Getting to Zero with CAV

What is CAV?

A C E S

Automated Connected Electric Shared
What does it look like?

How does it work?
How does it communicate?

- Vehicle-to-Vehicle
- Vehicle-to-Device
- Vehicle-to-Pedestrian
- Vehicle-to-Grid
- Vehicle-to-Home

Why are we talking about CAV?

381
What will it impact?

Greater Mobility & Equity  Workforce  Traffic Operations

Economic Development  Infrastructure  Health & Environment

How do we talk about it?

0  1  2  3  4  5

No Automation  Driver Assist  Partial Automation  Conditional Automation  High Automation  Full Automation

0  No Automation  Model T  Honda Fit
1  Driver Assist  Ford Jeep  Compass
2  Partial Automation  Tesla Model 3
3  Conditional Automation  Audi A8
4  High Automation  EasyMile Shuttle
5  Full Automation

Highly Automated Vehicles
When is it coming?

How do we plan for it?
Leadership

Who is leading these efforts?

Advisory Council
- Public-private partnership
- Vision and goals

Interagency CAV Team
- Statewide collaboration
- Coordinate programs

Policy Subcommittees
- Technical and policy expertise
- Develop policy and programs
- Public and private involvement
Who is involved?

CAV Advisory Council

Interagency CAV Team

Policy & Technical Advisory Committees

- **Infrastructure**: Chairs: DOT & County Engineers
- **Vehicle Registration**: Chair: Public Safety & Driving Schools
- **Equity**: Chair: Community Elders
- **Insurance & Liability**: Chair: Commerce & American Family Insurance
- **Traffic Regulations & Safety**: Chair: Public Safety & MN Safety Council
- **Economic & Workforce Development**: Chair: Dept. of Economic Development & Teamsters
- **Accessibility**: Chair: Council on Disability & Mobility Mania
- **Planning and Land Use**: Chairs: DOT & University of Minnesota
- **Cyber Security & Data Privacy**: Chairs: MnIT, Private Cyber Security/AI Firms

Guidestar Board of Directors
- Twin Cities Shared Mobility Collaborative
- University of Minnesota
- County Engineer and League of Cities CAV Committees
- ITS Minnesota

What is our vision?

**Vision**

Collaboration that shapes the future of mobility and maximize the potential of transformative transportation technologies to ensure greater safety, access, equity and health for all.

**Mission**

Engage with government, communities, researchers, business and industry to advance policy that prepares the state for connected and automated vehicles and shared mobility.

- Economic development
- Industry and community collaboration
- Advance safe testing & deployment
- Enhance quality of life
- Mobility for all

*To be reviewed by next Advisory Council*
How is Minnesota involved nationally?

Mission
To improve quality of life for Minnesotans and support a multimodal transportation system by successfully planning and preparing for emerging transportation technologies.

Goals
1. Educate and engage Minnesota on emerging transportation technologies
2. Build relationships and partnerships with stakeholders
3. Accelerate policy, research, engineering and deployment of technologies that improve safety
4. Remain accountable to the public by effectively using state funds

Who is CAV-X?

Executive Director
Technical Director Engineering & Research
Innovative Engagement & Relationships Director Policy & Planning
Communications & Engagement Coordinator

Technical Program Manager
Project Management & Project Controls

Project Manager
Project Manager AV shuttles, freight and transit
Project Manager Work zones and automated fleets
Project Manager Connected Corridors & Smart Cities
Graduate Engineer ITS and CAV Readiness

Information Specialist MnDOT Regional Transportation Management Center/Minnesota IT Services
Electrical Engineer MnDOT Office of Traffic Engineering
What parts of our lives will CAV impact?
What does the Advisory Council recommend?

- "Authorize testing without human drivers"
- "Invest in fiber, signals, pavement markings and smart signs"
- "Prioritize safety for all users: pedestrians, cyclists, people with disabilities, transit, and others"
- "Conduct pilot projects in urban, suburban, rural areas to public can see the tech and guide policy"
- "Create a public engagement plan"

Is it legal?

A state task force wants self-driving cars on the road in Minnesota. Legislators aren’t so sure.
What is allowed in Minnesota?

Automated ‘platoons’ of trucks might soon be driving on Minnesota roads

3 Planning
How is MnDOT planning for CAV?

How do you plan for an unknown future?
CAV Projects & The Four Es

Infrastructure – Fiber, Markings, Signals & Signs
Research – Platooning, Freight, Snow, Detection

Partnerships – Minnesota CAV Challenge
Operations & Maintenance – Data, Work Zones & Crash Cushions

Multimodal – Transit, Freight, Platooning, Bikes and Pedestrians
Education and Demonstrations

Why is education important?

Are you afraid to drive in an automated vehicle?

- Oppose 71%
- Support 19%

- Oppose 21%
- Support 79%

Americans (AAA survey)  
Minnesotans (MnDOT survey)
CAV & Local Projects

CAV Local Impacts

Wayne Sandberg, PE | Washington County Engineer
### Minnesota Highway System

<table>
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<tr>
<th>Roadway Type</th>
<th>Miles</th>
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<tr>
<td>Interstate</td>
<td>914</td>
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<tr>
<td>Trunk Highway</td>
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<td>County Highways</td>
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<td>City</td>
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<tr>
<td>Other</td>
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<tr>
<td>State Total</td>
<td>138,449</td>
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### County Highway System

- 4x Larger than State System
- Variable Configurations
  - Two Lane Rural Roads
  - Multi Lane Suburban Arterials
  - Urban Core – Multi Modal
  - Surface Type
  - Traffic Volumes
  - Truck Routes
Local Road Research Board

Report 2019-18

- Principal Investigator: Shauna Hallmark
- Technical Liaison: Douglas Fischer
- Project Coordinator: Thomas Johnson-Kaiser

Toolbox for Local Agencies

- Prepare for CAV
- 5-10 year window
- Acknowledge rapidly changing environment
- Recommend caution on investment
Transition

- Will take time
- 270 million registered personally owned vehicles on road today
- Deployment will be gradual – especially on local system
  - Start with automated driver assist
  - Continue with gradually increasing assistance
- Dual existence for many years

Pavement Markings

- Top consideration for local agencies right now
- Presence – are the lanes marked?
- Conspicuity – can the lines be seen?
- Clarity – what message is being sent?
Pavement Markings

Figure 3-2. Example of overlapping pavement markings

Signs

- CAV uses cameras – sign recognition
- Visibility – are the signs visible?
- Minimize Signs – do you have too many signs? Signs not needed?
- Standardization – use standard signs whenever possible
- Clear messages – remove conflicting signs
Signs

Maintenace

• Consider current and future maintenance expectations and levels
• Acceptable road hazards?
• Erratic driver behavior?
Maintenance

Summary

• What you can do now for CAV is basic stuff
• Good for CAV and for existing drivers
  • Especially older drivers
  • People unfamiliar with area
• Good investments to make NOW
What is next?

- County Engineers – CAV Committee
- City Engineers – CAV Committee
- Communication
- Data Capture and Information Sharing and Inventory
- Consistency and Standardization
  - National Committee on Uniform Traffic Control Devices (NCUTCD) Guidance
  - Minnesota Committee on Uniform Traffic Control Devices (MCUTCD)
Interaction of Public/Private/Academic

- Minnesota Guidestar
  - Founded in 1990s
  - MnDOT and MPS perspectives
  - Legislative outreach

Follow CAV and other emerging technologies
- Focus on impact to local agencies
- Hosted by SRF and Minnesota Guidestar
- Webinar format; 8-9am quarterly
- Next date Dec 4 (tentative)
- Open to all!!
Consultant Role #1 – Expertise

- Technology deep dive
  - Non-intrusive traffic detection
    - 1994 to now
    - Compared 20+ different sensors
  - Next generation of detection

Consultant Role #2 – Knowledge

- Breadth of experience
- Variety of clients/needs
- ITS On-Call in 6 states
- City, County, State, Federal
- MDOT tool to forecast CAV benefits
Consultant Role #3 – MacGyver

- TH 55 CAV deployment (Connected Corridor Project)
  - Signal Phase and Timing (SPaT) Challenge
  - Enables:
    - Red light violation warning
    - Eco-Driving
  - Bleeding edge
Consultant Takeaway – Long View

- Follow trends
- Stay knowledgeable

Top 10 Questions for CAV
Question 1: How can we make sure CAVs are safe?

- Understand federal and state roles
- Monitor evolution of technology
- Collaboration between government and auto industry
- Share data and information

Question 2: When will autonomous vehicles arrive?

[Diagram showing possible futures]
Question 3: Why is it taking so long?

- Technology/Cost
- Safety
- Fleet turnover
- Policy

• CAV will take time
  • Cruise Control
  • Adaptive Cruise Control
  • Lane Keeping
  • Blind Spot Warning
  • Emergency Breaking
  • SuperCruise/AutoPilot
Question 3: Why is it taking so long?

Enacted legislation | Executive Order | Both | None
--- | --- | --- | ---

1900 | 5th Avenue, New York City | 1913

Question 4: What are other states doing?
Question 5: How does policy need to change and how can we change it?

- Legalize AV testing and deployment
- Education
- Flexible and nimble policies that can adapt to rapidly advancing technology

Question 6: How can we advance CAV technology?

- Road environment – improve visibility of signs and pavement markings
- Accurate mapping – improve standard GPS technology
- Research and testing
- Public-private partnerships
Question 7: How should we educate communities??

• Discuss the levels of automation
• Meet communities where they are at
• Pair education with demonstrations
• Surveys and feedback to inform policy

Question 8: What new safety challenges will emerge?

• Ethical programming
• Social behaviors
• Cyber security
• New failure modes
Question 9: Who will have access to CAVs?

- How much will they cost?
- Will everyone have access?
- How do we ensure CAVs expand opportunity and do not increase disparities?
- Will you need a driver’s license?

Question 10: Who will be responsible?

- Are auto manufacturers liable?
- Do we have to sue the owner of each piece of technology?
- Is the owner responsible?
- How do we get crash data?
- Will insurance rates decrease or increase?
Other Questions: Will CAVs increase congestion?

- Will they decrease congestion?
- “Ghost cars”?
- Zero occupant vehicles?
- Driving no longer lost time?
- Need for congestion pricing?
- Will they lead to exurban sprawl?
- Will they impact transit?
Other Questions: Who are the major players?

- Automotive manufacturers
  Ford, GM, Audi, BMW, Honda, Tesla etc.
- Original Equipment Manufacturers (OEM)
  Aptiv, Bosch, Continental AG, etc.
- Tech companies
  Google/Waymo, Apple, Baidu, Intel, Nvidia, Uber, Lyft, Amazon, etc.
- How are the US DOT, MnDOT, law enforcement and safety advocates involved?

Other Questions: How can I get involved?

- Understand how CAV impacts TZD
- Watch this space
- Stay informed
  - T3 Forum hosted by SRF and Minnesota Guidestar
  - MnDOT demonstrations and events