attracting new types of members through our membership drive, provide varied committee types and topics, and attempt to show benefit to industry professionals beyond the traditional traffic/transit engineering.

A final initiative which will affect both the Section and District is a result of recommendations by the ONE ITE Task Force. The charge of the task force was to provide recommendations to better streamline the overall ITE structure, reduce inconsistencies, clarify roles and responsibilities for all levels of ITE, and create opportunities to better enhance the member experience within ITE. As a result, a couple key actions are forthcoming in 2019. First, new District Charters are proposed to be drafted in 2019 with Section Charter to follow in 2020. Second, Affiliate membership status within ITE is being phased out over the next two years. At that time, it is the intent that current Section Affiliates in good standing would be converted to full members or become what is call a “Friend of ITE”. More details will be communicated to the membership in the coming months from ITE International. Please see the [ITE website](http://www.ite.org) for more detailed information.
The Section Executive Board is reviewing initiatives for 2019. In addition to continuing to provide varied and current topics for Section and Committee Meetings, we are looking into Professional Development opportunities. Our Professional Development Committee is looking at single topic options, along with the potential to bring back a full day seminar. A second initiative is to look at ways to bring outstate members opportunities to participate in more Section Activities. One idea is to expand a video conferencing option for Committee Meetings which would allow for more dialogue and discussion. If you have other ideas, the Board is interested in any suggestions the membership has which would enhance your experience and make our Section stronger.

I invite each of you to help make 2019 a memorable year. Please keep an eye out for new information and continue to attend Section meetings, participate in committees, take advantage of Professional Development opportunities, and enjoy networking and social events.

I’d like to close by introducing the 2019 Executive Board.
Vice-President: Jake Folkeringa, SRF Consulting Group
Secretary: Kevin Peterson, Washington County
Treasurer: Tyler Krage, Alliant Engineering
Director: Phil Kulis, SRF Consulting Group
Director: Joe DeVore, KLJ Engineering
Director: Jonah Finklestein, Spack Consulting
Past President: Scott Poska, City of Minneapolis

Jeff Preston
2019 NCITE President
Minnesota Transportation Conference
March 13-14, 2019
St Paul River Center | St Paul, MN

2019 Midwest District & MOVITE Annual Meeting
June 19-21, 2019
Hyatt Regency | St. Louis, MO

Attend an Upcoming NCITE Technical Committee Meeting!
Check out upcoming topics here.
For more information on the committees and how you can get involved:
https://nc-ite.org/Committee_Listing

For professional development opportunities:
http://nc-ite.org/content.php?page=Professional_Development_Meetings

Upcoming NCITE Events:
http://nc-ite.org/calendar.php
Jeff Preston, 2019 NCITE President
Job Title and Employer: Senior Engineer, Stantec
Past Work: City of Woodbury – Engineering Department
Education: Bachelor of Civil Engineering – Iowa State University
Where You Live: Blaine, MN
Family: Dina, Claire (10), Noah (8), Lilly (4)
Hometown: North St. Paul, MN
Hobbies: Coaching kids soccer/football/basketball, Golf, Vikings and Timberwolves games
Favorite TV Show: Game of Thrones, too much Discovery/History Channel....
Favorite Food: Grilled with cold beer
Favorite Book: Vince Flynn books
Best Vacation: Hawaii / Italy / Disney with the Kids

Jake Folkeringa, 2019 NCITE Vice President
Job Title & Employer: Senior Associate, SRF Consulting Group
Past Work: SEH (intern), WSN (intern), Subway Sandwich Artist!
Education: Bachelor of Civil Engineer, University of Minnesota, 2008
Where You Live: Elk River, MN
Family: Rachel (Wife)
Pets: Nala (dog)
Hometown: Brainerd, MN
Hobbies: Hunting, fishing, four-wheeling
Interesting Facts:
• I am a reserve police officer.
• I love all things Google.
• I was a trumpet player in the University of Minnesota Marching Band.
• I’ve sung as tenor in multiple barbershop quartets.
Favorite Food: Anything as long as I don’t have to make it
Favorite Restaurant: Raising Cane’s
Instruments Played: Trumpet, piano, and guitar
Best Vacation: Grouse hunting in northern Minnesota
Get to know the 2019 board!!

Kevin Peterson, 2019 NCITE Secretary
Job Title & Employer: Engineer II, Washington County Public Works
Past Work: SEH, Bonestroo
Education: NDSU
Where You Live: Stillwater, MN
Family: Wife (Meghan), Son (Felix, 5), Daughter (Lucy, 2)
Pets: Dog (Maddie, 7)
Hometown: Hastings, MN
Hobbies: Travel, Family Time, Getting Outside
Interesting Facts:
- I skipped a Chemistry test in college to road trip to the Salt Lake City Olympics.
- I honeymooned in Peru (everyone should see Machu Pichu).
- I’ve never seen the movie Titanic.
- I’ve never had stitches.

Favorite TV Show: Vikings Games
Favorite Podcast: This American Life
Favorite Food: Poke
Favorite Restaurant: El Chiringuito (Tamarindo, Costa Rica)
Favorite Book: A Gentleman in Moscow
Favorite Car: Tesla
Desired Superpower: Ability to stay awake while reading
Biggest Accomplishment: 2018 NCITE Young Professional of the Year!
Instruments Played: Arm pit
Best Vacation: Peru

Tyler Krage, 2019 NCITE Treasurer
Job Title & Employer: Traffic Engineer at Alliant Engineering
Past Work: Intern at U of M Parking and Transportation Services, then Alliant Intern
Education: BS in Civil Engineering from University of Minnesota, 2014
Where You Live: Whittier, Minneapolis
Family: Wife, Meredith
Pets: Rab-Dad to 2 Netherland Dwarf Rabbits, Pepper and George
Hometown: Houston, MN
Hobbies: Live Music, Rock Climbing, Camping, Biking, Homebrewing
Interesting Facts:
- I grew up on an elk farm.
- I dated a foreign exchange student in High school and got to stay in Germany with her family for 2 weeks after graduation. We broke up on day 8.
- I once hit 2 deer with my car in 24 hours.

Favorite TV Show: Modern Family and Chopped
Favorite Music: All over, but more Alternative. Currently trying to kick a bad Steely Dan habit.
Favorite Car: 1992 Geo Prizm
Instruments Played: Trombone in High School and dabble in drums
Best Vacation: Road trip to Austin. Texas, not MN.
MEET THE 2019 EXECUTIVE BOARD

Get to know the 2019 board!!

Joe DeVore, 2019 NCITE Director
Job Title & Employer: Traffic Engineer and Project Manager at KLJ
Past Work: SRF, City of Minneapolis, and City of White Bear Lake
Education: BS in Civil Engineering from the University of Minnesota - Twin Cities
Where You Live: Lino Lakes, MN
Family: My wife Laura and both or our families are local.
Pets: Daisy (aka hoppydaisy) the Instagram semi-famous bunny
Hometown: Hugo, MN
Hobbies: Playing softball, going fishing, and watching Minnesota sports teams
Interesting Facts:
• I was the bullpen catcher for the Gopher baseball team for 4 years.
• I regularly volunteer as a Capstone mentor for the UMN Civil Engineering class.
• I have drove the same 2001 Ford Ranger since high school. 294,000 and counting.
• I secretly love event planning and home project planning and budgeting.
Favorite Food: Anything BBQ (Ribs, Brisket, Steaks, and Burgers)
Favorite Restaurant: Ginger Hop and Lucy’s Burgers
Favorite Car: Ford Ranger
Desired Superpower: Clone ability
Most Embarrassing Moment: My wife and I planned a 3-day winery trip to Napa, CA only to be evacuated on the first day because of the wildfires in 2017.
Instruments Played: Drums and Piano
Best Vacation: Chicago, IL and Cape Coral, FL

Jonah Finkelstein, 2019 NCITE Director
Job Title & Employer: Transportation Engineer at Spack Enterprise
Past Work: Project Engineer at Alliant Engineering
Education: Bachelor of Science Degree from University of Minnesota
Where You Live: Apple Valley, MN
Family: Fiancé – Laura, kids – Hailee (13) and Jonah (10)
Pets: Monte (Shitsu), lots of fish
Hometown: Winnipeg, Manitoba
Hobbies: Rock Climbing, Back Packing, Circus Arts
Interesting Facts:
• I was a professional Circus performer for 3-years with the Wallenda Family
• I love cold weather back packing. With a record low temperature of -27 degrees no one else is crazy enough to be outside and the quiet and stillness is a great break from the busy day to day life.
• I am terrified of needles and still close my eyes and turn away when I get shots.
• I did not become a US citizen until I graduated from college.
• I only know four interesting facts about myself.
Favorite TV Show: Stranger Things
Favorite Food: Chicken Wings
Favorite Book: Eiger Dreams by Jon Krakauer
Biggest Accomplishment: Professionally – Passing my PE Exam, Personally – Achieving my childhood dream of becoming a professional circus performer.
Get to know the 2019 board!!

Philip Kulis, 2019 NCITE Director

Job Title & Employer: Associate at SRF Consulting Group
Past Work: Transportation Analyst at Kittelson and Associates
Education: MS Penn State University
BS Rochester Institute of Technology (Rochester, NY)
Where You Live: St Louis Park, MN
Family: Ali my fiancé
Pets: Cali the cat
Hometown: Ithaca, NY
Hobbies: Golfing, biking, hiking, photography, and home improvement projects
Interesting Facts:
• I’ve had the joy of spending Christmas morning in the emergency room.
• Prior to moving to Minnesota, I lived in the hottest part of the country, Arizona.
• My fiancé is Canadian, eh! This has afforded me the opportunity to have maple syrup ice pops.
• I rewired my bathroom and I’m still here to talk about it.
Favorite Food: Buffalo chicken pizza
Favorite Restaurant: Surly – love the hog frites!
Best Vacation: Last year Ali and I went to Banff, Alberta, Canada for a winter vacation that included hiking, tubing, skating, snowmobiling, and some amazing views.
The Younger Member Committee has some exciting events lined up for 2019.

Upcoming Events:
**Feb 20th** - Lunch & Learn for students on U of M Campus
**April 20th** - Service Event (Minneapolis Earth Day Cleanup) - All are welcome to volunteer!

Tentative 2019 YMC Schedule:
**June** - Bike Tour
**July** - NCITE Summer Social
**September** - Escape Room
**October** - Gopher Tailgate
**November** - NCITE Annual Meeting

If you would like to be added to the YMC email list, or know of any new hires/coworkers that would enjoy our events, please send email addresses to

**Ellie Lee** (elle@alliant-inc.com) or **Kristin Carlson** (carl4498@umn.edu)

Plan on taking the PE Exam this Spring? The NC-ITE YMC and ASCE Young Member Group are teaming up to create an informal study group for the test in April. This is a pilot study group, so logistics will be flexible to adjust to interest. Contact Ellie Lee (elle@alliant-inc.com) or Tyler Krage (tkrage@alliant-inc.com) with questions or interest.
NCITE is excited to announce a new student chapter in Duluth, Minnesota!

President - Jason Miller
Secretary - Sarina Men
Treasurer - Travis Kemp

The group’s first chapter meeting was held in late January. You can find more information at the DTSo link below, or contact the group at dtso@umn.edu. Welcome!

DTSo Members (left to right):
Cole Arvidson, Chet Jurrens, Brandon Anderson, Travis Kemp, Jason Miller, Sarina Men (in front), & Matt Monke (in back)

Photo Credit (not pictured): Matt Henderson

www.nc-ite.org
ITSO is excited to announce the officers for 2019:

President - Lucas Borgerson  
Vice President - Babak Mirzazadeh  
Secretary - Jason Fye  
Treasurer - Wyatt Schirrick

2018 was an exciting year!

The NDSU Student Chapter participated in:
- NOCoE’s Transportation Technology Tournament
- 10th Annual Collegiate Traffic Bowl Tournament at the University of MN’s Student Leadership Summit
- The Student Poster Competition at the MWITE District Meeting
- Volunteering in the North Dakota Science Olympiad
- Volunteering at the Distressed Children and Infants International Fundraiser

2018 Guest Speakers included:
- April Walker, A. Walker Consulting: February 2018
- Chung T. Tran, Federal Highway Administration: March 2018
- Thomas Fakler, Ulteig Engineering: October 2018
- Joe DaVore, KLJ Engineering: November 2018
- Aaron Murra, NDDOT: November 2018

For more information on the NDSU Student Organization & upcoming 2019 events:
The First—US 12 near Montrose

The first continuous Green T intersection in Minnesota was designed by MnDOT District 3 and opened to traffic in October 2015. The purpose of the project was to improve safety at the intersection of US 12 and MN Highway 25 near Montrose. Before conversion, the intersection had STOP control on the minor road, Highway 25. The intersection was experiencing approximately 2 crashes per year, including a fatal right-angle crash in 2004 and a serious injury right-angle crash in 2005.

For the Intersection Control Evaluation, a standard signalized intersection, an un-signalized Continuous T, a signalized Continuous Green T, and a roundabout were considered. The Green T was selected because of the heavy through volumes on US 12 towards Minneapolis and the existing passing lanes in the area. Limited widening and no right-of-way were needed and the Green T was constructed without impacting the wetland areas adjacent to the intersection, Figure 2. The continuous US 12 eastbound movement and the left turn from Highway 25 do not need to merge due to the existing passing lane section.

Safety performance since conversion has been positive. Since 2016 there have been two minor crashes, one weather related run-off-road and one rear-end. Giving priority to the heavy through movement on US 12 has maintained efficient traffic operations to and from the metro area. US 12 Safety Coalition and local maintenance personnel report very positive comments and encourage further use when possible.

Figure 2: Minnesota’s first continuous Green T intersection along US 12 near Montrose.
The Second—St. Louis County Road 4/Rice Lake Road and Airport Road near Duluth

The second Continuous Green T intersection was developed by St. Louis County and opened to traffic in October 2016. It is located at the intersection of Rice Lake Road (County State Aid Highway 4) and Airport Road, in the City of Duluth. Before conversion, the intersection had stop control on the minor road, Airport Road, which is one of two roads that provide access to Duluth International Airport.

For the five-year crash history in the before period of 2009 through 2013, right-angle crashes represented 50 percent of all crashes. The PM peak period experienced the worst traffic operations. With an intersection level of service of F, the delay for vehicles turning left from Airport Road was 195 seconds and the 95th percentile queue length on Airport Road was 460 feet. St. Louis County received reports of the traffic queue on Airport Road being greater than 2,000 feet during certain times.

One aspect of the intersection that suited it well for a Continuous Green T was that the northbound traffic on Rice Lake Road during the PM peak hour is greater than the southbound traffic on Rice Lake Road. With the Green T, this northbound traffic moves continuously and this minimizes the overall delay on Rice Lake Road. St. Louis County has observed that traffic operations at this intersection have significantly improved after construction and the maximum observed traffic queue on Airport Road is less than 200 feet.

The cost of the Continuous Green T was approximately $1 million, which is a fraction of the cost of grade separation, yet the intersection design is providing significant benefits for traffic operations and safety.

Aerial video of the intersection can be viewed here: https://youtu.be/bz53KPlbAVw
The Third—Coming in 2019

The third continuous Green T intersection will be constructed in 2019 at the intersection of MN Highways 65 and 107 near the town of Braham in District 3. The location is unique in that Highway 65 transitions to a 4-lane divided cross section for about one-half mile, Figure 4. The intersection is located near the mid-point of a horizontal and vertical curve along Highway 65. Of the three locations, this one has had the greatest safety problems with four fatal right-angle crashes.

For the Intersection Control Evaluation, a rural roundabout and an RCUT were also considered. The Green T was selected to address the right-angle crash problem within the curved geometry and with minimal reconstruction to the existing alignment and four-lane cross section.

Non-motorized Users

Pedestrians and non-motorized users must be considered before using this type of intersection. All three sites described above are rural and do not have pedestrian or bike facilities crossing them. In this context, the expectation is that non-motorized users should cross with caution, similar to any other rural two-lane highway or expressway. It is unknown at this time how non-motorized users should be served in an urban or suburban environment. Traffic on the continuous green leg could be stopped with a ped-activated push button. But it’s uncertain whether or not this would cause problems with familiar drivers that have become accustomed to the continuous green indication. Unless it is clear how non-motorized users can be safely served, the current approach has been to use the continuous Green T in rural areas only.
A hybrid design that has promise along high-volume, principal arterials is illustrated in Figure 5. Particularly at a location with heavy crossing volumes and an important direct route for non-motorized users, a grade-separated crossing could be used in conjunction with a continuous Green T connection back to the major road. Also called a single loop interchange, this concept could function well within a corridor that is primarily signalized and already developed. With no turn lanes on the bridge, structure cost could be minimized while at the same time separating a street with a heavy crossing volume for both vehicles and non-motorized users. Cost and right-of-way impact would be much less than a full interchange.
TECHNICAL COMMITTEE UPDATE

Geometric Design Technical Committee
Committee Chair: Thomas Jantscher - tjantscher@hrgreen.com
Recent Agenda Items: Safe Systems presentation by Will Stein, FHWA.
Future Agenda Items: Presentation on MnDOT Land Use Context Design Guidance by Jim Rosenow and Greg Pates, MnDOT.
Next Meeting: Thursday February 14, 8:30am – 10:30am, HR Green.

Intersection Traffic Control Technical Committee
Committee Chair: Philip Kulis - PKulis@srfconsulting.com
Recent Agenda Items: MnDOT Non-Motorized Transportation Committee Update and 2019 brainstorming session.
Next Meeting: TBD

ITS Technical Committee
Committee Chair: Todd Olson - toolson@alliant-inc.com
Recent Agenda Items: Cory Johnson, MnDOT – Connected Corridors.
Future Agenda Items: Dan Nelson, AECOM – Clear Roads AVL/GPS Technologies Case Study Project.
Next Meeting: TBD

Pedestrian and Traffic Safety Technical Committee
Committee Chair: KC Atkins - katkins@tooledesign.com
Recent Agenda Items: Pedestrian Beacons and Signals in Higher Speed, Non-Urban Areas.
Future Agenda Items: Brainstorming future meeting ideas and identifying topic champions.
Next Meeting: TBD

Planning Methods and Applications Technical Committee
Committee Chair: Steven Ruegg - ruegg@pbworld.com
Recent Agenda Items: DTA and ABM zone validation and back-casting, POPGEN usage, updates on ABM best practices writing assignments.
Future Agenda Items: Steve Ruegg retirement and election of new chair.
Next Meeting: March 2019, exact date, time, and location TBD.

Traffic Operation and Maintenance Discussion Group
Committee Chair: Adam Bruening - adam.bruening@co.washington.mn.us
Recent Agenda Items: Discussions on temporary traffic control, year-end inventory, and pavement marking techniques.
Future Agenda Items: Signals, signs, striping, and pavement markings round table.
Next Meeting: Wednesday March 6th, 11:30am, Location TBD (First Wednesday of each month).

Simulation and Capacity Analysis Technical Committee
Committee Chair: Justin Sebens - jsebens@srfconsulting.com
Recent Agenda Items: VISSIM and Transit Signal Priority along Route 54 North in Saint Paul.
Future Agenda Items: TBD
Next Meeting: TBD
AECOM (as part of a consultant team) supported the Minnesota DOT with an Autonomous Bus Pilot to research vehicle and infrastructure requirements for an automated vehicle (AV) bus that can safely operate in cold weather climate. This was the world’s first AV bus pilot focused on winter weather testing. Phase 1 included a technology assessment, feasibility study, pilot site selection and solicitation of an AV industry partner. Phase 2 involved working with the selected technology partner in performing self-driving vehicle testing in a variety of weather conditions.

A unique aspect of Minnesota is cold and snowy winter weather conditions which currently create several challenges for AV operations. Low visibility, snow covered roads and the use of road salt, create challenges for AV cameras and sensors that rely on the ability to see lane striping and surroundings. The purpose of the pilot was to identify winter weather operational challenges and better prepare for AV bus operations in mixed general traffic.

A final report summarizing our findings is available at: [www.dot.state.mn.us/automated/bus/](http://www.dot.state.mn.us/automated/bus/)

**Technology Partner**

Efforts included an assessment of AV bus technology and review of similar demonstrations. Several active 10-15 passenger shuttle pilots were underway in Europe and in warmer U.S. states but no testing in winter weather. We concluded that the AV bus technology was developed enough to proceed with a partner solicitation.

An Industry Forum was conducted to engage potential partners and to review pilot options, present draft requirements and obtain input that was incorporated into the final vendor RFP. MnDOT selected EasyMile for the pilot who delivered an EZ10 AV shuttle to the MnROAD controlled test site in November 2017. The vehicle operates at low speed (12-15 mph); accommodates 12 passengers; has no driver's seat, steering wheel or pedals; requires pre-programmed routes; and utilizes GPS navigation, LiDAR and odometry systems to operate at Society of Automotive Engineers (SAE) Level 4 automation.

**Winter Weather Testing**

Winter weather testing occurred at the MnROAD low volume test track during December 2017 and January 2018. Testing was conducted in a variety of temperature (-24 to +40 degrees), weather, pavement and lighting conditions including other vehicles, pedestrians and bicycles sharing the roadway. The team also performed controlled testing by making ice patches along pavement sections, applying road salt and utilizing snow making machines. Safe performance during clear weather was a requirement before approving any public demonstrations for the 2018 Super Bowl. Key testing conclusions are summarized next:
Clear Weather
The AV shuttle operated as expected under clear weather conditions. There were a handful of emergency stops/slowdowns due to external stimuli picked up by the vehicle sensors, but in general the shuttle moved along its intended route and performed controlled stops at locations designated for passenger pick up and at intersections.

Falling / Blowing Snow
The AV shuttle experienced emergency stops and slowdowns when operating in falling snow, blowing snow (especially during snow making operations), and from loose snow kicked up from the test track. The vehicle sensors detected snow particles and would perform multiple successive emergency stops thinking there were obstacles in the path. Once the shuttle had passed the areas of snow making, it tended to resume normal operations. Some snow accumulation was observed in the LiDAR sensor housing which contributed to operational challenges.

Snow / Ice on Pavement
The AV shuttle navigated well through patches of ice or several inches of snow/slush on the pavement, but lost its location on the programmed path if the tires experienced slipping. The shuttle course-corrected once back on dry pavement if conditions caused it to slip from the preprogrammed path.

Temperature / Battery Correlation
It was observed that extreme, below zero temperatures tended to drain the battery at a faster rate. At times, the AV shuttle required mid-demonstration battery charges, and the interior heating system and internal lights drained the battery at a noticeably faster rate. Extremely low battery levels did impact the ability to operate in automated mode.

Vehicle, Pedestrian, Bicycle and Obstruction Detection
The AV shuttle performed well in detecting other vehicles, pedestrians and bicycles and had no problem detecting and reacting to static obstacles placed in its path. The shuttle showed more conservative braking behavior and increased stopping distances as speed increased or as pavement conditions worsened.
Wheel Wander and Other
AV shuttle wheel wander accuracy ranged from 3mm – 1 cm. This precision became very apparent from visible wheel tracks left in snow covered pavement and wheel rutting that occurred along the crossover gravel roads at the MnROAD test track. Testing at different times of the day found that lighting conditions had no impact on AV shuttle operations. Applications of road salt creating a light film of dirt over the LiDAR sensors appeared to have minor impact on operations.

Minneapolis Super Bowl Demonstration
During the course of the pilot, public rides were offered to Minnesota decision makers, public/private stakeholders and public citizens at several sites to foster awareness, acceptance and support for AV technology. A major public demonstration occurred during the Super Bowl LII celebration in downtown Minneapolis on a closed block of Nicollet Mall. Over 1,345 participants rode the AV shuttle over a 3-day period. A majority of survey respondents were excited about the advent of AV technology and supported permanent deployments.

The pilot was the world’s first official attempt at AV shuttle operations in winter weather. Based on lessons learned, navigation and detection software enhancements have occurred improving performance in snow conditions. Additional enhancements planned or underway include integration of additional sensor technology, connected vehicle applications, ADA compliance and vehicle hardening for extreme winter weather. The pilot was an important step in garnering support from executive leaders in formalizing a Minnesota Connected and Automated Vehicle (CAV) program and contributed to the March 2018 Governor’s executive order to establish an Advisory Council that recently published recommended changes to Minnesota statutes, rules and policies to better prepare for the widespread adoption of CAV.
Managing High Volume Traffic in Construction Zones
Jacob Michalowski, PE | American Engineering Testing, Inc.

One of the challenges that team members face during construction on high-traffic-volume roadways is managing the flow of vehicles. Transportation agencies typically require the contractor to keep people, goods, and services moving safely and efficiently through and around the work zone, while minimizing negative impacts to residents, commuters, and businesses. To accomplish this for each project, the agency specifies the allowable road and lane closures, requirements for a transportation management plan, and the duties of the personnel in charge of it all.

To address traffic flow challenges, contractors, designers, and the agency come together to develop an effective and efficient solution to keep traffic and emergency vehicles moving smoothly. Often, three to four lanes of traffic are reduced to two lanes of traffic, which are then shifted onto temporary pavement sections, so the construction of the mainline pavement can be completed.

The pavement that is used to carry the temporary traffic, however, may not have been designed to carry the high-volume traffic loads that will be imposed upon them. It is important for the team to raise the question of whether or not, even for a short period of time, the pavement sections will hold up to the new traffic loads it will experience.

One common practice is to shift a traffic lane onto the existing shoulder, allowing the contractor to safely shut down other mainline lanes for construction activities. If the shoulder was not designed to carry the heavy loads imposed by the new traffic flow, there is a real risk that the shoulder pavement could fail.

Lane Diversion on I-35 MnPass Project

(Continued on page 22)
Failure of the shoulder pavement means that traffic flow would need to be adjusted again, restricting traffic to fewer lanes, possibly only one. This will inevitably cause major delays for the traveling public and emergency response vehicles – a situation that fails to meet the requirements set forth for traffic management. Further lane restrictions also reduce available space for construction crews to work, which could put pressure on project schedules.

To determine if the existing shoulder’s pavement structure can withstand those loads, a proper review, investigation, and design must be completed. The intensity of the review relates to how much risk the agency and the contractor are willing to take.

A full review will include historical plans from the original roadway construction to determine how the pavement section was designed. However, we all know that installation can sometimes deviate from plans, and that layer thicknesses that are supposed to be there, may not always be. This is why a physical pavement investigation is also critical.

One technology that has recently been used to evaluate shoulder pavement for temporary traffic loadings is the falling weight deflectometer (FWD). The FWD is a nondestructive pavement testing device used to quickly and economically evaluate pavement structures. The pavement, base, and subgrade response data obtained from the FWD testing can be used to evaluate if the anticipated traffic loadings will cause the pavement to fail prematurely.

If the review of the testing data shows the pavement structure is strong enough to carry the new loads, then there is little risk involved. On the other hand, this technology also allows the team to identify weak areas and, where needed, implement the proper pavement strengthening methods to increase the pavement structure so it will carry the temporary traffic loadings.

By implementing a full review, including the use of pavement testing technology such as FWD testing, the team of contractors, designers, and the agency can reduce the risk of pavement failure during construction. This in turn can reduce the havoc of severely restricted traffic flow on motorists, emergency vehicles, and commercial drivers, and help keep the project on schedule.
Need for New Safety Process

Transportation agencies across the country are tasked with maintaining transportation networks with less dollars than in the past. To stretch transportation funds further, the Wisconsin Department of Transportation (WisDOT) has chosen to manage their transportation assets based on safety analysis and performance to create a safer environment for the users of the system. SRF Consulting Group recently teamed with WisDOT to develop a new statewide policy, the Safety Certification Process, which is used to analyze and determine potential safety improvements for all state highway projects. The new process supports WisDOT’s system-wide implementation of performance-based practical design as an asset management tool and is incorporated to assist in the allocation of available resources to the right projects at the right time. The Safety Certification Process has allowed WisDOT to be more efficient with transportation dollars and improve the overall health of the system by focusing on projects’ specific purposes and needs, rather than standards.

Safety Certification Process Overview

The Safety Certification Process aligns with the statewide performance-based design initiative by improving the reliability of safety performance analysis methods and identifying cost-effective safety improvements. This process is implemented prior to identifying the project’s scope and undergoing design efforts to determine if safety concerns need to be addressed as part of a project, and if so, identify potential safety treatments to include within the project’s scope. Alternatively, if safety concerns are not identified through the process, the existing conditions will be perpetuated rather than allocating a portion of the limited funds to upgrade the facility to standards that only have nominal safety benefits. This is consistent with performance-based design and asset management techniques. The policy supports decision makers with data to validate selected safety treatments and assist with decision making. There is a wide range of safety treatments for decision markers to consider ranging from intersection control changes to widened shoulders to changes in roadway alignment.
The process will provide more reliable analysis results to help answer commonly raised project questions, including:

- In terms of safety, is a roundabout or a traffic signal a better choice for a project? Which is more cost-effective?
- Should wider paved shoulders be considered as part of a rehabilitation project to mitigate run-off-the-road crash history? Is there a more cost-effective treatment?
- In terms of safety alone, is it cost-effective to install offset left-turn lanes at a signalized intersection? It is assumed there would be a crash reduction with this treatment, but it might not be clear if the reduction in crashes outweigh the costs.

These routine questions can be difficult to answer confidently without reliable safety performance and economic data; however, the new policy works to address these types of questions giving rise to a new emphasis on cost-effective treatments driven by safety performance and economic data. WisDOT’s new policy includes two significant elements: safety performance analysis and economic analysis.

Safety Performance Analysis and Economic Analysis
The most notable policy change is the formal inclusion of Highway Safety Manual (HSM) methodologies for analyzing the safety performance of WisDOT projects and identified safety treatments. The HSM methodologies rely on Safety Performance Functions (SPFs), Crash Modification Factors (CMFs), and Empirical Bayes (EB) for the safety performance analysis. SPFs are regression equations based on site characteristics and safety performance of similar sites that predict crash frequency and severity as a function of traffic volumes and roadway characteristics. They are dependent on the type of roadway (e.g., rural two-lane roadway or urban multi-lane roadway). CMFs are factors for predicting the potential change in crash frequency or severity due to installing a specific treatment, such as rumble strips. The use of the EB method, when applicable, increases the reliability of the safety analysis results by weighting the existing crash data and the crash predictions of the SPFs. Together these functions and factors help an analyst predict the safety performance of projects.

To put the SPFs into practice, the Interactive Highway Safety Design Model (IHSADM) software is used to complete the HSM calculations, which predict the crash frequency and severity. The HSM methodologies, as applied through the IHSADM software tool, enable the comparison of future safety performance of the assumed base project and the project with the addition of safety treatments. After the safety alternatives are analyzed and the safety performance of each is known, economic analysis methods are applied to determine the present value of crash reductions for the alternative treatments.

The goal of the economic analysis is to determine whether the safety treatments are cost-effective and understand how the safety performance and crash cost savings of the treatments compare. The policy aims to answer many questions, including:

- Are additional capital costs necessitated by the safety treatment recouped through improvements to the safety performance?
- What are the benefit-cost ratios of proposed safety treatments?

Examples of Safety Certification Process
Two examples outlining the implementation of the new Safety Certification Process assisting with the decision making on projects are outlined below.
Example 1: Two-Way Left-Turn Lane vs. Median
A pavement rehabilitation project includes extending the life of a three-lane urban roadway with a two-way left-turn lane (TWLTL). Based on a review of observed crash data using the Safety Certification Process, safety concerns warrant investigation of replacing the TWLTL with a raised median to reduce the number of conflict points.

Based on industry and professional knowledge, the overall safety performance would be improved with a raised median; what is not as well understood and is project specific is whether the improvement in safety performance justifies the additional construction costs. The Safety Certification Process is used to predict the safety performance of these two scenarios by utilizing facility specific SPFs. The predicted crash frequency and severity are then monetized to understand the change in crash costs, which are the benefits of implementing a raised median. Lastly, a benefit-cost ratio for the crash cost savings and additional construction costs associated with a raised median is calculated to determine the economic feasibility of constructing a raised median to improve safety performance.

Example 2: Roundabout vs. Traffic Signal
The industry has debated the “roundabout or traffic signal” question with no clear answer and would benefit from a process that includes in-depth safety analysis to understand the trade-offs.

It is known that roundabouts reduce the severity of crashes; however, there may be additional costs associated with constructing a roundabout, and it needs to be determined if these additional costs are recouped through improvements to safety performance. The Safety Certification Process provides insight by predicting the safety performance of a roundabout and traffic signal based on site specific characteristics (i.e. traffic volumes, lane geometry, signal phasing, etc.). Similar to the first example, the safety performance is monetized for each scenario and a benefit-cost ratio is calculated to weigh the improvement of safety performance with a roundabout against the additional costs of construction.
Identified safety treatments are largely determined using institution knowledge, best practices and engineering judgment to mitigate crash concerns for sites. While it is recognized that institutional knowledge, best practices and engineering judgment will continue to be the primary role in initial identification safety treatments, the new process will implement data-driven methodologies to increase the reliability and confidence in decision making.

Summary
Project prioritization efforts have become increasingly important to transportation agencies as the funding for transportation has decreased in recent years. An increased focus has been placed on developing policies to operate the system in an increasingly fiscally responsible manner. The new Safety Certification Policy ultimately focuses on managing transportation assets based on safety, allowing WisDOT to stretch their funding effectively across the system and improve the overall health of the system with limited funding.
ITE LOL

HI. I'M AN ENGINEER.

THAT MEANS I HAVE EXCELLENT EMPLOYMENT POTENTIAL AND I CAN FIX THINGS AROUND THE HOUSE.

HOW ARE YOUR SOCIAL SKILLS?

WOW. LOOK WHO WANTS THE MOON.

Source: Dilbert.com from 11/19/13. Happy Valentine’s Day from NCITE!
MEMBERSHIP UPDATE

New Members

Paul Ackerley - MnDOT
Enoch M. Banza – SDSU
Pravin Dhakal - Isthmus Engineering Inc.
Carolyn Fackler - MnDOT
Travis Kemp – UMD
Eric Peterson - MnDOT
Buddhika Prasad Rajapaksha – SDSU
Edward C. Sanderson - MnDOT
Wyatt Schirrick – SDSU
Sarah Schmidt - SRF Consulting Group
Collin James Schroeder - SRF Consulting Group
Brian Sorenson - MnDOT
Xinyi Yang – SDSU

Moves

Rick E. Laughlin – HR Green, Inc, formerly with HDR

If you or a friend has changed jobs or moved, we would like to stay in touch. Members, please update your information by visiting http://www.ite.org/membership/index.asp. To access this area, you will need to know your membership number. Your “username” is your membership number, and your “password” is the first 6 letters of your last name (e.g. Johnson=Johnso). Non-members please contact Morgan Hoxsie via phone (612.294.9726) or email (Morgan.Hoxsie@kimley-horn.com) for assistance. Please provide you name, title, employer, complete street address (including mailstop, if applicable), telephone number, fax number, and email address.