The 20 Year Streets Funding Plan represents a one-of-a-kind approach to strategically quantify and build equity into the street asset management process.

### Project Prioritization Process

#### Quantitative Criteria

**ASSET CONDITION**
- Infrastructure condition
- Safety
- Utility Need

**EQUITY — COMMUNITY DEMOGRAPHICS**
- Non-white majority
- Concentrated poverty
- Vehicle availability
- Potential users

**EQUITY — USES AND MODES**
- Modal needs
- Total users

#### Qualitative Screening

- Are there other nearby projects that will also be under construction?
- Can projects be combined to reduce disruption or cost?
- Is this the right fix at the right time?
- How does this project fit with known city priorities and goals?
- Do other agencies or utilities have projects that can be coordinated?

This qualitative screening provides the needed detailed evaluation to deliver a balanced and well-thought capital program. This process will be used annually to develop the street paving portion of the CIP.

#### How were the criteria selected?

The criteria and relative weighting were informed by staff, public, and stakeholder input as part of the 20 Years Street Funding Plan process developed during 2016. The criteria specifically apply to the selection of street paving capital projects.

### What is the history of the 20 Year Streets Funding Plan?

The plan is informed by the Neighborhood Park and Street Infrastructure ordinance, a landmark agreement passed by the City Council in April 2016 to equitably address needed funding to repave City streets and maintain neighborhood parks far into the future.

The new ordinance specified the use of a criteria-based system with a focus on racial and economic equity to annually select projects for the Capital Improvement Plan. The ordinance increased the capital street paving budget, which is a part of the City’s CIP, by $21.2 million per year (adjusted for inflation) annually for 20 years, starting in 2017.
The 20 Year Streets Funding Plan details the process and criteria for how the City of Minneapolis selects street improvement projects for inclusion in the annual Capital Improvement Program (CIP).

The 20 Year Streets Funding Plan’s Three Main Public Input Opportunities

- **Workshop #1**: 3 Big Questions
  - July 25, 2016: Workshop #1
  - The first small group workshop helped define transportation equity and form the remainder of the engagement process. Representatives of key organizations and staff from various city departments throughout Minneapolis that focus on equity participated in this workshop.

- **Open House + Online Survey**: 850 Total Votes
  - August 2016: Open House and Online Survey
  - A public open house highlighted the discussion from Workshop #1 and gave attendees a chance to weigh in on the same three transportation equity questions. An online survey with the same questions was available for most of the month.

- **Workshop #2**: 10 Criteria Ranked
  - August 8th, 2016: Workshop #2
  - The second small group workshop helped decipher the results of the engagement process to date and refine the relative importance of the various equity criteria for project selection and prioritization.

Containers showing different project selection factors that the public weighed in on during the 20 Year Streets Funding Plan community engagement in 2017

Figure 1

Public Works staff adjusted the points given to the ‘Low-Income’ criteria to bring it into alignment with the high percentage of participants marking it as a priority.

Figure 2

The chart shows current five year Minneapolis capital improvement projects that were selected using the 20 Year Streets Funding Plan guidelines.

You can find out more online at: [www.minneapolismn.gov/publicworks/20yearplan](http://www.minneapolismn.gov/publicworks/20yearplan)
Transportation Data Analysis and Visualization Using INRIX Data for NYC DOT

Abstract
This project presents a “big data” analysis using 204 million GPS records that were made available to New York City Department of Transportation (NYC DOT) by the INRIX corporation; this data is stored in a database, using the “csv” format. This project involves the Extraction, Transformation, and Load (ETL) procedure that was created to support the On-Line Analytical Processing (OLAP). The new OLAP Database is then interconnected with a commercial visualization tool that offers user friendly geospatial data analysis, and the generation of key performance indicators such as the roadway-link speed distribution, and the 85th percentile speed by hour of the day, for a given corridor. With this data analysis combined with the visualization tool, we can identify slow speed hot spots (e.g. using heat maps).

The analyses undertaken were for the West Village/Hudson Square Transportation Study Lower Manhattan, Brooklyn-Queens Expressway Rehabilitation and/or Replacement Project in Brooklyn using a visualization tool to analyze the average speed per corridor of interest.

INRIX Data for May 2017 included trip records for approximately 984,207 device-Ids summing up to almost 204,680,565 waypoints. Used fields included:
• TripId, a trip’s unique identifier (2,733,310 records).
• WaypointId, the order of the waypoint.
• CapturedDate, the capture date and time of the waypoint in UTC.
• Latitude, decimal degree latitude coordinates of the waypoint.
• Longitude, decimal degree longitude coordinates of the waypoint.
• DeviceId, A device’s unique identifier.

Methodology

• The data was partitioned using SQL geospatial data analysis.
• Map Matching for the selected study area.
• The data was divided into AM, and PM hourly periods covering weekdays and weekends.
• Parameter calculation: average speed, standard deviation speed and speed percentile (25th, 50th, 75th, 85th), and these parameters were investigated with respect to day-of-week, time-of-day.

Findings

• An easy way to conduct data analysis is using a visualization tool.
• We can analyze customized segments in different locations.
• We can identify slow spots and perform an analysis before and after.
• Easy to communicate graphically to the public and project stakeholders.

Future Work:
We aim to expand the data analysis to incorporate additional datasets from other sources such as crash data, construction data, etc. Establish a modern data warehousing and data analysis hardware/software platform to develop automated and semi-automated data related reports to support NYCDOT management and operations and planning.
Using the Surrogate Safety Assessment Model to Evaluate Access Management Alternatives

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Grant G. Schultz, Ph.D., P.E., PTOE, Professor, Brigham Young University
Dennis L. Eggert, Ph.D., Professor, Brigham Young University

Abstract

In a traditional safety impact analysis, it is necessary to have crash data on existing roadway conditions and a few years must pass before accumulating additional crash data to evaluate the safety impact of an improvement. This is a time-consuming approach and there remains uncertainty in the crash data integrity. The Surrogate Safety Assessment Model (SSAM) was developed for resolving these issues. With SSAM, a conflict analysis is performed in a simulated environment. A planned improvement alternative is modeled and no physical installation of the alternative is needed. This study evaluated if SSAM can be used to assess the safety of a highway segment in terms of the number and type of conflicts and to compare the safety effects of multiple access management alternatives. An evaluation of the effect of converting a two-way left-turn lane (TWLTL) into a raised median on a section of an urban street was performed using SSAM on VISSIM's simulation's trajectory file. The analysis showed that a raised median would be much safer than a TWLTL median for the same level of traffic volume with approximately 30 to 50 percent reduction in the number of crossing conflicts. The analysis showed that approximately 14,000 veh/day would be the demand level where the median conversion is recommended for the four-lane study section. The study concluded that the combination of a simulation software program with SSAM could be a viable surrogate analysis approach for evaluating and comparing the safety effects of multiple access management alternatives.

Background/Objectives

• It is often difficult to evaluate the impacts of access management alternatives using crash data as this requires installation of an alternative and uncertainty in crash data
• Conflict analysis in the field can be used to circumvent the use of crash data; however, it is difficult to identify conflicts in the field, especially for spatial analysis of conflicts
• The Surrogate Safety Assessment Model (SSAM) is a tool that can be used to perform both spatial analysis and filtered analysis of specific locations to identify conflicts

Objectives

• Evaluate if SSAM can be used as a complementary tool to analyze safety impacts of access management alternatives
• Does the spatial distribution of conflict points in SSAM resemble observed crashes?
• What is the AADT threshold to consider replacing a TWLTL with a raised median?
• Analyzing Trajectory (TRL) File by SSAM

VISSIM Model Development

Trip Generation: ATE Trip Generation 8th Edition for 71 driveways/ accesses
Simulation Setup: Analysis for median types:
- Existing condition (TWLTL)
- Raised median

Study Site: American Fork Main Street – AC 8 (C-U)

Roadway Characteristics
- Moderate to low speed (30-55 mph)
- Moderate volume (24,000-30,000 AADT)
- Signal spacing 1,210 ft., Street spacing 300 ft., Drive spacing 360 ft.,
- 1.182 mile segment

Surrogate Safety Analysis Model (SSAM)

SSAM is a method to automate a conflict analysis by directly processing vehicle trajectory data produced by microsimulator models (VISSIM, AIMSUN, Paramics, and TOSIM)

Analysis Steps

1. Microsimulation Modeling
2. Producing Trajectory (TRL) File by VISSIM
3. Analyzing Trajectory (TRL) File by SSAM
4. Making an Inference

Segment 1 Results

Comparison of Observed and SSAM for all conflict types

Obj: 1: Calibration of SSAM – Compare Observed and Model


How much safety improvement can be expected by replacing existing TWLTL with a raised median?

What is the AADT threshold to consider replacing a TWLTL with a raised median?

- Data analysis was completed comparing access traffic volumes, main street traffic volume (AADT), and numbers of conflicts to determine relationships between traffic volumes and conflicts
- ANOVA analysis was also conducted from which it was determined that the most dominant factor that affects the number of conflicts

- The threshold AADT where a TWLTL should be converted to a raised median is ~34,000 veh/day - the conversion is recommended to occur before these volumes to avoid large increases in conflicts

Conclusions/Acknowledgments

Conclusions

- SSAM combined with a simulation model is a viable and useful complement to traditional crash analysis and field conflict analysis
- Similarity in spatial distribution and frequency between observed crashes and conflict points identified by SSAM
- When SSAM is used for evaluating safety impacts of replacing a TWLTL with a raised median, the following was observed:
- Raised medians reduce the number of crossing conflicts significantly (32-50% reduction)
- The threshold AADT where a TWLTL should be converted to a raised median is ~34,000 veh/day, although the conversion is recommended to occur before these volumes to avoid large increases in conflicts

Acknowledgements

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UDOT
Keeping Utah Moving

Research conducted by:

Brigham Young University
Using Driving Simulation to Model Motorist and Bicycle Interactions at Separated Bike Lanes

Katerina Deliali (Research Assistant), Francis Tainter (Research Assistant), Dr. Cole Fitzpatrick (Research Assistant Professor), Dr. Michael A. Knodler (Professor), Dr. Eleni Christofa (Assistant Professor)

Introduction

Separated bicycle lanes, or cycle tracks, are increasing in popularity across the nation. When the Massachusetts Department of Transportation (MassDOT) became the first DOT to publish a Separated Bike Planning & Design Guide, it provided evidence that separated bicycle facilities were likely to become even more common. Despite documented benefits of separated bike lanes, including safer cycling and increased ridership among differing populations of bicyclists, there remain ongoing concerns about potential conflicts between bicycles and vehicles when they merge back together at an intersection. The fear is that following a period of separation, drivers are less likely to anticipate and scan for the presence of bicycles.

Background

This project models the interaction between bicyclists and drivers at critical crossing points in simulator scenarios that capture these problematic areas and traffic configurations:
• The base case of the simulated scenarios derive from actual real-world locations, which were then modified in a simulated environment to quantify the impact of specific infrastructure design elements on driver performance.
• The project evaluates various strategies for integrating bicyclists and drivers following a period of separation and document the specific behaviors that may impact safety: In turn, this both improves design and provides a mechanism for specifying the right design features for different installation types.
• The outcomes better enhance the development of safe and effective roadway designs that accommodate the mixing of bicycles and motorized vehicles.

Research Plan: Driving Simulator Experiment

Non-Protected Intersection
Non-Protected Bike Lane

• Driver encounters a non-protected bicycle lane as they approach a non-protected intersection
• The bicycle lane remains non-protected into the next roadway segment

Non-Protected Intersection
Protected Bike Lane

• Driver encounters a non-protected bicycle lane as they approach a non-protected intersection
• The bicycle lane transitions to non-protected in the next roadway segment

Protected Intersection
Non-Protected Bike Lane

• Driver encounters a non-protected bicycle lane as they approach a protected intersection
• The bicycle lane transitions to protected in the next roadway segment

Protected Intersection
Protected Bike Lane

• Driver encounters a protected bicycle lane as they approach a protected intersection
• The bicycle lane remains protected into the next roadway segment

Scenario Development

<table>
<thead>
<tr>
<th>Scenario Number</th>
<th>Roadway Segment</th>
<th>Intersection</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bike</td>
<td>P</td>
</tr>
<tr>
<td>2</td>
<td>No Bike</td>
<td>P</td>
</tr>
<tr>
<td>3</td>
<td>Bike</td>
<td>NP</td>
</tr>
<tr>
<td>4</td>
<td>No Bike</td>
<td>NP</td>
</tr>
</tbody>
</table>

Experimental Goals & Future Steps

Experimental Goals
• Identify measures that improve the visibility of cyclists at protected and non-protected intersections
• Determine if turning radii, sight distance, and street markings have a greater effect on driver awareness of cyclists
• Assist decision makers and practitioners with the proposed implementation of protected intersections including bicycle infrastructure

Future Steps
• Evaluate various design characteristics of protected intersections in a controlled driving simulator environment

Acknowledgements

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Urban Applications of Bike Lanes: Lessons Learned

11th Ave S
Cycle Track
- Bidirectional cycle track
- & urban greenway
- 5 ft. cycle track
- 4 ft. buffer
- Two lane roadway with
limited on-street parking (~9,000 sq ft)

Music Row Left-Side Bike Lanes
- Left-side bike lanes
- One-way street pair
- 3.3 miles
- Two lane roadway
- On-street parking (~7,000 sq ft)
- Bike box, roundabout connection

10th Ave S
Parking Protected Bike Lanes
- Parking-protected
- Bike lanes
- ~1 mile
- Two lane roadway
- On-street parking
(~6,000-1,000 sq ft)

Project Description
This bidirectional cycle track and urban greenway project
accommodates the growing number of vehicles, bicycles,
pedestrians, and transit users using the key 11th Ave S
corridor in one of Nashville’s quickest growing downtown
districts, The Gulch.

Opportunities
- Handing over space along the corridor to incorporate
- elements such as benches and bike racks
- Better delineate pedestrian and cyclist space

Challenges
- Ongoing adjacent construction
- Unmapped utilities found during project construction
- Balancing needs of a variety of roadway users

Outcomes
- Increased comfort
- Increased safety
- Increased connectivity

Project Description
Originally equipped with right-side bike lanes (between on-
street parking) and the travel lane, this one-way street was
reconceived as an excellent opportunity to implement left-side
bike lanes to increase the safety and comfort of cyclists
by shifting them away from on-street parking.

Opportunities
- Hands-on first application of left-side bike lanes
- Bike box applications for length of bikeway

Challenges
- Roundabout connection
- Neighborhood pushback on reconfiguring on-street
parking
- Neighborhood pleased with safer and more
comfortable street

Outcomes
- Reduced percent speed after project implementation, with
one lane experiencing a 45% decrease and the other a 54%
- Decreased vehicle speeds
- Reduced motorized vehicle speeds

Project Description
This project is a neighborhood level green
- removal, cut-through traffic, and a less
- congested alternative
- to the popular 12 South corridor.

Opportunities
- Traffic calming
- Increased existing pavement width
- Opportunity for Nashville’s first ‘floating’ bus stop
- and related bike bus only lane

Challenges
- Deep neighborhood punchback on reconfiguring on-street
parking
- Stop signs

Outcomes
- Increased comfort
- Increased safety
- Increased connectivity

INTRODUCTION
Growth

Nashville is growing – fast. In fact, 88 people on average move to
Nashville per day. The City, residents, and its partners have to diligently
work to keep pace with this growth by expanding the community’s
cycle and walk network. Since 2003, 240 additional miles have been added to the
network. The rapid changes occurring in the urban form create both
opportunities and challenges for designing and constructing new bike
facilities. To better meet the needs of cyclists and create safer and more
efficient transportation corridors, Nashville has been applying
increasingly robust and challenging bike facility design applications, such as
the three project examples highlighted.

NETWORK IMPLEMENTATION
Three Recent Applications

NETWORK VISION
Nashville’s WalkNBike Plan

Released in 2016, the WalkNBike Plan guides Nashville’s implementation of the city-wide bike network. A survey offered during the planning
process revealed an overwhelming need for more protected bike facilities in order to encourage a larger portion of the population to utilize
facilities. In response, the city has identified over 76 miles of future protected bikeway facilities across the city.

RESIDENT SURVEY
Perceived Level of Comfort on Different Bike Facilities

100+&$507&37*&8

KCI Technologies, Inc. works hand-in-hand with the Metropolitan Government of
Nashville and Davidson County’s Department of Public Works to design and
implement new bike facility designs. As part of each new project, existing traffic
conditions, crash histories, and right-of-way opportunities and challenges are
evaluated. The following highlights three recent design applications which have been
completed in the last three years.
Traffic Signal Data Sharing in the City of Frisco, Texas

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SPaT Data – What is it and how is it transmitted to users?

- Signal Phase and Timing (SPaT) data is a message that describes the state of the traffic signal.
- SPaT data is used to inform drivers, vulnerable road users, or onboard vehicle systems about the state of the traffic signal.
- SPaT data can be combined with a MAP message that defines the geometry of the intersection.
- DSRC radios allow a two-way data transmission directly between vehicle/vulnerable road user and a traffic signal controller.
- Third party can gather data from a traffic signal controller, convert data to a SPaT message and transmit to a vehicle or an app via a cellular connection.
Traffic Signal Data Uses

• Safety
  – Red light running
  – Collision avoidance
  – Other applications under development

• Efficiency
  – Engine management
  – Energy recapture

• Driver Information
  – Can reduce stress with knowledge

• Signal Performance Measures (Network/Corridor/Intersection)
  – Vehicle delay
  – Arrivals on green/red by movement/approach
  – Split failures by movement/approach
  – Average speed
Frisco’s Current Traffic Signal Data Sharing

• Agreement with Traffic Technology Services (TTS)
  • TTS partnered with Audi of America
    – Audi Traffic Light Information Service launched in Las Vegas in December 2016
    – Service launched in Frisco June 2017
  • TTS continues to work with other OEMs to build systems
  • Frisco open to sending signal data through connected vehicle module to other third party data brokers
How does the system work in Frisco?

- Frisco uses Trafficware’s ATMS.Now system to monitor traffic signals.
- The system includes a Connected Vehicle Module.
- TTS gets data from Trafficware’s Connected Vehicle Module that is connected to 122 signal controllers in Frisco.
- TTS receives signal status data from the Connected Vehicle Module and then produces a prediction of how much longer the signal will remain red.
- TTS creates a SPaT message for the prediction and sends the message to Audi who then transmits it to the vehicle via a cellular connection.
1. Agency/Region provides real-time traffic signal data, roadway, and signal timing plan information.
2. Data feed from ATMS to TTS cloud-based servers via web service.
3. Develop SAE J2735 MAP and SPAT messages for each traffic signal location.
4. Deliver all messages to customer backend system.
5. Customer manages vehicle heading, maneuver, and geolocation and returns targeted MAP and SPAT content to vehicle.
6. Information displayed to end user for relevant connected and automated vehicle applications.
Status of other TTS Users

• Texas Suppliers (Live or Onboarding)
  – Frisco (1st in Texas, 2nd in North America)
  – Sugar Land
  – Flower Mound
  – Grapevine
  – Arlington
  – Grand Prairie
  – Plano

• Active Metro Areas with Suppliers
  – Dallas
  – Denver
  – Gainesville
  – Houston
  – Kansas City
  – Las Vegas
  – Los Angeles
  – Phoenix
  – Portland
  – San Francisco
  – Washington, DC

• Definitions
  – Government agencies = Suppliers
  – OEMS/others = users
Signal Performance Measures

- Signal performance measures are derived from two data sources
  - Signal event data used to create SPaT messages
  - Anonymous vehicle probe data from subscribers to Traffic Light Information Service
  - Over 900 vehicles in Dallas-Fort Worth area have the service enabled
- Data is presented using Microsoft Power BI
- Charts include the following
  - Key Performance Indicators
  - Intersection Summary
  - Historic Summary
Network Wide Key Performance Indicators (Dec 2017 to May 2018)

Key Performance Indicators

- **Avg Vehicle Delay (s)**
  - Number of Vehicles:
    - 0 - 10K
    - 10K - 20K
    - 20K - 30K
    - 30K - 40K
    - 40K - 50K
    - 50K - 60K
    - 60K - 70K
    - 70K - 80K
    - 80K - 90K
    - 90K - 100K

- **% Split Failures**
  - Percentage of Arrivals:
    - Dec 2017
    - Jan 2018
    - Feb 2018
    - Mar 2018
    - Apr 2018
    - May 2018

- **Arrivals by Phase State**
  - Red 43.52%
  - Green 56.48%

**Additional Data**

- **Avg Veh Delay (s)**: 26.3
- **Total Veh Delay (hr)**: 1615.2
- **Level of Service**: C
- **Avg Split Failure %**: 2.5
- **Total Split Failures**: 10975
- **Green Arrivals**: 166346
- **Red Arrivals**: 128154
- **Total Arrivals**: 433623

*Includes arrivals when no signal information available in the car*
Network Wide Intersection Summary (Dec 2017 to May 2018)

Intersection Summary

433329 Total Arrivals
26.3 Avg Veh Delay (s)
1612.9 Total Veh Delay (hr)
2.5 % Split Failures
40.7 Avg Speed (mph)

Traffic Volume Profile

Day Group: Mon-Thu, Fri, Sat-Sun

Arrivals

Phase State: Green, Red

Avg Vehicle Delay

Maneuver: left, thru, right

% Split Failures

Maneuver: left, thru, right

Corridor: All

Selected int: All Selected

Selected Signals: 95
Network Wide Historic Summary
(Dec 2017 to May 2018)
Preston Road Summary
(Dec 2017 to May 2018)

- Major North/South arterial through Frisco
- 11 signalized intersections over 4.8 miles
- 6 lane divided with speed limits from 45mph to 55mph
- AADT varies from 35,000 to 55,000 vehicles per day
- Left-turn phasing varies - protected only and FYA with lead/lead, lead/lag and lag/lag
- Results are from Mon-Fri, 7am to 9am and 5pm to 7pm in NB and SB directions only
Preston Road Intersection Summary (Dec 2017 to May 2018)

Intersection Summary

- 9014 Total Arrivals
- 36.0 Avg Veh Delay (s)
- 38.2 Total Veh Delay (hr)
- 1.8 % Split Failures
- 40.0 Avg Speed (mph)

Traffic Volume Profile

Day Group  | Mon-Thu | Fri
--- | --- | ---
Number of Vehicles

Hour of Day

Arrivals

- Phase State: Green • Red
- Number of Vehicles

Maneuver

- Left • Thru • Right
- Seconds

% Split Failures

- NS | SB

Selected Signals: 11
Other Data Sharing Projects Underway in Frisco

- Waze Connected Citizens Program (CCP) partner
- Live two-way data exchange with Waze
- Automated posting of road closures to Waze due to
  - Road construction
  - Emergency closures due to crashes, gas line breaks, etc.
  - Special events
- Automated posting of crashes and other traffic incidents to Waze map that are reported to 911
Contact Information

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The Connected Vehicle Intersection

**What should we be doing differently today?**

1. Prepare infrastructure for the immediate future:
   - ATC control hardware
   - Next generation trajectory-based detection
   - IP communications to the cabinet
   - IT/Agency support to push data into the cloud
     - Maps, data processing, analytics all will be here
2. Deeper engagement between stakeholders to ensure we utilize the breadth of these disruptive technologies:
   - SPAT Challenge / ATCMTD / NSF
   - PPP: INDOT / Denver lab / research

**Enterprise Data Management (EDM)**

- Data Transformation & Data Retention
- SPM Relay Service
- Full Screen Object Tracking (FSOT)
- Traffic Cabinet
- DSRC Radio
- On-Board Unit (OBU) Equipped DSRC Radio
- Roadside Unit (RBU)
- ATC Controller
- Connected Vehicle Applications
- CoProcessor
- Advanced Transportation Management System (ATMS)
- Traffic Sub-System
- Signal Performance Measures (SPM)
- Measures of Effectiveness (MOEs)
- Data APIs
- Enterprise Data Management
- Cloud-Based Advantages
  - Eliminates need to purchase, install, maintain and upgrade on premise hardware
  - No-hassle software upgrades and support
    - All done in the cloud for you
  - Store large datasets
    - As much as 1000 terabytes
  - Ideal dissemination point for all stakeholders/systems
  - Cellular IP emerging as C2F value, extending system reach
  - Standards underway to format real-time CV data
  - Map providers will be key data integrators

**Technical Advantages of Cloud Storage/Processing**

- 10 SQL Server data processing servers
- Data management services
- Massively Parallel Processing Engine
- E.g. Azure Cloud: 70 servers 1PB (1000TB) $1200/mo
- Active GEO-replication
- High-availability & failover
- Disaster recovery

**Key Technology Enabler: 5.9 GHz Dedicated Short Range Communications (DSRC)**

- Broadcast by Vehicle: BSM (Basic Safety Message) - vehicle position, speed, heading, acceleration, brake status, size, steering, every 100 milliseconds
- Broadcast by Infrastructure: SPaT (Signal Phase and Timing) and GID/MAP (Intersection Map) every 100 milliseconds
- Specific Standards
  - SAE J2945 - on-board vehicle-to-vehicle (V2V) safety communications system for light vehicles
  - Transmit and receive SAE J2735-defined BSM
  - Using DSRC wireless communications
  - Defined in the Institute of Electrical and Electronics Engineers (IEEE) 1609 suite and IEEE 802.11 standards

**The Connected Vehicle App Development & Management Platform**

- The CVCP is installed in the communications slot of a shelf-mount or rack-mount ATC controller, OR the CVCP is installed in an A2 communication module slot of a 2070 controller that uses a 2070-1C CPU module
- Multi-Modal Intelligent Traffic Signal System (App)
- Consistent with NTCIP 1211 – Object Definitions for Signal Control and Prioritization
  - Transit Signal Priority
  - Freight Signal Priority
  - Emergency Vehicle Preemption
  - Mobile Accessible Pedestrian Signal System

**Elements of EDM**

- Data Quality Management
- Data Design & Architecture
- Management of Unstructured Data
- Online Transaction Processing (OLTP)
- Presentation of Information
- Database Administration
- Data Warehousing & Business Intelligence
- Data Governance

**In the Field**

- Video or Radar
- Full Screen Object Tracking (FSOT)
- DSRC Radio
- On-Board Unit (OBU) Equipped
- Connected Vehicle Applications
- ATC Controller
- NTCIP 1211 – Object Definitions for Signal Control and Prioritization

**Preparing for the immediate future:**

- ATC control hardware
- Next generation trajectory-based detection
- IP communications to the cabinet
- IT/Agency support to push data into the cloud
- Ensuring pedestrian, bicycle and vehicular mobility throughout construction.
Design
- The primary purpose of this program is to create a public benefit.
- The crosswalk design must include the two white horizontal markings with standard design and reflectivity to mark the edges of the crosswalk and ensure it meets minimum standards.
- No text or logos.
COMMUNITY CROSSWALKS
INSTALLATION
SAVING NEW INFRASTRUCTURE

- In-lane bus stop improvements were done in 2016 including curb ramps at the entire intersection.
- Neighbors wanted to add curb bulbs to the two remaining corners the following year using community funding.
- Low cost bulbs were installed, saving 2016 ramps ($40k) and drainage costs.
Pedestrian Wayfinding

- Along with walking, biking, and buses, we have a large population that commute to downtown via Ferry boats
TRAFFIC CALMING DIVERTERS

- We identified cut-through traffic on N 90TH Street as an issue we wanted to address to enhance safety for a nearby Neighborhood Greenway
- Low Cost Diverters & Planters were installed ($30k).
TACTICAL SIDEWALK

- We wanted to delineate a walkway on existing pavement in a school zone.
- Low Cost Tactical Sidewalk was installed ($1300).
LOW COST WALKWAY

- We wanted to install a walkway on “goat trail” in a school zone.
- Low Cost Walkway was installed ($145K) for three city blocks
LOW COST WALKWAY
LOW COST WALKWAY
THE CAMPAIGN
Stop For Me is a community-led campaign to improve safety for everyone who uses Saint Paul’s sidewalks and crosses our streets. The campaign is organized by St. Paul’s 17 district councils, St. Paul Smart Trips and the St. Paul Police.

THE CITYWIDE CAMPAIGN WILL:
• Bring attention to how often pedestrians take their life into their hands when they cross a street or parking lot.
• Raise awareness that state law requires drivers and cyclists to stop for pedestrians at every intersection, whether or not there is a painted crosswalk or stop light.
• Educate everyone who uses our streets that we need to share the road, show more respect and patience, and recognize that the moment we step out the door, we are all pedestrians.

CRASH FACTS
• Motorist behaviors cause about half of all pedestrian-vehicle crashes and pedestrian behaviors cause the other half.
• Pedestrian vehicle crash rates are highest during morning and evening rush hours. The number of severe crashes spikes at 2 a.m.
• The majority of pedestrian fatalities on Minnesota roads are males. We see a spike between the ages of 20-24, but fatalities happen to all ages.
• The majority of crashes occur at signalized intersections. One-third of all motor vehicles involved in pedestrian crashes were making a left or right turn.
• The majority of crashes occur on low-speed roadways (35 mph or less) and in urbanized areas, particularly Hennepin and Ramsey counties. The most severe and fatal crashes disproportionately occur in rural areas compared to population size.
• Motorist behaviors that primarily cause pedestrian-vehicle crashes include failure to yield attention and distraction.
• Pedestrian behaviors that primarily cause pedestrian-vehicle crashes include inattention, crossing mid-block, walking along the roadway and ignoring sign or signals.

CRASH DATA COMPARISON
<table>
<thead>
<tr>
<th></th>
<th>Jan 1 - July 15, 2018</th>
<th>Jan 1 - July 15, 2019</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pedestrians</td>
<td>84</td>
<td>103</td>
</tr>
<tr>
<td>Bicycles</td>
<td>46</td>
<td>46</td>
</tr>
<tr>
<td>Fatalities</td>
<td>3</td>
<td>3</td>
</tr>
</tbody>
</table>

FOR EVENT ORGANIZERS
Putting together a crosswalk event is easy.
Over the past year, we’ve put together lots of resources for community members to host their own crosswalk events. To host a crosswalk demonstration and get some ideas to make it your own, feel free to download materials from www.smart-trips.org/stop-for-me
• Event toolkit
• Event instructions
• Event safety briefing sheet
• General pedestrian safety tips
• Sample police operation plan
• Invitation to Stop For Me event
• Sample tally sheet
• Volunteer sign in sheet
• Sample crash data analysis form
Background

Identify Secondary Crash Pairings, Then Identify Patterns to Facilitate mitigation

Secondary Crash Performance Measures:
- Assorted Data Sources
  - Speed & Volume Data
  - BT & MVDS Sensors
  - Private 3rd Party data
  - I-PASS ORT Data
  - CCTV Cameras
  - Crash Database from Police

Facilitates Basic Crash Performance Measures
- Daily, Monthly and Seasonal Variations
- Route and Milepost Locations
- Vehicle type and quantities
- Causation and Crash Type (when provided by police)

But... How to calculate Crash Delay & Impact?

Performance Measure Reports

Finding Crash Impact on upstream traffic

Goal: Measure the total delay caused by a crash using sensor and crash data.
Solution: Rule-based algorithm locates ‘Impact Zone’ at sensors upstream of crash.
Identification and Evaluation of Patterns

SECONDARY CRASH IDENTIFICATION

Two Secondary ID methods: Static & dynamic

- Method 1: Static Boundary
  - Crashes within 1 Hour, 1 Mile
- Method 2: Dynamic Search (Spatial & Temporal)
  - Any crash within the upstream Impact Zone (i.e., below-avg. speed)
  - Pairings then Audited by Traffic Engineer
  - Obvious removals for most part (ramps, reporting errors, etc.)

5-Year Study Period: Consistent Results

<table>
<thead>
<tr>
<th>Month</th>
<th>Total Crashes</th>
<th>Time to Impact Zone</th>
<th>Audible Total</th>
<th>Pairings</th>
<th>Time - Quota</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan</td>
<td>100</td>
<td>0.7 Mile</td>
<td>50</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Feb</td>
<td>150</td>
<td>0.7 Mile</td>
<td>75</td>
<td>75</td>
<td>150</td>
</tr>
<tr>
<td>Mar</td>
<td>200</td>
<td>0.7 Mile</td>
<td>100</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>Apr</td>
<td>250</td>
<td>0.7 Mile</td>
<td>125</td>
<td>125</td>
<td>250</td>
</tr>
<tr>
<td>May</td>
<td>300</td>
<td>0.7 Mile</td>
<td>150</td>
<td>150</td>
<td>300</td>
</tr>
<tr>
<td>Jun</td>
<td>350</td>
<td>0.7 Mile</td>
<td>175</td>
<td>175</td>
<td>350</td>
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<tr>
<td>Jul</td>
<td>400</td>
<td>0.7 Mile</td>
<td>200</td>
<td>200</td>
<td>400</td>
</tr>
<tr>
<td>Aug</td>
<td>450</td>
<td>0.7 Mile</td>
<td>225</td>
<td>225</td>
<td>450</td>
</tr>
<tr>
<td>Sep</td>
<td>500</td>
<td>0.7 Mile</td>
<td>250</td>
<td>250</td>
<td>500</td>
</tr>
<tr>
<td>Oct</td>
<td>550</td>
<td>0.7 Mile</td>
<td>275</td>
<td>275</td>
<td>550</td>
</tr>
<tr>
<td>Nov</td>
<td>600</td>
<td>0.7 Mile</td>
<td>300</td>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>Dec</td>
<td>650</td>
<td>0.7 Mile</td>
<td>325</td>
<td>325</td>
<td>650</td>
</tr>
</tbody>
</table>

Average Secondary Crash: 0.7 Miles & 40 Min.

Time of Day Patterns

Percentage of All Crashes, Secondary Crashes & Toll Transactions - By Hour 2013 to 2017

Proximity & Duration Patterns

Secondary Crash Pairings Proximity - 2016 and 2017

Zoomed In: 2.5 miles and 90 min.

Year | Crashes | Percentage | Secondary | Total |
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2013</td>
<td>3.4%</td>
<td>259</td>
<td>7525</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>3.7%</td>
<td>322</td>
<td>8653</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>3.1%</td>
<td>288</td>
<td>9301</td>
<td></td>
</tr>
<tr>
<td>2016</td>
<td>2.7%</td>
<td>251</td>
<td>9301</td>
<td></td>
</tr>
<tr>
<td>2017</td>
<td>2.9%</td>
<td>252</td>
<td>8763</td>
<td></td>
</tr>
</tbody>
</table>

Authors

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SUMMARY

The Average Secondary Crash:

- 0.7 Miles Upstream
- 40 Min. During Peak Hour
- Or 40 Min. After Primary Crash After Severe Downstream Crash

LOCALIZED HOTSPOTS

2017 Secondary Crashes: Route I-294 by Milepost
Background

As people age, they experience declines in various health domains including vision, hearing, cognitive functions, physical flexibility, and psychomotor performance.

These declines can have significant implications for their actual as well as perceived driving performance and safety.

This study examines older drivers’ self-reported comfort and avoidance behaviors in various driving situations and road designs.

It also investigates fatal crash involvement risks with respect to roadway design components and other environmental factors.

Data & Method

AAA Longitudinal Research On Aging Drivers (LongROAD)

Prospect cohort of 2,990 participants aged 65–79 at baseline

Diverse participants from five sites

Annual follow-up

Utilizes data from the driving health and functioning questionnaire and self-reported driving crash/violation data

Fatality Analysis Reporting System (FARS) and NASS General Estimates System (GES)

National crash data for 2014-15 from NHTSA

Analyses

Pearson’s chi-square test, Spearman’s rank-order correlation (rho), and unadjusted/adjusted logistic regression models

Result-Health Condition

Cognitive Health Condition

Driving Comfort (n = 2,900+)

Vision Health Condition

Driving Situation

No 1+ 0

Nighttime -0.1894

Left turn w/o signal -0.2350

In bad weather -0.2167

On busy roads -0.2312

In unfamiliar areas -0.2603

Driving alone -0.1405

Night/bad weather -0.1904

In rush hour traffic -0.2103

On the freeway -0.1761

Back up -0.1983

Avg. Comfort 0.5884

Far + Near Sight

Driving Situation

No 1+ 0

Nighttime 0.2878

Left turn w/o signal 0.2256

In bad weather 0.2111

On busy roads 0.2592

In unfamiliar areas 0.2398

Driving alone 0.2165

Night/bad weather 0.2475

In rush hour traffic 0.2402

On the freeway 0.2281

Back up 0.2324

Avg. Comfort 0.3051

LongROAD Health and Functioning Questionnaire

LongROAD Health and Functioning Questionnaire

Variable

Item Description

Cognitive Health

In the past 7 days, my thinking has been slow

It has seemed like my brain was not working as usual

There had to work harder then usual to keep track of what I was doing

There had trouble shifting back and forth between different activities that require thinking

Vision

Ability to see during the day

Ability to see at night

General eyesight (using glasses/contacts as usual)

For eye glasses

Driving Self-regulation: Comfort

Making left turns across oncoming traffic where there are no left turn arrows

Driving at night

Driving at night in bad weather

Driving in bad weather

Driving in rush hour traffic

Driving on busy roads

Driving on unfamiliar areas

Backing up

Driving alone

Driving on a gravel road

Failing to notice a pedestrian when turning right from a main road

Underestimating the speed of an oncoming vehicle when passing

Staying in a highway lane that you know will be closed ahead until the last minute before forcing your way into the other lane

Getting into the wrong lane approaching an intersection

Missing “Yield” signs and narrowly avoid colliding with other traffic

Failing to check a rear view mirror before pulling out, changing lanes, etc.

Hitting something when backing up that you had not previously seen

Crashes and citations

Number of crashes involved in over the past year when you were driving

Number of times cited over the policy in the past year

Number of times received a traffic ticket (not parking tickets) in the past year

Result-Crash Risk

Logistic Regression Model for Older Driver’s (65+) Fatal Crash Involvement

Predictor

Odds Ratio

Reference

Speed & Curve

low speed & straight road 5.60 0.01 0.00

high speed road 6.51 0.01 0.00

curved segment 2.31 4.97 0.00

high speed & curve 5.17 4.24 0.00

Relation to Junction

intersection 0.40 0.02 0.00

railway crossing device 1.53 0.65 0.52

rail grade crossing 97.20 4.38 0.00

Crashes with barrier 1.90 1.46 0.32

Travelfactor

2way-uncontrolled 2.58 0.30 0.00

one-way 0.60 0.87 0.39

2way-continuous left turn 1.23 0.96 0.32

entrance or ramp 2.64 3.28 0.00

Traffic Control Device

signal 2.54 7.76 0.00

regulatory signs 2.54 0.01 0.00

red light 1.79 0.50 0.00

dark-lighted 1.00 0.01 0.39

dark-seeking dark-lighted 1.00 0.01 0.39

Discussion

For more information, visit us at http://aaafoundation.org/
City of Minneapolis

PEDESTRIAN CRASH STUDY

The Minneapolis Pedestrian Crash Study assessed trends, contributing factors, and characteristics of pedestrian crashes in the City of Minneapolis over the past 10 years to better understand where, how, and why pedestrian crashes are occurring in Minneapolis. The statistics shown in this summary provide a glimpse of trends across the city.

Minneapolis is a Good City for Walking

- **MINNEAPOLIS IS UNIQUE.** The alarming national trends of increasing numbers of pedestrian crashes over the past several years does not hold true in Minneapolis.

- **SLOWING DOWN YIELDS LESS SEVERE CRASHES.** Pedestrian crashes are less likely to be severe on lower-speed streets. While the vast majority of pedestrian crashes occur on streets with a 30 MPH speed limit, the likelihood of a fatal or severe injury pedestrian crash increases on streets with higher speed limits.

- **CRASHERS ARE CONCENTRATED TO A SMALL NUMBER OF STREETS.** Eighty percent of all pedestrian crashes occurred on 10 percent of the streets in the city, and seventy-five percent of fatal and serious injury pedestrian crashes occurred on 5 percent of streets in the city. Focusing improvements on these streets will yield the greatest benefits in pedestrian safety.

- **CRASH FACTS** (2015)

Source for Pedestrian Crash Data: 10-Year Dataset

Figure 1. Crashes Over Time

While crashes involving all modes and pedestrian crashes statewide have increased, pedestrian crashes in Minneapolis have remained constant over the decade.

Source for Crashes, All Modes, Minnesota: MnCMAT

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Sources:
Making the Case for Safer Design Alternatives: Innovative Techniques for Presenting Operational and Safety Benefits to the Public

Peter Kauffmann, PE, PTOE, Traffic Engineer
Lauren Gaines, Roadway Designer
Daniel Spann, PE, PTOE, Transportation Director

Background

Any engineer who has ever worked on a roadway project has experienced pushback when implementing aggressive strategies such as access management or alternative intersection designs. Is there a way to emphasize safety benefits in the decision-making process?

This paper presents a case study of a roadway widening project for a 4.4-mile stretch in Tennessee. The project used a new public outreach strategy to highlight safety benefits to stakeholders and elected officials. The goal was to elevate safety measures of effectiveness (MOEs) to a level comparable to where congestion MOEs are today, where delay, and travel time performance are relatively well recognized.

In this approach, intersection delay, travel time, and other traditional MOEs are supplemented by additional performance metrics that highlight other benefits and trade-offs encountered during roadway design, most notably physical impacts and safety concerns. The resulting set of MOEs can then be packaged into a three-pronged comparison of Physical Impacts, Safety Impacts, and Operational Impacts. This comparison promotes several groups of impacts on equal footing during the decision-making process.

Safety Impacts

Now more than ever, the general public is increasingly cognizant of safety issues. This shift is due in large part to the success of campaigns such as Vision Zero and an increasing awareness of the prevalence of traffic fatality. As engineers, we have an ethical and moral obligation to be advocates for safer design solutions.

The traffic engineering toolbox includes cutting-edge quantitative analysis techniques that allow for the safety impact of different alternatives to be compared directly. This project used two such techniques, conflict point analysis and future crash projections, to develop impactful comparisons of safety performance MOEs.

Operational Impacts

Historically, traffic operations are the performance measure that garners the most interest from elected officials and the general public. In this project, traffic operations results were presented at a high level, alongside the entire corridor and at intersections, to keep a focus on big-picture differences in travel time and delay performance between the alternatives. Delay is also broken down across the network to ensure the impacts on local traffic, which is not commonly considered by decision makers.

Physical Impacts

Right-of-way acquisitions is a contentious topic and costly component of any roadway project. For example, the Roundabout Concept caused the most concerns among property owners due to larger intersection footprints. However, the Roundabout Concept did not require left turns, and in fact had less overall impact along the length of the corridor. The assessment highlighted this fact by separately considering physical impacts in intersection versus impacts between intersections. This approach highlighted the conservation of a trade-off between moderate takings at all properties versus concentrated impacts at a few centers.

Typical Sections, between intersections

<table>
<thead>
<tr>
<th>Section</th>
<th>Existing Conditions (2016 Volumes)</th>
<th>No-Build Condition (median divided)</th>
<th>Five-Lane Concept (unrestricted)</th>
<th>Roundabout Corridor Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Right-in/Right-out</td>
<td>+45%</td>
<td>-6%</td>
<td>+2%</td>
<td>-3%</td>
</tr>
<tr>
<td>Right-in/Left-out</td>
<td>+6%</td>
<td>+2%</td>
<td>-3%</td>
<td>+2%</td>
</tr>
<tr>
<td>Total width</td>
<td>+2%</td>
<td>+2%</td>
<td>+2%</td>
<td>+2%</td>
</tr>
</tbody>
</table>

Change in Projected Crashes relative to Baseline (2041 No Build)

Between Intersections At Intersections

<table>
<thead>
<tr>
<th>Safety Impact</th>
<th>No-Build Condition</th>
<th>Five-Lane Concept</th>
<th>Roundabout Corridor Concept</th>
</tr>
</thead>
<tbody>
<tr>
<td>Base erosion</td>
<td>+45%</td>
<td>+6%</td>
<td>-3%</td>
</tr>
<tr>
<td>Additional costs</td>
<td>represent a project increase of approx. +45% more crashes due to volume growth from 2016 to 2041</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The Highway Safety Manual (HSM) includes techniques to directly quantify projected crashes. This manual is the gold standard for roadway design and uses HSM methodology to incorporate specific design elements and projected volume growth. The resulting projected future crashes for each alternative were aggregated corridor-wide. HSM predicted that adding a median would significantly reduce future crashes between intersections, in contrast to a crash increase without access management. Similarly, implementing roundabout control was predicted to reduce future crashes at intersections by 25% through improvements in control.

This analysis technique illustrates the benefits of access management between intersections and of roundabout control at intersections.

Results & Outcome

The tools used in this comparison are not new; rather, what has been lacking is a way to present a complete picture of analysis results and conclusions to decision makers and stakeholders in a manner that is quantitative and thorough while staying understandable. In this paper, the authors utilized a combination of traditional crash impacts and side street impacts improved the standing of alternatives that included progressive access management elements, even though some of those alternatives did not perform as well in an uncontrolled five-lane section in terms of mainline delay or property impacts.

However, presenting the full set of MOEs at public meetings gilt the City Council and the community an improved understanding of the trade-offs involved in each alternative. The data provided a more complete understanding of the performance differences, far surpassing any of the alternatives from a quantitative perspective. The specialists managing safety benefits on an even footing with other performance measures.
**Objective**

The Des Moines Area MPO seeks to support long-range planning of trail maintenance by providing data to make performance-based decisions on prioritizing trail maintenance.

The Central Iowa Trail Condition project was created to fill this information gap within the central Iowa trail system. It intends to:

- Develop a bike-based data-collection vehicle to improve the efficiency of collecting data on the extensive trail network.
- Create an inventory of condition data for all paved trails within central Iowa with a focus on trail roughness and geo-located photos of trail surfaces.
- Provide data to local agencies, consultants, and the public to inform a long-term maintenance strategy for the central Iowa trail network.
- Make the project replicable and promote the project to expand knowledge regarding approaches to collect trail condition data.

**Approach**

Using an electric-assist bicycle, an iPhone, an app designed to detect pavement roughness, and a pair of cameras, the Des Moines Area MPO created a tool to efficiently collect data to evaluate trail condition. The Data Bike maintained a consistent speed for data collection regardless of terrain as the electric-assist bicycle provided the rider additional power while pedaling.

The Data Bike uses three main components to collect data:

1. The rRuf app on the iPhone collected accelerometer data to produce a segmented response-based roughness condition rating.
2. A GoPro camera mounted at the rear of the bike provided geo-located photos of the trails.
3. A Samsung Gear 360 mounted above the rider’s head provided imagery used for Google Street View.

**Preliminary Results**

<table>
<thead>
<tr>
<th>Trail Name</th>
<th>Miles Collected</th>
</tr>
</thead>
<tbody>
<tr>
<td>American Discovery Trail (Riley)</td>
<td>18.7</td>
</tr>
<tr>
<td>Bill Riley Trail</td>
<td>2.4</td>
</tr>
<tr>
<td>Chichaqua Valley Trail (Gay Lea)</td>
<td>14.4</td>
</tr>
<tr>
<td>Des Moines River Trail</td>
<td>2.8</td>
</tr>
<tr>
<td>Gay Lea Wilson Trail</td>
<td>15.5</td>
</tr>
<tr>
<td>Great Western Trail</td>
<td>13.0</td>
</tr>
<tr>
<td>High Trestle Trail</td>
<td>19.6</td>
</tr>
<tr>
<td>John Pat Dorrian Trail</td>
<td>1.9</td>
</tr>
<tr>
<td>Kruidenier Trail</td>
<td>2.1</td>
</tr>
<tr>
<td>Levee Trail</td>
<td>2.7</td>
</tr>
<tr>
<td>Mark C. Ackelson Trail</td>
<td>2.7</td>
</tr>
<tr>
<td>Martin Luther King Jr Trail</td>
<td>2.3</td>
</tr>
<tr>
<td>Meredith to Bill Riley Trail</td>
<td>1.2</td>
</tr>
<tr>
<td>Meredith Trail</td>
<td>3.3</td>
</tr>
<tr>
<td>Neal Smith Trail</td>
<td>5.9</td>
</tr>
<tr>
<td>Principal Riverwalk</td>
<td>1.6</td>
</tr>
<tr>
<td>Raccoon River Valley Trail</td>
<td>80.0</td>
</tr>
<tr>
<td>Summerset Trail</td>
<td>13.6</td>
</tr>
<tr>
<td>Walnut Creek Trail</td>
<td>2.5</td>
</tr>
</tbody>
</table>

City of Ankeny Trails

1. Using a Yuba Spicy Curry electric bicycle, the rider maintains a steady speed to collect consistent data on the trails.
3. An iPhone running the rRuf App measures the roughness of trails and helps score condition of pavement.
4. A rear-facing GoPro camera takes geo-referenced photos of the trail conditions.
1 Introduction
The Iowa DOT’s Traffic Critical Program is focused on work zone performance through a data driven approach to monitor, communicate, and continuously improve the mobility and safety of motorists during the construction season.

Projects identified as Traffic Critical require enhanced traffic impact mitigation strategies, such as: Intelligent Work Zones (IWZ), limited construction hours (including night work), innovative contracting mechanisms, and Traffic Incident Management (TIM) plans to mitigate traffic impacts.

The program has grown from 20 TCP with 14 Intelligent Work Zone (IWZ) systems in 2014 to 89 TCP with 27 IWZ systems in 2018.

2 Coordination
The TCP program requires considerable coordination with multiple private and public stakeholders including:
- DOT/Office of Traffic Operations Staff
- Traffic Management Center Staff
- Support Consultant Staff
- System Integration Staff
- IWZ Vendor
- University staff
- Permanent Device ITS Maintenance Vendor

3 Selection
The Iowa DOT has developed a TCP Checklist that can be used to identify key construction projects based on the following requirements and criteria for TCP designation:
- Location
- Mobility and Safety Analysis
- Mobility Mitigation
- Safety Mitigation
- TCP Plan Tier Designation

4 Performance
To monitor the work zones, the Iowa DOT has partnered with the Center for Transportation Research and Education (CTRE) to develop visualization tools which track the traffic performance at all times to support daily and longer term decision making.

The performance monitoring tools document the impact work zone projects have on traffic as well as traffic sensor operating status. Connecting to the data collected by cameras, sensors, and dynamic message signs, the web-based performance monitoring tool is updated every night to add the information of the previous day into the view. Meanwhile, all the historical data is retained from the database so that the information from any time interval can be queried at any point.

5 Summary
- The Iowa DOT has established, and is continuously refining, a Traffic Critical Program
- The goal of moving traffic safely and efficiently through road construction areas reinforces the need for developing new ways to enhance work zone traffic management and performance monitoring
- TCP is a data driven approach which includes high performance computing, alerting, and data visualization tools

The performance monitoring tool is designed in a straightforward way so that any issues in traffic speed and sensor conditions can be quickly identified from a color-coded map. Besides the display of traffic data, calculated performance measures are also visualized which provides insights into the performance of each project. The visualization panel connects to each of the work zones and historical data at once.

In 2017 a sensor based text alerting system was developed which generates event messages once a stopped condition is detected and a final text is sent when these conditions clear.

Work Zone Congestion Alert
I-80/35 WB @ MM 128.4 – 129.1
Began: 6/19/2018 10:18 AM
Current Speeds: 15 mph
Project Name: Project 1j
EventID: 1416

Congestion Cleared
I-80/35 WB
Duration: 34 minutes
Project Name: Project 1j
EventID: 1416
How do you make lasting change?

Change can be gradual in any industry and adding play, vibrancy and temporary placemaking to road rights-of-way is no different. A first example can spark imagination, start to show what is possible. In Calgary a street lab prototyping hay bale cycle tracks showed cross-corporate collaboration and a positive public response: that playing with and on the street (in a safe way) builds community and is an effective form of public engagement. To remove process barriers and build a supportive internal culture more examples would be needed. To speed this process small grants were offered to reveal determined partners who have ideas on how to improve their community. Unleashing these Calgarians would help our City support vibrancy faster, but not without effort and conversation on: risk, letting go, safety and design.

Why play in the street?

Timeline:

- Finalize Process 2017
- Promote 2017
- Walk21 2017
- Receive and support ideas 2017-2019
- Celebrate and learn 2019
What is ActivateYYC?

ActivateYYC is a new, one-time microgrant program that centres on local community projects that bring people together to walk, play and be neighbourly.

These projects employ tactical urbanism – quick, temporary, and low-cost initiatives. ActivateYYC provides grants of up to $750 to organized groups and businesses to experiment with temporary local projects and events that motivate Calgarians to walk, play and be neighbourly.

Projects are encouraged to take place in any season of the year. To support, organize and administer these grants, the Federation of Calgary Communities has partnered with The City of Calgary and Walk21 to introduce the ActivateYYC program to local communities!

Why do communities apply?

They have a great idea to make their community more walkable.

They are trailblazers who want to help The City and future community builders learn about the barriers and processes to good community building work.

They want to contribute to Calgary.

Why embrace resident-led?

Letting residents lead in their own neighbourhood provides many benefits to the community:

1. Empowering communities to invest in their neighbourhoods while keeping citizens and our infrastructure safe
2. Building resiliency by re-connecting neighbours
3. Supporting local businesses
4. Listen and align our services to better respond to the priorities of communities

What is the risk of not evolving? Versus the opportunity?

1. Not meeting The City’s Pedestrian Strategy
2. Declining walking rates
3. Guerrilla tactics

1. Sharing the right-of-way safely
2. Play streets
3. Learning to engage as partners
4. Letting go: where and when
What is Tactical Urbanism?

Small enhancements, from “everyday delights” to prototyping.

Budget

<table>
<thead>
<tr>
<th>What's needed</th>
<th>How much</th>
<th>Who pays</th>
</tr>
</thead>
<tbody>
<tr>
<td>150 Microgrants</td>
<td>$112,500</td>
<td>Federation</td>
</tr>
<tr>
<td>Program administration</td>
<td>$40,000</td>
<td>Federation</td>
</tr>
<tr>
<td>Communications and promotion</td>
<td>$5,000</td>
<td>City and Federation</td>
</tr>
<tr>
<td>Process review</td>
<td>$15,000</td>
<td>City</td>
</tr>
<tr>
<td>Total</td>
<td>$172,000</td>
<td></td>
</tr>
</tbody>
</table>

Measuring Success

<table>
<thead>
<tr>
<th>Measure</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>Projects completed and feedback provided</td>
<td>150</td>
</tr>
<tr>
<td>Number of projects per ward</td>
<td>Minimum 8</td>
</tr>
<tr>
<td>Number of people impacted</td>
<td>6,000</td>
</tr>
<tr>
<td>Surveyed residents feel safer walking in their communities</td>
<td>Majority of respondents</td>
</tr>
<tr>
<td>Simpler processes to support community-led initiatives</td>
<td>Lessons learned report and recommendations</td>
</tr>
</tbody>
</table>

What support is needed?

1. Federation of Calgary Communities
   - Arm’s length giving transparency in awarding funding and collecting feedback on City experience
   - Promote and support applicants
2. Judging Advisory Committee
   - Provide urban expertise and fairness
3. City staff
   - Buddy up to support success
   - Assemble the experiences
   - Recommend process changes

Jen Malzer M.Sc P.Eng
Transportation Engineer, Liveable Streets
The City of Calgary, Calgary AB Canada
jen.malzer@calgary.ca

Robert Whyte M.Plan RPP MCIP
Coordinator, Transportation Strategy
The City of Calgary, Calgary AB Canada
robert.whyte@calgary.ca
Minneapolis evaluates its work to...

Create a dialogue based on facts
Built internal & external support
Track our success
Learn from mistakes
Do better next time
Take pride in our work!
How Minneapolis integrates evaluation

Levels of evaluation
Project level evaluation feeds into program and department evaluation

- Division
- Programs
- Projects

We're focusing on the project level to build a data library

Lifecycle of a project evaluation

Before *project is installed*
1 year after
3-years after

Base Metrics
- Photos
- Daily Users
- Speeds
- Crashes

Additional Metrics
Examples: surveys, observations, many others

Joint ITE International and Midwestern/Great Lakes Districts Annual Meeting and Exhibit
August 20-23, 2018   Minneapolis, MN
Green Line LRT Alignment
West Bank Road & Ramp Reconfiguration

Reconstructed ramps

New Signals
West Bank Station - Access via Stairs/Elevators on Cedar and 19th Avenues

Cedar Ave.
Washington Ave. Mall

No Autos Beyond this Point

No Autos Beyond this Point
In order to turn left, bikes must make a 2-stage turn.

http://www1.umn.edu/pts/bike/bikesafety.html
Mid-block Crosswalk -“Z” Crossing at Amundson/Keller Plaza
east bank station
Event Crowd Staging Area
stadium village station
Stadium Village Station – Pedestrian Access
Stadium Village Station – Pedestrian Crossing
stadium village station
Washington Ave Connector w/ Washington Ave Bridge Circulator and East Bank Circulator Routes
Metro Transit Routes now returned to Washington Ave
Vibration and Electromagnetic Impact (EMI) Goals

△ **DO NO HARM** - Preserve the existing environmental quality our research facilities

△ Construct long term mitigation that is proven and operationally efficient

△ Keep specific lab mitigation to a minimum (vibration isolation tables, active cancellation systems)

△ Ensure compliance with performance standards through monitoring and enforcement
vibration mitigation: floating slab track
floating slab track
Vibration Certification Testing Overview

- Overnight hours 8/19/13 – 8/24/13
- 19 laboratories – serve as proxy for the research environment per 2010 Agreement
- Over 100 discrete runs: eastbound; westbound; dual train; varying speeds; varying stopping conditions
- Will return in January for cold-weather testing
- Periodic testing: Quarterly first year; semi-annually after
  Long-term vibration monitoring systems: in-building, near-track and flat-wheel detection
EMI Mitigation: Double Split Power Supply
**EMI Certification Testing Overview**

- Overnight hours began 8/12/13 – Quiet Zone requirements

- 20 sensors at 10 locations - one at 75’ and one at 100’ or 110’

- Over 200 discrete runs: eastbound; westbound; trains passing; substations off-line; varying speeds; varying stopping conditions

- Periodic testing: Quarterly first year; semi-annually after

- Long –term EMI monitoring more difficult
Maintenance & Operation Addendum

Defines operational procedures and ongoing maintenance responsibilities

Parties involved: Metropolitan Council, University of Minnesota, City of Minneapolis, and Hennepin County

Includes issues:

- Maintenance of EMI and vibration mitigation systems, sharing data, and operational mitigations to meet standards
- Transit operations (bus and LRT) & operation/maintenance of traffic signals/signs, pavement markings
- Washington Ave Mall maintenance (ie: trash/snow removal, lighting, storm water/sewer, landscaping, street furniture, retaining walls)
Geometric Highway Design Process for the 21st Century

### Alternative Design Processes

<table>
<thead>
<tr>
<th>Alternative Design Processes</th>
<th>Total K</th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>PDO</th>
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<tr>
<td>Partial Application of AASHTO Criteria</td>
<td>0.0</td>
<td>1.5</td>
<td>2.5</td>
<td>3.0</td>
<td>3.5</td>
</tr>
<tr>
<td>Fully Application of AASHTO Criteria</td>
<td>0.0</td>
<td>1.5</td>
<td>2.5</td>
<td>3.0</td>
<td>3.5</td>
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<tr>
<td>Partial Application of AASHTO Criteria</td>
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<td>2.5</td>
<td>3.0</td>
<td>3.5</td>
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<tr>
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<td>2.5</td>
<td>3.0</td>
<td>3.5</td>
</tr>
</tbody>
</table>

### NCHRP Report 839 – A Performance-Based Highway Geometric Design Process

#### Attributes of an Effective Design Process
- The process must be efficient
- The process should be scalable
- The process must be executable by properly trained professionals in a consistent manner
- The process should be transparent
- The process must be defensible

#### Recommended Highway Design Process

1. Define the Transportation Problem or Need
2. Identify and Charter All Project Stakeholders
3. Develop the Project Scope
4. Determine the Project Type and Design Development Parameters
5. Establish the Project’s Context and Geometric Design Framework
6. Apply the Appropriate Geometric Design Process and Criteria
7. Designing the Geometric Alternatives
8. Design Decision-Making and Documentation
9. Transitioning to Preliminary and Final Engineering
10. Agency Operations and Maintenance Database Assembly
11. Continuous Monitoring and Feedback to Agency Processes and Database

#### Case Study

Freeway section with design exceptions may perform better than one designed to current standards. For this case study two freeway typical sections were compared using HCS and ISATEs to compare the capacity and predicted crashes. The section with design exceptions operates at a better level of service and is predicted to have fewer total crashes than the section that meets the FHWA controlling criteria.

ADT = 150,000 vpd
Directional Distribution = 60/40
K = 10% DHV = 9000 vph
Trucks = 8%
PHF = .94

### Strawman Context Framework

#### Cost-effective Approach to Horizontal Curve Design Policy

The AASHTO HSM describes the safety effect of curvature for two-lane rural highways. Crash frequency is a function of the radius of curve, length of curve and traffic volume.

#### Comparison of Travel Distance with Same Central Angle

### Geometric Highway Design Process

[Diagram showing design processes and criteria]
Geometric Highway Design Process for the 21st Century

<table>
<thead>
<tr>
<th>Project Type</th>
<th>Mobility</th>
<th>Access</th>
<th>Safety</th>
<th>State-of-good Repair</th>
</tr>
</thead>
<tbody>
<tr>
<td>New Location</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3R</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reconstruction</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

Generalized Profile of Typical or Critical Operational Issues Governing Geometric Design by Context

<table>
<thead>
<tr>
<th>Roadway Type</th>
<th>Rural Natural Zone</th>
<th>Rural Zone</th>
<th>Suburban Zone</th>
<th>General Urban Zone</th>
<th>Urban Center Zone</th>
<th>Urban Core Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td>Local</td>
<td>Accessibility to adjacent land uses with minimal cost and environmental disruption</td>
<td>Access to land uses for motor vehicles and vulnerable users</td>
<td>Mobility for full range of road users including motor vehicles, bicycles and pedestrians</td>
<td>Access to land users by pedestrians, transit users and bicyclists; access for freight and goods delivery.</td>
<td>Travel time reliability for transit buses and taxis; mobility for pedestrians</td>
<td></td>
</tr>
<tr>
<td>Collector</td>
<td>Mobility and reliability of traffic service (travel time and travel time variance) for reasonable range of vehicle types</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Arterial</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Freeway</td>
<td>Minimization and reliability of minimization of total costs of motor vehicle trips of all types (including especially freight); such costs to include both vehicle operating and travel time costs</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

New Construction vs. Reconstruction

**New Construction**
- Unknown Safety Performance
- Unknown Operational Performance
- Available F/W of Sufficient Width
- Minimal Impacts to Adjacent Development
- Construction Costs are Quantity Based

**Reconstruction**
- Known Crash History
- Operational Performance Known
- Limited F/W
- Adverse Impacts to Adjacent Development
- Maintenance of Traffic / Local Access Drive
- Construction Cost

Alternative Concepts for More Flexible Design

There has been an increasing movement toward increasing flexibility to help transportation designers meet the needs of multiple stakeholders. Each of these alternative concepts has useful features that should be considered in developing a revised geometric design process. Yet, none of these concepts are, by themselves, a complete process for identifying all factors relevant to design decisions.
VISION ZERO PROGRAM
2020

FREMONT, CA

QUICK FACTS
Population: 231,664
4th largest city in the Bay Area
1. San Jose
2. San Francisco
3. Oakland
4. Fremont
Part of the Silicon Valley Region
Home of Tesla Motors factory

MAJOR TRAFFIC CRASH TRENDS

<table>
<thead>
<tr>
<th>Year</th>
<th>重大交通事故数量</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014</td>
<td>34</td>
</tr>
<tr>
<td>2015</td>
<td>37</td>
</tr>
<tr>
<td>2016</td>
<td>25</td>
</tr>
<tr>
<td>2017</td>
<td>26</td>
</tr>
</tbody>
</table>

Since start of Vision Zero program, major traffic crashes ↓ 27%

FREMONT’S VISION ZERO PROGRAM

Policy Adoption
- Major traffic crashes at historic highs in 2014-2015
- Policy adopted September 2015
- Action plan approved in March 2016 (prepared in-house)
- 7th city to adopt Vision Zero Action Plan, 1st mid-sized city

Key Implementation Efforts
- Primary Team:
  - Public Works Transportation (engineering)
  - Police Department (enforcement)
  - City Manager’s Office (education/communication)
- Reallocated existing funds towards safety
- Leveraged pavement maintenance programs for Safer Street design
**ROAD TO ZERO**

**ACTIONS COMPLETED (2016-2017)**

- Pedestrian countdown signals citywide
- LED street lighting upgrade citywide
- 35 miles of lane narrowing and buffered bike lanes
- Initiated school safety assessments at all 42 public schools
- Low cost safety videos
- Tripled number of speeding stops
- Youths “Look for Safety” program
- Constructed 50 new neighborhood speed lumps
- Lowered speed limits on 12 streets

**INITIAL RESULTS**

**Comparing Factors in Major Crashes Before & After Vision Zero**

- **MAJOR CRASHES**
  - Fatalities Down 13%
  - Severe Injuries Down 31%
- **SPEED LIMIT**
  - 40 mph or more Down 55%
- **DARK/NIGHT** Down 21%
- **DUI** Down 10%

- **TRAVEL MODE**
  - Walking Down 44%
  - Bicycling Down 29%
  - Motorcycle Up 43%
  - Driving Down 29%

- **SAFETY**
  - 44% reduction in major crashes involving pedestrians

- **Greater reduction for collisions involving vulnerable road users**
- **Correlation** between types of collisions/actions in years 1 & 2

**SAFETY**

**SPEED LIMIT**

- 30 mph

**SAFEST-STREETS**

- Enhance Pedestrian Crossings
- Tame High Speed Arterial Streets
- Make Freeway Interchanges Safer for Walking and Bicycling
- Expand Safe Routes to Schools Program
- Continue Targeted Enforcement of Speeding
- Reduce Impaired Driving
- Promote Crash Avoidance Technologies

**SAFER PEOPLE**

- Expand Traffic Safety Education Programs
- Provide New Traffic Signals at Priority Locations

**SAFER VEHICLES**

- Promote Crash Avoidance Technologies
CRASH DATA ANALYSIS FOR OLDER DRIVERS, PEDESTRIANS AND BICYCLISTS

OLDER DRIVERS
- Education of high hazard traffic maneuvers and route planning efforts to identify “safe routes” may be successful for older drivers. (i.e., avoid left turn maneuvers, congested roadways).
- When designing projects in areas of higher older driver populations, additional consideration may be given to shifting the operational/safety balance towards safer performance.
- Mitigation measures aimed at increasing traffic control visibility:
  - Redundant/near side signal heads
  - Duplicate/oversized stop signs
  - Reflective backplates/posts
  - Reverse angle parking
- More restrictive traffic control may be warranted where complex maneuvers are required:
  - Protected only left turn phasing
  - Access management

PEDESTRIANS
- Between 2011 and 2015 ped crashes have shown an increasing trend with a 10% increase in all crashes and a 35% increase in fatal crashes.
- Pedestrian crashes follow typical volume trends by hour of day; however, fatal pedestrian crashes have a higher distribution during nighttime hours from 8 pm to 6 am.
- Roadways with speeds of 35-45 mph account for 50% of pedestrian fatalities, but only 17% of crashes.
- High speed fatal crashes are far more geographically disbursed than low speed crashes.

BICYCLISTS
- Unlike pedestrian patterns, both total crashes and injury crashes involving bicycles appear to follow traditional commuting patterns by time of day.
- A decreasing trend is observed for the frequency of bicycle crashes as roadway ADT increases.
- Focus Areas:
  - Urban numbered routes or county routes
  - Roadways with an ADT < 17,500 with PM peak hour focus
  - Posted speeds of 35 MPH or less
  - Accommodations needed for both intersections (crash frequency) and non-intersections (crash severity)
  - Bicycle visibility important on all roadway types and speeds even during daylight conditions.
Crash Analysis in the Time of Big Data

2018 Joint Institute of Transportation Engineers (ITE) International and Midwestern/Great Lakes Districts Annual Meeting and Exhibit

August 22: 1:15 PM to 2:45 PM, Poster Session: Complete Streets/Vision Zero

Bryan Nemeth, P.E., PTOE, Bolton & Menk, Inc. and Dan McCormick, P.E., Carver County, MN

Contact: bryanne@bolton-menk.com, 952-890-0509

Introduction

Many public agencies keep a record of crashes but use this data on a project by project basis or look at a specific location when there is a complaint from a public official or the general public. There is so much data available it can be difficult to identify where there are issues before there is a complaint. Carver County and Bolton & Menk cooperated on the development of a county specific crash tool to not only include the crash specific information but also complete much of the crash analysis information automatically on a county-wide basis. This is used to get an entire look at the county transportation system all at once.
20 Years.

Studies may be advantageous over the next understanding where future investments or potential safety concerns, and determining where there are current and needs of the transportation network, evaluating the existing and future capacity. 

This includes:

Connecting to other jurisdictions.

Transportation network within and among jurisdictions are evaluating the transportation plan update. As metropolitan council regional planning area are currently in the process of updating their.

County and local jurisdictions within the Background
• engineering

• enforcement, and

• education.

Through forth an effort to reduce the crashes general trends in the severe crashes and put their transportation system that focused on provided counties with a safety review of focusing on causation factors. These implementation in a systematic basis to identify low cost safety projects for Roadway Safety Plans (CRSP) were an effort Transportation (MNDOT) Districts County all counties and Minnesota Department of effort to complete roadway safety plans for in 2009, the State of Minnesota began an needs.

understanding of context and potential crash severity locations without a focused plans have been high level, pointing out high generally safety reviews in Transportation.
Crash data is used in coordination with transportation safety plans to:

- Determine safety focus areas,
- Determine mitigation needs, and
- Guide crash analyses,

The goal is to complete much of the analysis within the tool as a part of the overall transportation safety plan for the County.

This tool is continually updated as new locations with a high level of incidence, locations of crashes but also incidents, less severe crashes, and national-wide goals to reduce severe crashes.

The tool is continuously updated as new incidents of prioritized can be revised as

Identifications of priorities becomes available so that

conditions change.
future project specific needs. Low cost spot safety improvements and mitigation measures. This is used to identify need of further review or potential need of further review for potential locations in be used to identify hot spots and locations in aggregates the data into summaries that can existing crash locations and identities and types. The safety analysis takes into account looking at the non-severe crashes and looking at the non-severe severe crash types but also most numerous severe crash types but also information and looking just the crash expanding the data beyond just the crash a useful and meaningful way. This includes further refines and evaluates the data in and further refines the crash data from DPS The crash tool uses the crash data from DPS of mitigation measures. Roadway safety analysis and determination and identity how Carver County approaches and identity how Carver County approaches and plan is used to state the county safety goals. The safety component of the Transportation
Collector

County Highway/County Road to City

Arterial

County Highway/County Road to City

County Highway/County Road to County

County Highway/County Road

State Highway to County Highway

State Highway to State Highway

Intersections included in the tool:

opportunities.

Certain locations including crash mitigation system and understand the opportunities at types and patterns on the county roadway.

The tool is used to understand the crash.

Tool Features
Improvement needs based on the crash data.

Needs Identification

Identity locations where there are safety trends have changed over time.

Used to understand how crashes at locations used to identify crash location clusters and hot spots for potential mitigation.

Heat Map

- Type
- Severity and frequency

Used to identify the locations most in need of improvements. Based on crash score and safety score.
### Top 20 Intersections & Top 20 Segments by Crash Score

<table>
<thead>
<tr>
<th>Intersection or Segment ID</th>
<th>Name</th>
<th>Crash Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>BM10</td>
<td>MN 41 &amp; State Hwy 7 &amp; Lake Lindan Drive</td>
<td>86</td>
</tr>
<tr>
<td>161</td>
<td>CSAH 33 &amp; CSAH 34</td>
<td>78</td>
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**Legend**

- Top 20 Crash Score Intersections
- Top 10 Crash score road segments

---

Source: MnDOT, MnGeo, Carver County
### Crash Analysis in the Time of Big Data: Page 16 of 21

<table>
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<th>Rank</th>
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<th>Crash Score Categories</th>
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<th>A</th>
<th>B</th>
<th>C</th>
<th>P</th>
<th>O</th>
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#### High Frequency Crash Types

- [Diagram showing crash distribution by severity]

**Note:** Created on June 04, 2018, Cerner County Intersections

**2013-2015 (3 Years)**

**Crash Score Report**
Conclusions

is up-to-date.

improvements on a county-wide basis that
mitigation measures, and prioritize safety
identify crash trends, identify crash
trends, identify crash
trends, identify crash
trends, identify crash
trends, identify crash
trends, identify crash
trends, identify crash
trends, identify crash

The Crash Tool is an effective way to
and the public.
for providing updates to elected officials.
The report and associated maps are useful.
years efforts.
but also provides a comparison to previous
how the county is achieving safety goals.
An annual report identifies the trends for
quick review.
The tool effectively organizes the data for
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Turning SRTS and ATP Plans to Reality: How to Best Fund Improvements Over Time

Min Zhou, P.E.
CITY OF COLTON
PROFILE

Population: 55,000
Top 5% most polluted city
Median Income: 33% blow state avg
~70% students
PROJECT TIMELINE

2014 - Applied for Grant

2015 - Grant Awarded

Jan. 2016 - Project Kick-Off

July 2017 - Traffic Committee Meeting

Nov. 2017 - Final Review with City Staff

Dec. 2017 - Completion of Plan
COLLABORATIVE EFFORTS

SBCTA
CITY PLANNING PUBLIC WORKS
SCHOOLS LOCAL COMMUNITY
GENERAL PUBLIC
PURPOSE OF PLAN

1. Assess the needs of bicyclists & pedestrians in the city
2. Examine gaps in the active transportation network
3. Identify engineering improvements & non-infrastructure programs
4. Provide the city with a set of tools to implement the recommendations
SAFE ROUTES TO SCHOOL (SRTS) PLAN

10 Schools

Abraham Lincoln Elementary
Ulysses Grant Elementary
Cooley Ranch Elementary
Alice Birney Elementary
Woodrow Wilson Elementary
Paul Rogers Elementary
Reche Canyon Elementary
McKinley Elementary
Colton Middle School
Colton High School
PROPOSED SRTS IMPROVEMENTS

ALICE BIRNEY ELEMENTARY SCHOOL Proposed Engineering Recommendations

1. Mt. Vernon Avenue & Olive Street: Restripe to high visibility herringbone style crosswalk.
2. Olive Street (between Rainier Avenue and Bothell Avenue): Increase signage for one-way circulation. Install sidewalk along West side of roadway. Provide ADA compliant curb ramps.
3. Olive Street Corridor: Add school signage at this location.
4. Eton Drive (between 16th Avenue and Fairview Avenue): Install sidewalk along both sides of the roadway.
5. Palm Drive & Fairview Avenue: Add high visibility herringbone style crosswalk along southwest leg.
6. Olive Street & Fairview Avenue: Convert all-way STOP into traffic circle or install bulbouts. Install ADA compliant curb ramps. If STOP control is kept, restripe STOP bars at all approaches. Restripe school crosswalk with high visibility paint and add two school crosswalks. Add school signs.
8. Olive Street (north of Bothell Avenue): Install sidewalk on both sides of roadway to close gaps. Implement road diet and eliminate parking and add curbs between Bothell Avenue and Orangewood Street.
10. Fairview Avenue & Laurel Street: Install ADA compliant curb ramps.
11. Holly Avenue & Laurel Avenue: Install ADA compliant curb ramps.
12. Holly Avenue: Install sidewalks along both sides of roadway between Laurel Avenue and Olive Street.
13. Olive Street & Holly Avenue: Restripe existing STOP bars, add high visibility herringbone crosswalk and school signage.
14. Colton Avenue Corridor: Add school signage approaching Fairview Avenue and restripe crosswalks. Add pedestrian push button for south side of Vic Way to Colton Street. Add raised crosswalk median to separate traffic in 40 mph zone.
15. Colton Avenue & Fairview Avenue: Restripe school crosswalk with herringbone style. Add right turn lane for southbound traffic pending warrants.
17. Colton Street: Install sidewalks along both sides of road. Add ADA compliant curb ramps.
PROPOSED SRTS PLAN

27 Segments

12.6 Miles of Improvements
PEDESTRIAN PLAN

Pedestrians Walking on Sidewalk
PROPOSED PEDESTRIAN PLAN

16 Corridors

17 Miles of Improvements
PROPOSED BICYCLE CORRIDORS

27 Corridors

41 Miles of Improvements
IMPLEMENTABLE PLANS

Cost Summary By Plan

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<th>IMPROVEMENT TYPE</th>
<th># OF CORRIDORS</th>
<th>ESTIMATED COST</th>
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<td><strong>70</strong></td>
<td><strong>$18,488,032</strong></td>
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*Some corridors are double counted since they are both in the pedestrian and/or bicycle plan and Safe Routes to School Plan.
Can Your Bike Lane Design Be Maintained?
Consider the unique maintenance requirements for planning a protected bike lane.

Summer Maintenance
Summer maintenance may include sweeping or flushing the bike lanes for leaves and debris.

Many on-street bike lanes are swept weekly. Plan that Level of Service for Cycle Tracks.

Winter Maintenance
Winter maintenance includes snow and ice control on all bike facilities including protected bike lanes.

The process of cleaning bike lanes in the summer may require special trips or multiple passes, leading to extra time or material costs. In many cases, standard street sweepers fit and can maneuver between the tube delineators, or extend brooms to fit. However, alternate equipment and procedures may also be needed. Sometimes it’s possible to purchase what might work; other times, field staff come up with ingenious solutions to use what is already available.

Summer specialized equipment includes a street sweeper, a jeep buncher and bobcat sweeper.

Pretreating /Anti-icing

Will maintenance equipment fit?

Winter maintenance requires the right equipment for the constraints and needs at hand. This means the capital cost of winter maintenance includes a variety of equipment. It may be necessary to physically remove snow in some cases of excess snow.

Bike Lane Maintenance Budgeting
- Need to create unit costs
- That can help policy makers fund long term o&m of new inventory
- Need to fund both new equipment and ongoing maintenance.
- Different rates for different facilities
- Define Level of Service goals

Level of Service (LOS) Goals

Minneapolis Example:
- For Protected Bike Lanes: LOS is equal to trails.
- For 2" or greater snowfalls: Plowed and treated within 24 hours of the end of the snow event.
- For lesser snowfalls the same goal is desired, but work is completed as soon as possible during the workweek only.
- For other facilities (on-street bike lanes, bike boulevards, etc.): LOS is the same as the street that the facility is located on.

Bike Lane Maintenance Equipment
Consider the unique maintenance requirements for planning a protected bike lane.

If you want to do this... you have to fund this.

IfTE Poster Sessions
Wednesday, August 22, 2018
Protected Bike Lanes in Minneapolis

What is a protected bikeway?
A bikeway that is **physically separated from motor vehicle traffic** by flexible delineators, curb, planters, or parked vehicles. They can also be called separated bike lanes or cycle tracks.

Protected bikeways are policy
To make bicycling a real option for more people, Minneapolis is implementing a network of protected bikeways. Following policy goals outlined in the City’s Climate Action Plan, the City updated its Bicycle Master Plan in 2015 to include a near-term network of protected bikeways, with the goal of installing **30 miles by 2020**.

Plymouth Bridge

On track to meet our goal:

- **Policy Goal**
- **Plan Updated**

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Design Toolbox
Protected bicycle facilities currently being implemented in Minneapolis include various types of protection with the goal of creating more permanent separation network-wide.

Maintenance
Minneapolis is committed to year-round maintenance of our entire network of protected bicycle facilities. The City continues to train staff and to acquire the appropriate equipment.

What’s next for protected bikeways?
Counts in Minneapolis show that bicycle traffic is increasing 6 times faster on streets with protected bikeways than on streets with only shared bicycle lanes. The City is considering where protected bikeways fit in to the city’s bikeway network beyond just the planned 30-mile network, referencing new guidance like NACTO’s All Ages and Abilities Design Guide.
BETTER TOGETHER:

Harmonizing preemption systems, signal timing to improve safety and mobility
Smart cities connect systems and infrastructure to operate more efficiently.
CONNECTED VEHICLE ADOPTION

LAGGARDS
No V2X communication, dependent on driver and fixed signal timing

LATE MAJORITY
Legacy point-to-point communications, including optical and sound

EARLY MAJORITY
Modern point-to-point communications with GPS locating and remote management

EARLY ADOPTERS
Integrated software solution leveraging city and vehicle infrastructure

INNOVATORS
Fully integrated solution leveraging IoT and third party data sources and cloud technology

Multi-modal migration
Software/cellular-based solution
A full smart city solution
CONNECTED VEHICLE ECOSYSTEM

SMART CITY PLATFORM

DSRC (BSM, SPaT, MAP)
- 5.9 GHz radio

OPTICOM GPS-enabled
- 2.4 GHz radio

OPTICOM IR
- Light-based (IR)

Cellular (3G, 4G, 5G)

Opticom Centralized Vehicle Software

Opticom API

Opticom GPS Vehicle (2100)

Opticom IR Vehicle (794)

Opticom GPS intersection (3100)

Opticom Phase Selector (764)

Opticom IR intersection (722)

Performance Analytics

System Management

Advanced Apps (V2X, Predict, IoT)

Traffic Controller

TRAFFIC MANAGEMENT CENTER

Cellular (3G, 4G, 5G) or Fiber or WiFi

Cellular, Fiber or WiFi

NTCIP

NTCIP or Discrete I/O

Vehicle

(794)

Opticom

(2100)

Opticom

(722)

Opticom

(764)

Opticom

API

OBU

Opticom GPS

Cellular, Fiber or WiFi

Advanced Apps

(V2X, Predict, IoT)

Cellular (3G, 4G, 5G)

Performance Analytics

System Management

OTA (DSRC, SPaT)
PROBLEM
New rapid transit routes needed priority and had to coexist with existing point-to-point preemption
• Transit vehicles had existing CAD/AVL

SOLUTION
Deploy a phased multimode priority control system
• CAD/AVL integrated with GPS/radio-based TSP on rapid transit route vehicles
• Snowplows clear rapid transit routes efficiently with signal priority when needed
• Public safety vehicles continue to respond quickly and safely with point-to-point IR preemption and are able to upgrade easily in the future

SOLUTION OVERVIEW
Public safety, public transit and public works vehicles leverage infrastructure
Phased technology migration plan allows multimode priority requests
Priority control solution integrates with existing CAD/AVL system
Public safety vehicles get safe, fast passage with existing IR system
**From pilot to priority: Faster buses in NYC**

**PROBLEM**
Bus travel times slow, and getting slower
- Route M15-SBS: 2nd highest passenger loads in city
- Congested, intermodal route
  - Heavy pedestrian, bicycle traffic
  - Unloading trucks
- Cross traffic coordination required
- Urban canyon reduced GPS effectiveness
- 13,000 traffic signals -- difficult to deploy hardware

**SOLUTION**
Deliver centralized transit signal priority control
- Leverage existing infrastructure, investments
- Undergo Sophisticated traffic engineering design

**SOLUTION OVERVIEW**
Collaborative pilot-to-procurement project with multiple stakeholders
Leveraged existing investments in network communications
Accelerated deployment via cellular/software-based solution
Sophisticated TSP analysis to reduce impact on traffic flow

**18%**
Bus travel time reduction
A full Smart City solution: Montreal, QC

- Multimodal management across multiple regions
- Cellular and radio-based connected vehicle technologies
- Conditional TSP based on schedule and passenger loads
- Easy-to-deploy software solutions built for scalability

PROBLEM
Growing metropolitan area with public safety and transportation challenges
- Aging infrastructure
- Limited budgets
- Regional transit and emergency response -- different cities with different technologies

SOLUTION
Mixed connected vehicle technologies and applications
- Software/cellular-based TSP in City of Montreal
- Radio-based TSP in surrounding regions
- Software/cellular-based EVP

SOLUTION OVERVIEW
- Multimodal management across multiple regions
- Cellular and radio-based connected vehicle technologies
- Conditional TSP based on schedule and passenger loads
- Easy-to-deploy software solutions built for scalability

OPTICOM TSP SOFTWARE
GTT INTELLIGENT TRANSPORTATION SOFTWARE
FIBER NETWORK
ATMS
TRAFFIC CONTROLLER
OPTICOM GPS/IR
TRAFFIC CONTROLLER
Other technologies and considerations

- **Turnkey services for technology management and optimization**
  SAN FRANCISCO MUNICIPAL TRANSPORTATION AGENCY

- **Cellular-based in-vehicle SPaT data**
  INDYGO - INDIANAPOLIS PUBLIC TRANSPORTATION CORPORATION

- **Bi-directional lane management**
  ABQ RIDE - ALBUQUERQUE, NM

- **Adaptive preemption and priority via NTCIP**
  HARRIS COUNTY, TEXAS EMERGENCY SERVICES DISTRICTS
Balancing the Diverse Needs of Communities to Improve Regional Connectivity in Denver, CO

North Metropolitan Industrial Area Connectivity Study

Regional Transportation Issues
- equitably assessing goals of different groups
- facilitating multi-jurisdictional coordination and cooperation
- improving connectivity between communities and across barriers
- understanding multimodal and complex projects

Balanced Evaluation Process
- using a subregional lens
- focusing on connectivity (not boundaries)
- integrating 40+ local plans
- determining travel sheds of similar travel patterns

Improvements by Mode/Purpose

Travel Sheds

Decision Support Tool

Top Nine Projects
Introduction

The Iowa DOT’s Traffic Critical Program is focused on work zone performance through a data driven approach to monitor, communicate, and continuously improve the mobility and safety of motorists during the construction season.

Projects identified as Traffic Critical require enhanced traffic impact mitigation strategies, such as: Intelligent Work Zones (IWZ), limited construction hours (including night work), innovative contracting mechanisms, and Traffic Incident Management (TIM) plans to mitigate traffic impacts.

The program has grown from 20 TCP with 14 Intelligent Work Zone (IWZ) systems in 2014 to 89 TCP with 27 IWZ systems in 2018.

Selection

The Iowa DOT has developed a TCP Checklist that can be used to identify key construction projects based on the following requirements and criteria for TCP designation:

- Location
- Mobility and Safety Analysis
- Safety Mitigation
- TCP Plan Tier Designation

Performance

To monitor the work zones, the Iowa DOT has partnered with the Center for Transportation Research and Education (CTRE) to develop visualization tools which track the traffic performance at all times to support daily and longer term decision making.

The performance monitoring tools document the impact work zone projects have on traffic as well as traffic sensor operating status. Connecting to the data collected by cameras, sensors, and dynamic message signs, the web-based performance monitoring tool is updated every night to add the information of the previous day into the view. Meanwhile, all the historical data is retained from the database so that the information from any time interval can be queried at any point.

Coordination

The TCP program requires considerable coordination with multiple private and public stakeholders including:

- DOT/Office of Traffic Operations Staff
- Traffic Management Center Staff
- Support Consultant Staff
- System Integration Staff
- IWZ Vendor
- University staff
- Permanent Device ITS Maintenance Vendor

The performance monitoring tool is designed in a straightforward way so that any issues in traffic speed and sensor conditions can be quickly identified from a color-coded map. Besides the display of traffic data, calculated performance measures are also visualized which provides insights into the performance of each project. The visualization panel connects to each of the work zones and historical data at once.

In 2017 a sensor based text alerting system was developed which generates event messages once a stopped condition is detected and a final text is sent when these conditions clear.

Summary

- The Iowa DOT has established, and is continuously refining, a Traffic Critical Program
- The goal of moving traffic safely and efficiently through road construction areas reinforces the need for developing new ways to enhance work zone traffic management and performance monitoring
- TCP is a data driven approach which includes high performance computing, alerting, and data visualization tools
Adaptive Signal Control Technology
A Case Study in the Systems Engineering Process

1. Traffic Adaptive Background
Potential Benefits
- More efficient and safer traffic flow
- More efficient use of the transportation network
- Improved traffic flow by automatically adjusting signal settings

Kadence P2 (1/15-2/12)

2. The Project Timeline

- October 2015 – Preliminary Engineering complete
- April 2014 – ASCT White Paper developed

3. Challenge – know the Problems & Objectives

4. Requirements

- Access Control
- External control
- System Design

5. Alternatives Analysis – Approach

- Some solutions may change the way you think about traffic and
- Some alternatives are “set and forget” (kind of) while others are highly

Where might adaptive work well (or not)

- Can react to event traffic
- Algorithms attempt to achieve objectives (e.g. reduce TT, AoR)
- Stop bar detection – MOEs (e.g. AoG, Delay)

Potential Benefits

- Reduce congestion, delay and accidents by creating smoother flow
- Improve travel time reliability by improving progression
- Continuously distribute phasing green time as necessary
- Adapt to unexpected changes in traffic conditions
- More efficient use of the transportation network

Differences in ASCT Operation

- External control – issue hold / omits / force-offs, or detector calls via
- Internal control – issue hold / omits / force-offs, or detector calls via

Validation Testing

- SCOOT satisfied requirements
- Verification Testing

- Traffic impacting events planned
- Traffic impacting events planned

Pilot Implementation

- Field Survey – making conditions and implementation
- Traffic monitoring, travel time, and other evaluations

10. Planned Events

- Risks and Benefits Summary
- Implementation Details
- Lessons Learned
- Future Work

11. Test Results

- applaudable response (17%) is impressive capability
- various issues identified (4% or 12%)

6. Pilot Implementation

- Field Survey – making conditions and implementation
- Traffic monitoring, travel time, and other evaluations

7. Montrose Rd Corridor

- Traffic Adaptive Detection

8. Kadence Cycle and Split Timing

- TBC (12/5-10)
- RHODES

9. SCOOT Cycle Timing

- TBC performed better on weekends

12. Lessons Learned

- Things to do in-house
- Engage all stakeholders very early in the process, develop champions

- High maintenance costs
- Technology is not mature

Lessons Learned

- Stuffing impacts from a change in operation
- Uncalculated problems with existing infrastructure
- Higher maintenance costs
- Communication

Adaptive Timing Limitations

- Adaptive control
- External control
- System Design

- Senior Management
- Systems Engineering
- Change Management
- Training
- Operations and Maintenance

-Build the Foundation First
- Manage Expectations!!
- Uncovered problems with
- Staffing impacts from a

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Driverless Future: A policy roadmap for city leaders
Akhil Chauhan, Vice President, Arcadis
Marwan Abboud, Senior Vice President, Arcadis

Introduction
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Cities will soon have to make complex decisions related to infrastructure, urban mobility, land use, and social equity and inclusion as people give up car ownership and take up ridesourcing and, in the near future, ridesourcing run by AVs.

Public policy will play a decisive role in shaping AV technology and guiding its impact on cities, as it did during past technological revolutions involving the railroad, the streetcar, and the automobile.

What’s at Risk?

If cities don’t plan for AV
- High vehicle ownership
- Amplified congestion
- Increased Vehicle Miles Traveled
- Growing disparity for job and transportation access
- Diminished transit ridership
- Greater demand for parking

Methodology
Using three cities as a guide, we developed a model that compares the driver’s cost of owning a car with the cost of using ridesourcing in an AV. We then predicted how many people could switch to AVs and stop owning cars. This cost model also shows how AVs and shared mobility could lead to a reduction in vehicle ownership and cars on the road. By comparing the cost of car ownership versus hypothetical AV ridesourcing and ridesharing services, we determined the price point and Vehicle Miles Traveled (VMT) at which people were likely to give up their personal cars. The inputs to the model included the number of trips per day, the average VMT, parking costs and market segmentation by vehicle type.

Conclusion
While the speed and pace of AV technology adoption remain unclear, its imminence is certain. In the face of this, city leaders — together with transit agencies, private operators, developers, other stakeholders, and the public at large — have an obligation to define new policies that protect against risks while seizing new opportunities.

Six Priorities for City Leaders
- Leverage Technology to Enhance Mobility
- Prioritize and Modernize Public Transit
- Implement Dynamic Pricing
- Plan for Mixed-Use, Car-Light Neighborhoods
- Encourage Adaptable Parking
- Promote Equitable Access to New Jobs and Services

Factors
- High vehicle ownership
- Amplified congestion
- Approaching maximum travel demand
- Mixed-use living
- Ridership
- Parking

Projected AV Modal Shift

Current & Projected Modal Share

Factors
- High vehicle ownership
- Amplified congestion
- Approaching maximum travel demand
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- Ridership
- Parking

Projected AV Modal Shift

Open data and technology standards; universal apps; smartcards
- Last-mile shuttles; kiss-and-rides
- Cordon/zone pricing; variable tolls; vehicle mile travel fee; weight-distance tax
- New investment criteria; mixed-use in new neighborhoods; parking in-lieu fees
- Conversion of on-street parking; redevelopment of parking lots; mandate or incentivize parking garages
- Payment alternatives; dial-a-ride; equitable service coverage; retraining and certification

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Iowa DOT Traffic Critical Program: Performance Monitoring Intelligent Work Zones
Tim Simodynes, Iowa DOT and Skylar Knickerbocker, InTrans

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✓ Mobility Mitigation
✓ Safety Mitigation
✓ TCP Plan Tier Designation

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5 Summary
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✓ The goal of moving traffic safely and efficiently through road construction areas reinforces the need for developing new ways to enhance work zone traffic management and performance monitoring
✓ TCP is a data driven approach which includes high performance computing, alerting, and data visualization tools
Traffic Signal Data Sharing in the City of Frisco, Texas

Brian A. Moen, P.E., Assistant Director of Engineering Services/Transportation
bmoen@friscotexas.gov
SPaT Data – What is it and how is it transmitted to users?

- Signal Phase and Timing (SPaT) data is a message that describes the state of the traffic signal.
- SPaT data is used to inform drivers, vulnerable road users, or onboard vehicle systems about the state of the traffic signal.
- SPaT data can be combined with a MAP message that defines the geometry of the intersection.
- DSRC radios allow a two-way data transmission directly between vehicle/vulnerable road user and a traffic signal controller.
- Third party can gather data from a traffic signal controller, convert data to a SPaT message and transmit to a vehicle or an app via a cellular connection.
Traffic Signal Data Uses

• Safety
  – Red light running
  – Collision avoidance
  – Other applications under development

• Efficiency
  – Engine management
  – Energy recapture

• Driver Information
  – Can reduce stress with knowledge

• Signal Performance Measures (Network/Corridor/Intersection)
  – Vehicle delay
  – Arrivals on green/red by movement/approach
  – Split failures by movement/approach
  – Average speed
Frisco’s Current Traffic Signal Data Sharing

• Agreement with Traffic Technology Services (TTS)
• TTS partnered with Audi of America
  – Audi Traffic Light Information Service launched in Las Vegas in December 2016
  – Service launched in Frisco June 2017
• TTS continues to work with other OEMs to build systems
• Frisco open to sending signal data through connected vehicle module to other third party data brokers
How does the system work in Frisco?

- Frisco uses Trafficware’s ATMS.Now system to monitor traffic signals.
- The system includes a Connected Vehicle Module.
- TTS gets data from Trafficware’s Connected Vehicle Module that is connected to 122 signal controllers in Frisco.
- TTS receives signal status data from the Connected Vehicle Module and then produces a prediction of how much longer the signal will remain red.
- TTS creates a SPaT message for the prediction and sends the message to Audi who then transmits it to the vehicle via a cellular connection.
DATA FLOW - END-TO-END

1. Agency/Region provides real-time traffic signal data, zuru-built drawings, and signal timing plan information.
2. Data fed from ATMS to TTS cloud-based servers via web service.
3. Develop SAE J2735 MAP and SPAT messages for each traffic signal location.
4. Deliver all messages to customer backend system.
5. TTS Data.
6. Customer manages vehicle heading, maneuver, and geolocation and returns targeted MAP and SPAT content to vehicle.
7. Information displayed to end user for relevant connected and automated vehicle applications.
Status of other TTS Users

• Texas Suppliers (Live or Onboarding)
  – Frisco (1\textsuperscript{st} in Texas, 2\textsuperscript{nd} in North America)
  – Sugar Land
  – Flower Mound
  – Grapevine
  – Arlington
  – Grand Prairie
  – Plano

• Active Metro Areas with Suppliers
  – Dallas
  – Denver
  – Gainesville
  – Houston
  – Kansas City
  – Las Vegas
  – Los Angeles
  – Phoenix
  – Portland
  – San Francisco
  – Washington, DC

• Definitions
  – Government agencies = Suppliers
  – OEMS/others = users
Signal Performance Measures

• Signal performance measures are derived from two data sources
  – Signal event data used to create SPaT messages
  – Anonymous vehicle probe data from subscribers to Traffic Light Information Service
  – Over 900 vehicles in Dallas-Fort Worth area have the service enabled
• Data is presented using Microsoft Power BI
• Charts include the following
  – Key Performance Indicators
  – Intersection Summary
  – Historic Summary
Network Wide Key Performance Indicators (Dec 2017 to May 2018)

Key Performance Indicators

- **Avg Vehicle Delay**
  - Number of Vehicles
  - Avg Delay (s) Bins

- **% Split Failures**
  - Percentage of Arrivals
  - Months: Dec 2017 to May 2018

- **Arrivals by Phase State**
  - Pie chart
  - Green: 56.48%
  - Red: 43.52%

- **Statistics**
  - Avg Veh Delay (s): 26.3
  - Total Veh Delay (hr): 1615.2
  - Level of Service: C
  - Avg Split Failure %: 2.5
  - Total Split Failures: 10975
  - Green Arrivals: 166346
  - Red Arrivals: 128154
  - Total Arrivals*: 433623

*Includes arrivals when no signal information available in the car.
Network Wide Intersection Summary (Dec 2017 to May 2018)

Intersection Summary

433329 Total Arrivals
26.3 Avg Veh Delay (s)
1612.9 Total Veh Delay (hr)
2.5 % Split Failures
40.7 Avg Speed (mph)

Traffic Volume Profile

Day Group: Mon-Thu, Fri, Sat-Sun

Number of Vehicles

0 10K 20K

Hour of Day

Corridor: All

Selected int: All Selected

Approach Direction

Phase State: Green, Red

Maneuver: left, thru, right

Selected Signals: 95
Network Wide Historic Summary
(Dec 2017 to May 2018)
Preston Road Summary (Dec 2017 to May 2018)

- Major North/South arterial through Frisco
- 11 signalized intersections over 4.8 miles
- 6 lane divided with speed limits from 45mph to 55mph
- AADT varies from 35,000 to 55,000 vehicles per day
- Left-turn phasing varies - protected only and FYA with lead/lead, lead/lag and lag/lag
- Results are from Mon-Fri, 7am to 9am and 5pm to 7pm in NB and SB directions only

Key Performance Indicators

- Avg Vehicle Delay
- % Split Failures
- Arrivals by Phase State
Preston Road Intersection
Summary (Dec 2017 to May 2018)

Intersection Summary

- 36.0 Total Arrivals
- Avg Veh Delay (s) 38.2
- Total Veh Delay (hr) 1.8
- % Split Failures 40.0
- Avg Speed (mph)

Traffic Volume Profile

Arrivals

- Phase State: Green, Red

Avg Vehicle Delay

- Maneuver: left, thru, right

% Split Failures

- Maneuver: left, thru, right

Intersections

- Intersection N:
  - All

- Corridor:
  - PRESTON RD

- Selected Int
  - 655 - PRESTON RD & ELDORADO PKWY
  - 657 - PRESTON RD & MEADOW HILL DR
  - 660 - PRESTON RD & MAIN ST

Selected Signals

- 11
Other Data Sharing Projects Underway in Frisco

- Waze Connected Citizens Program (CCP) partner
- Live two-way data exchange with Waze
- Automated posting of road closures to Waze due to
  - Road construction
  - Emergency closures due to crashes, gas line breaks, etc.
  - Special events
- Automated posting of crashes and other traffic incidents to Waze map that are reported to 911
Contact Information

Brian A. Moen, P.E.
City of Frisco
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Tel: (972) 292-5450
Transportation Data Analysis and Visualization Using INRIX Data for NYC DOT

Abstract
This project presents a “big data” analysis using 204 million GPS records that were made available to New York City Department of Transportation (NYC DOT) by the INRIX corporation; this data is stored in a database, using the “csv” format. This project involves the Extraction, Transformation, and Load (ETL) procedure that was created to support the On-Line Analytical Processing (OLAP). The new OLAP Database is then interconnected with a commercial visualization tool that offers user friendly geospatial data analysis, and the generation of key performance indicators such as the roadway-link speed distribution, and the 85th percentile speed by hour of the day, for a given corridor. With this data analysis combined with the visualization tool, we can identify slow speed hot spots (e.g. using heat maps).

The analyses undertaken were for the West Village/Hudson Square Transportation Study Lower Manhattan, Brooklyn-Queens Expressway Rehabilitation and/or Replacement Project in Brooklyn using a visualization tool to analyze the average speed per corridor of interest.

INRIX Data for May 2017 included trip records for approximately 984,207 device-IDs summing up to almost 204,680,565 waypoints. Used fields included:
- TripId, a trip’s unique identifier (2,733,310 records).
- WaypointSequence, the order of the waypoint.
- CaptureDate, the capture date and time of the waypoint in UTC.
- Latitude, decimal degree latitude coordinates of the waypoint.
- Longitude, decimal degree longitude coordinates of the waypoint.
- DeviceId, A device’s unique identifier.

Methodology
- The data was partitioned using SQL geospatial data analysis.
- Map Matching for the selected study area.
- The data was divided into AM, and PM hourly periods covering weekdays and weekends.
- Parameter calculation: average speed, standard deviation speed and speed percentile (25th, 50th, 75th, 85th), and these parameters were investigated with respect to day-of-week, time-of-day.
- Server Characteristics: Processor: Intel (R) Xeon (R) CPU E5-2640 @ 2.00 GHz, Ram Memory: 64 GB, System type: 64-bit.

Findings
- An easy way to conduct data analysis is using a visualization tool.
- We can analyze customized segments in different locations.
- We can identify hot spots and perform an analysis before and after.
- Easy to communicate graphically to the public and project stakeholders.

Future Work:
We aim to expand the data analysis to incorporate additional datasets from other sources such as crash data, construction data, etc. Establish a modern data warehousing and data analysis hardware/software platform to develop automated and semi-automated data related reports to support NYCDOT management and operations and planning.
Driverless Future: A policy roadmap for city leaders

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**INTRODUCTION**

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**CONCLUSION**

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Advancing Transportation Choices in Des Moines

Presented by:
City of Des Moines, Iowa

Jennifer McCoy
City Traffic Engineer
JLMccoy@dmgov.org

Brian Willham
Principal Traffic Engineer (former)
Transportation Planning Efforts

The Tomorrow Plan
Mobilizing Tomorrow
Bicycle and Trail Master Plan
PlanDSM
GuideDSM
DART Forward 2035 Update
Neighborhood Plans
MoveDSM
ITS Master Plan
Step it Up DSM
Connect Downtown
Common Thread: Multi-modal Transportation

City of Des Moines Transportation Goals

Develop a complete multi-modal transportation network for pedestrians, bikes, transit, and automobiles.

Develop updated street design standards that allow for and balance the needs of all forms of transportation.

Provide opportunities for healthy lifestyles through walking as a primary mode of transportation.

Make transit a more attractive option for all City residents.

Enhance the bicycle network by expanding bicycle facilities that are safe, comfortable and easily accessible.

Ensure freight facilities continue to meet the needs of the local economy while being sensitive to impacts on surrounding land uses.

Ensure the Des Moines International Airport continues to meet the needs of the local economy.

Plan for future changes in transportation demand, technology, and innovation.

The City of Des Moines established these goals for the transportation system as a part of Plan DSM adopted in April 2016. For additional details, visit PlanDSM.dm.gov
Managing Expectations

84% of commuters travel to/from their workplace in a single-occupant vehicle

U.S. Census Bureau, 2010-2014 American Community Survey (ACS) 5-year estimates

Des Moines, IA Quick Stats

- **601,187** metro population
- **35.4** median age
- **3.5%** unemployment rate
- **$47,170** average annual salary
- **$168,873** median home price
- **$802** average monthly rent
- **60.3° / 41.4°** average high/low temperatures
- **36.0 inches** average annual rainfall
- **20.1 minutes** average commute time

Des Moines, Iowa Metro Area

#9 in Best Places to Live

Overall Score 7.1 / 10

THE BEST CITIES FOR CAR LOVERS

- 1 - Colorado Springs, CO
- 2 - Des Moines, IA
- 3 - Salt Lake City, UT
- 4 - Richmond, VA
- 5 - Dayton, OH
- 6 - Denver, CO
- 7 - Wichita, KS
- 8 - Boise, ID
- 9 - Raleigh, NC
- 10 - Virginia Beach, VA
“Transportation plays a key role in an exciting and healthy living and working environment when it considers more than moving vehicular traffic. The concept of a multi-modal transportation system is one that offers a range of transportation choices and supports mixed land uses along corridors” –

Plan DSM Transportation Section

Street Design Elements being considered for Downtown

- Fewer / Narrower Traffic Lanes
- 1-way to 2-way Conversions
- Crosswalk Improvements
- Protected Bike Lanes / Intersections
- Transit Lanes
- Parking Changes
- Traffic Signal Removal
**Meetings / Coordination**

Individual Business Owners  
Historic East Village Association  
DM Transportation Safety Committee  
DM Bicycle Collective  
DM Public Works  
(Infrastructure / Snow Removal)  
DM Police / Fire Department  
DART  
Des Moines MPO  
Nelson/Nygaard (Connect Downtown consultant)  
Sam Schwartz (DM Transportation Master Plan consultant)  
City of Cedar Rapids  
State of Iowa Capitol Planning Commission  
Operation Downtown

**Issues / Opportunities**

[Image of engagement map with key themes]

[Image of bar chart showing most common concerns reflected in public comments]
Proposed Street Changes

Proposed Bike Plan

Proposed Bicycle Network:
- Buffered or Protected Bike Lanes
- Bike Lanes
- Bicycle Boulevard
- Shared Lane Marking
- Existing Shared-use Path
- New Shared-use Path

Data Sources: FDOT, City of Des Moines

NOTE: Peak hour parking restrictions on Locust, Mulberry and 7th have already been removed as a 'pilot' project.
Connect Downtown Pilot Project

- Balances safety / operation between Pedestrians, Bicyclists, Transit, and Vehicles
- Supports Goals of PlanDSM / GuideDSM
- Good opportunity with Bridge Out

Project Development

1. Connect Downtown Consultant – Roadway Sections / Concepts
2. City Engineering Department – Design
3. City / Connect Downtown Team – Engagement
4. PUBLIC EDUCATION
5. Construction
6. Public Engagement during Pilot (1 year)

Location Map
Public Education

E Grand Avenue Complete Street Concepts

Pedestrians
1. Crosswalk
   At intersections, use the white crosswalks like usual
2. Sidewalk
   No change, keep enjoying the East Village Shops!

Transit Users
3. Raised Concrete Bus Stop
   DART riders can wait for this bus on safe bus stops near the new travel lanes where the buses will make their regular stops

Bicyclists
4. Protected Bike Lane
   The areas marked in green are potential conflict areas
5. Bike Lane Crossing
   Watch for turning vehicles!
6. Two-stage Bike Box
   1 - Travel through the intersection in the crossing; 2 - Wait in the green box until the side street gets a green light
7. Yield to Pedestrians
   Bicyclists Yield to Pedestrians when their paths cross

Drivers
8. Travel Lane
   Lanes for drivers are pretty normal, but be sure to watch out for others trying to park and bicyclists when crossing areas marked in green
9. Parking Stall
   Parallel parking is now cut away from the curb. Use the white T’s and new lines to help line yourself up in the parking spot
10. Parking Meter
    Don’t forget to plug the meter!
    You will need to cross the bike lane to the sidewalk to get to your meter

This demonstration day will feature the plan to re-stripe East Grand Avenue and you will be the first to experience these enhancements to the Downtown streetscape.

MondDAYS
AUGUST 7

FOOD TRUCKS • MUSIC • CITY RIDE
5-8 p.m. Gathering  •  8:30 p.m. City Wide
East Grand Ave between 2nd & 4th
Pilot Project Costs

Construction Cost = $185,000

- Existing Marking Removal / Fog Seal
- Regular Traffic Paint (Not Durable)
- Minor concrete changes (Curb Ramps / Islands)
- Parking Meter Additions / Relocation (by City)
- No Landscaping (to be completed w/ future Streetscape Project)

Pilot Project Maintenance Costs

- Annual Paint / Delineators (contractor provided) = ~ $50,000

Permanent Improvements Cost Estimate = $475,000 - $525,000

- Concrete Islands, traffic signal mast arm extensions, curb ramp relocations, durable markings, etc
- On-going maintenance (Painting)
Lessons Learned (so far)

Performance Metrics

Engagement / Evaluation / Data Collection During / After Pilot

Number of Injury crashes
Corner radii / Truck Aprons for Islands
Traffic Signal Timing Updates
Delivery truck blockage of travel lanes
Parking meter usage
Emergency Response Time (Fire/EMS)
Volume of all modes of travel
Speed of vehicular traffic
Pedestrian comfort metrics
Public Works (sweeping / snow removal)
A Case Study in the Systems Engineering Process

1. Traffic Adaptive Background

Potential Benefits
- Improve traffic flow and safety
- Reduce emissions and energy consumption
- Increase transportation network efficiency

2. The Project Timeline

- August 2014 – Preliminary Engineering Project kickoff
- September 2014 – Detailed System Requirements
- February 2015 – Implementation Plan

3. Challenge – know the Problems & Objectives

- Take the system as is and make improvements?
- Design to address specific needs?

4. Requirements

- Controller / cabinet responsible for basic timing and safety constraints
- Performance Management – Data Driven
- Traffic Adaptive

5. Alternatives Analysis – Approach

- Analyze each city’s specific needs
- Use of controllers, cabinets, and software

6. Pilot Implementation

- Field Survey – making conditions and improvements
- Analysis Tools: Design, Planning, and Performance

7. Montrose Rd Corridor

8. Kadence Cycle and Split Timing

9. SCOOT Cycle Timing

10. Planned Events

11. Lessons Learned

- Things to live in mind
  - Engage all stakeholders – from field operators to senior management
  - Implement new technologies through planning
  - Build the foundation first

12. Adaptive Timing Limitations

- Building impacts from a change in operations
- Uncoordinated with other signal control technologies
- Higher maintenance costs

3. Challenge – know the Problems & Objectives

- Initial Constraints
- Performance based management – data driven

4. Requirements

- Type of operation (SCOOT, TBC, Kadence, etc.)
- Compatibility
- Detection
- Communications

5. Alternatives Analysis – Approach

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