Planning for Disruption: Connected and Autonomous Vehicles

Final Report

Tom Fisher

College of Design
University of Minnesota

CTS 19-28
The future of transportation is inseparable from the future of work. Over the last century, transportation has focused on moving people and goods, but work in the 21st century has started to change dramatically due to vehicle automation, changing consumer patterns, and the rise of virtual retail. These factors will bring profound changes in transportation, infrastructure, and access to resources in the city, including housing, food, public spaces, and labor opportunities.

This research project investigated the implications of the forthcoming changes in transportation, mobility, and the nature of work. It focused on the impact of vehicle automation on jobs access and explored the tensions that arise as new vehicle automation technologies are introduced into the streets of neighborhoods with historically disadvantaged residents.

**Abstract (Limit: 250 words)**

Connected vehicles, autonomous vehicles, mobility, shared mobility, labor force, work trips


Unclassified

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PLANNING FOR DISRUPTION

Connected & Autonomous Vehicles

PA 5211 LAND USE PLANNING
Instructor: Dr. Fernando Burga
Teaching Assistant: Chris DesRoches
Humphrey School of Public Affairs
Fall 2018

PREPARED BY
Teaching Assistant: Lynda Chao

PROJECT COLLABORATION WITH
City of Minneapolis
Scott County
University of Minnesota - Resilient Communities Project
Minnesota Design Center
Center for Transportation Studies
The projects in this report were completed in collaboration with the City of Minneapolis, Scott County, the Minnesota Design Center (MDC) and Center for Transportation Studies (CTS) as part of the Fall 2018 Resilient Communities Project (RCP) partnership. RCP is a program at the University of Minnesota’s Center for Urban and Regional Affairs (CURA) that connects University faculty and students with Minnesota communities to address strategic projects that advance local resilience and sustainability.

The contents of this report represent the views of the authors and do not necessarily reflect those of RCP, CURA, CTS, MDC, the Regents of the University of Minnesota, Scott County, or the City of Minneapolis.

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This publication may be available in alternative formats upon request.

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## Exhibit Agenda

**December 6, 2018**

- **12pm - 4pm**  
  Open House
- **12:25pm**  
  Brief General Announcement I
- **1:45pm**  
  Brief General Announcement II
- **2:45pm**  
  Brief General Announcement III
- **3:45pm**  
  Final Announcement + People’s Choice Awards
The American auto industry is currently testing, designing and planning for connected and autonomous vehicles (CAVs). The forthcoming deployment of CAVs will disrupt land use regulations and transform the way we live, work, and travel in our cities.

During the Fall 2018 semester, Master of Urban and Regional Planning students worked in collaboration with UMN’s Center for Transportation Studies, the Metropolitan Design Center and the Resilient Communities Project to explore how CAVs will reshape our cities.

By considering the City of Minneapolis and Scott County as case studies students explored the following questions:

• How will CAVs challenge the land use regulations that shape our cities?
• How can comprehensive plans address the forthcoming CAV disruption?
• Who will be left out of the CAV disruption in terms of equity, diversity, justice and the public good?

The six projects you will see represent the result of their efforts.

The PA 5211 Land Use Planning class is comprised by:

Assistant Professor
Fernando Burga, PhD

Teaching Assistant
Chris DesRoches

Masters of Urban and Regional Planning Students:

Martha Allen
Corrin Bemis
Lynda Chao
Ian Corder
Ari Del Rosario
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John Fleming
Patrick Haney
Isaac Hase-Raney
Emily Houser
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Gwendolyn Jenkins
Lee (Ellie) Meekyung

Kathryn Leys
Daniel Mcniel
Elliot Mohler
Eric Molinari
Jacqueline Nowak
Gabriela Olvera
Megan Reineccius
Emily Reno
Galen Ryan
Benjamin Schneider
Galen Ryan
Benjamin Schneider
Koehl Simmons
Forrest Steinhoff
Yuyan Wang
CAVs will not only drive development in densely populated areas where concentrations of people foster a sharing economy, but also potentially lead to CAV-oriented sprawl due to the increased capacity to travel long distances without making stops.

How will these developments promote land uses that support a sense of place and community? To confront this key question, MURP students were directed to apply the New Urbanist Transect as an organizational framework for their projects.

The transect represents a cut through an ideal city showing a range of different built environment according to density. Our projects range from special districts next to the urban core to rural areas beyond suburbia to establish a comprehensive framework. This framework allows us to consider CAV innovations comparatively between urban-suburban and rural areas to inform policy-making as well as place-making.
MURP students were directed to include “Equity Figures” in their posters to inject a qualitative dimension that would otherwise remain hidden by the aggregate characterization of demographic analysis.

The figures represent the voices of under-represented groups and use Twitter to capture the disruptive power of social media in the public sphere. They articulate the opinions of regular residents, fierce advocates and everyday citizens who agree, disagree, and complicate the normative dimension of planning work with new questions, reflections and answers.

**Freight for the Future**
Hi I’m Dave. I am a local resident of Savage. I am a proud father, hunter, and American. I work at the Amazon distribution center in Shakopee and struggles to commute on Highway 13 every day.

**Planning for Disruption**
Hi, I’m Jerome. I work as a baggage handler at the MSP. I take the bus to downtown and transfer to the light rail to get to work. I’ve seen a lot of change around Washington Avenue since I started 15 years ago.

**Planning for Disruption**
Hi, I’m Linda. I migrated to the U.S. from El Salvador and now call East Lake Street my home. I came to Minneapolis to seek new opportunities as a chef. After hard work, I was able to open up my own restaurant on Lake Street.

**The CAV Urban Village**
Hi I’m Ed Chen! I’m a 37-year-old single Asian-American father. I work at here at Canterbury Park and my son Henry and I are excited to see the recalibration of the place I work!

**Paving the Way**
Hello, my name is Charlie Walker and I am a member of the National Federation of the Blind in Minnesota. I tweet about issues that impact the visually impaired community.

**Shared Mobility for All?**
Hi, I’m Linda. I migrated to the U.S. from El Salvador and now call East Lake Street my home. I came to Minneapolis to seek new opportunities as a chef. After hard work, I was able to open up my own restaurant on Lake Street.

**A Renaissance in Transportation**
Hello! My name is Bob, and I will be live tweeting these posters periodically. As a wheelchair-bound individual, I have to rely on friends and family to drive me places but the advent of CAV’S could change all of that!
Help our teams refine their projects and participate in the exhibit through "Dot-democracy". Use the stickers attached to this flyer to vote for the following awards:

**PEOPLE'S POSTER AWARD**
[Place on Poster]
Select your **overall favorite poster**

**PEOPLE'S ANALYSIS AWARD**
[Place on Individual Analysis]
Select your favorite **Analysis, Diagram or Graphic**

**PEOPLE'S FUTURE AWARD**
[Place on Individual Analysis]
Place a sticker on the topic/analysis you think is the most **thought provoking or potential for future study**

Place your stickers directly on the posters.
Freight for the Future

The ports of Savage, Minnesota serve an important role in the regional freight system for the Twin Cities. The ports are privately owned and operated and they, as well as the regional freight system as a whole, face challenges to their continued success. Decaying infrastructure and a declining workforce present issues to freight’s future. Connected and Automated Vehicles (CAV) offer potential solutions to both.

The ports of Savage will need to adapt to accommodate the introduction of CAVs. This new technology will transform how the land in the surrounding region is used. These changes will not be instantaneously and adaptations can be phased into the site and surrounding region. A decreased need for pavement allows increased greenspace and can help protect the Savage fen while simultaneously opening the space for recreational use. Additionally, new types of intersection controls can relieve traffic congestion and make moving semi-trucks out of the ports on to Highway 13 easier.

The ports of Savage can benefit from CAVs by encouraging an educational and training museum on land reclaimed from paved surfaces. The Minnesota Department of Transportation (MnDOT) is looking for Requests for Proposals on studying CAV innovations on the regional highway system. MnDOT and Scott County can benefit from studying CAVs in a freight intermodal environment such as that found at the ports.
Connected and Autonomous Vehicle (CAV) technology is likely to be impactful on the transportation landscape within cities. Surprisingly few municipalities are developing strategic policies and ordinances to guide CAV disruption. CAV deployment could exacerbate social and economic disparities within cities by serving only affluent interests. **Planning for Disruption allows for policy and development suggestions that actively work toward addressing inequities.** The project offers scenarios along the Washington Avenue corridor through the Mill District, a downtown core T6 context, and the Lake Street corridor through the Powderhorn area, a main street T5 context. With a Minneapolis context, we utilize the Minneapolis 2040 Comprehensive Plan to establish goals.

The project begins with a review of processes and planning documents guiding AV implementation to-date. Next, the project moves to an analysis of the demographic and structural frameworks of the two study areas to identify existing disparities and opportunities for equity. Next, the background information is incorporated to develop and deploy five equity opportunities within CAV implementation: **Improve the Environment, Increase Housing Access, Increase Mobility, Support Diverse Economies, and Improve Public Health.**

Finally, opportunities for equity are explored through a series of design scenarios for CAV implementation. We conclude by suggesting **phasing strategies for future development** and a summary of proposed policies. In doing so, we aim to illustrate strategies for guiding CAV deployment in order to **address disparities** within cities while **improving conditions** overall.
The CAV Urban Village

Canterbury Park is an entertainment destination offering horse racing, table games, and poker in Shakopee, MN, a suburb of the Twin Cities. Recently, plans have been enacted to build high-end housing near the site. Canterbury Park real estate developers hope to promote what they describe as the “Canterbury Experience” by attracting additional commercial and entertainment development, as well as hotels for tourists to stay nearby. The master plan for the area maintains a 45-acre parking lot, with approximately 10,000 parking spaces, near the Canterbury Park horse racing track.

In this project, we consider the master plan for Canterbury Park in the context of a rapidly approaching future where Connected and Autonomous Vehicles (CAVs) dominate the transportation landscape. Due to a significant decrease in the amount of parking needed by CAVs as compared to human drivers, Canterbury Park’s 10,000-space parking lot will be rendered obsolete. This presents an opportunity to rethink the possibilities for this space.

Our neighborhood plan incorporates the design principles of people-centered design, green space, mixed-use development, and diversity of housing options, in order to enhance the “Canterbury Experience.” We evaluate the existing master plan, articulate a CAV design framework, and apply it to create a neighborhood plan for an urban village in what is currently a 45-acre parking lot. Our project provides a case study in recalibrating a master plan in the context of a CAV-oriented future.

The CAV Urban Village: Recalibrating the Canterbury Commons Master Plan

Emily Houser / Koehl Simmons / Forrest Steinhoff / Ari Del Rosario
The advent of connected autonomous vehicular (CAV) technology marks the next great transition in our transportation networks. **CAVs have the potential to create more reliable transportation systems** that can dramatically improve roadway safety for everyone. The American Planning Association estimates **50% of cars will be fully automated by the year 2040**. Planning for these changes can help communities harness the many benefits of CAV technology and address the various obstacles to equitable implementation.

The potential for CAVs to **improve safety, efficiency and accessibility** will result in dramatic changes to our transportation networks. This project explores the impacts of CAV technology on pedestrian safety in Scott County by envisioning four phases of CAV implementation in the city of Shakopee. The four phases of CAV implementation are represented through renderings of the same intersection as it changes over time.

To identify potential changes, we analyzed the impacts of CAV technology on land use, infrastructure, policy, and the environment in order to answer the question: **how Scott County can maintain consistency in the design, engineering, and construction of its transit network to ensure pedestrian safety and promote comfortable interactions between pedestrians and CAVs?**
How can Scott County provide equitable, inclusive public transportation for residents needing door-to-door transit services in rural areas?

Shared Mobility for All? Is a project proposal by Scott County to address the shared mobility needs of senior residents. As Babyboomers - the most populous generation in the U.S. - matures, the demands on shared mobility will increase. By examining this issue in the context of connected autonomous vehicles (CAVs) we clarify the assumptions made by shared mobility literature and challenges faced by riders. The three communities in our study, Shakopee, Jordan, and Belle Plaine, are included for their representation of unique demographics along the Highway 169 corridor.

We use the following qualitative research strategies to inform land use planning recommendations: (1) a survey to be administered on bus routes in Scott County, (2) a participatory mapping exercise, and (3) stakeholder interviews.

We then analyze our data and include a document analysis with field notes and precedent cases. Our findings challenge the assumption that shared mobility efforts should focus solely on senior citizens; we instead argue they should be tailored to the needs of low income and disabled persons, which often include seniors. We make six distinct recommendations for shared mobility in Scott County, and recommend that qualitative data collection continues as part of a more holistic and inclusive approach to planning for a future with CAVs.
A Renaissance in Transportation examines how connected autonomous vehicles (CAVs) could improve regional connectivity between Minneapolis and rural Minnesota. As a case study, we look at the journey on U.S. Highway 169 from Minneapolis to the new site of the Minnesota Renaissance Festival, which will be located just outside of Jordan, MN. New technology, such as CAVs, often reaches rural regions well after urban ones due to the lack of wireless infrastructure in the region. Rural regions also require the technology to serve needs that may not necessarily be addressed in an urban context requiring the technology to be tailored towards these specific needs. With population increases expected over the next twenty years, we are proposing rural Minnesota update its transportation system for a CAV future that will accommodate the future population increase of Scott County.

In our recommendations, we highlight how the decreased need for parking associated with CAVs will allow current parking garages to be retrofitted and transitioned into an office space, parking hybrid structure. Next, in order to better connect these rural areas, we propose transitioning park and ride structures into rural public transportation networks that can connect these previously unconnected regions to public transportation. Additionally, in order for CAVs to enter rural areas, a network of 5G cells will need to be installed along major travel corridors such as Highway 169. Finally, we review how parking lots that will no longer be needed could be used as a CAV maintenance hub in rural areas, providing storage, upgrades, and general maintenance work for CAVs.
Appendix

The following Appendix contains:
• Notes - Section for note taking during the Open House Exhibit
• Various photos during the Land Use Planning course (Fall 2018)
• Floorplan of the Mondale Atrium and layout of poster session
• Student Posters
**Freight for the Future**

The Ports of Savage as a CAV Innovation District

The Ports of Savage have made midwestern grain and mineral products economically competitive for decades. This project reimagines the Ports of Savage by considering their current port/freight land uses through the introduction of connected and autonomous vehicles (CAVs). Our posters explore the port setting and operations, suggest new ways to implement CAVs, and apply MnDOT's CAV Challenge RFP as a visioning framework. We begin by understanding the existing operations of the port and identifying stakeholders.

The ports are owned by private companies, creating governance challenges.

The ports are located close to the Twin Cities to allow ease of shipping to urban jobs but far to maintain a rural character.

Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, © OpenStreetMap contributors, and the GIS User Community

**Who owns the Ports and what do they do?**

The ports are owned by private companies, creating governance challenges.

- **Cargill**
  - Shipping goods, research and development, processing goods

- **CHS**
  - Shipping goods

- **Mosaic**
  - Shipping and processing goods

- **Superior**
  - Shipping and processing goods

- **Ceres**
  - Shipping goods

**TWIN CITIES**

SCOTT COUNTY

CARVER

HENNEPIN

DAKOTA

ANOKA

RAMSEY

WASHINGTON

**Study Area**

The Ports of Savage are currently active, industrial sites. Founded in the mid-twentieth century with the dredging of the Minnesota River for barge shipping, the site continues to make the small town of Savage, MN an economic power house.

**Dave Braun**

@MNHunter75 follows you
Father, hunter, American.
Savage, MN

Dave lives in Savage and works at one of the ports. He will be tweeting commentary about the proposal as we move along.

**How will autonomous vehicles change the freight shipping process?**

**Transportation Patterns**
- Eliminating drivers and their errors
- Changing intersection operations
- Designed long for freight

**Streamline Deliveries**
- Shift schedules to lower-traffic times
- No longer limited by driver schedules

**Government Regulation**
- Inspection schedules
- Infrastructure to vehicle communication
- Environmental protection

**Shipping Efficiency**
- Autonomous barge towing
- Streamline barge towing scheduling

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Local Land Use

Freight for the Future

The land use surrounding the Ports of Savage has inefficiencies. The ports create a buffer between the Minnesota River and the City of Savage, limiting use for residents and visitors. While the size of each port site is large, significant portions of the land are located in the floodplain of the Minnesota River. Given these constraints, what changes in land use would ensure the protection of the environment, increase access, and provide more benefits to all stakeholders?

Zoning Near the Ports of Savage: A disconnect?

We propose turning the Ports of Savage (shown in purple as "industrial") and the area surrounding Highway 13 into an innovation district. This area will allow for more mix of land uses and gear at the needs of both industry and residents as they transition to a CAV future. Currently, the corridor uses Euclidean zoning. The introduction of a performance-based code allows for mixed uses.

14 ZONES EUCLIDEAN ZONING

The current zoning in and near the Ports of Savage is complex and rigid, ill-suited for the uncertain future of autonomous vehicles.

4 ZONES PERFORMANCE-BASED CODE

The four zones reflect the current community of Savage but push it to be ready for an autonomous vehicle future.

The Ports of Savage demonstrate a typical American land use pattern. Making them more flexible can make the ports more open to innovation. Understanding the current and future needs of freight operators is important to consider how policy changes.

NEXT STOP

PA 5211: Land Use Planning

Shannon Engstrom, Patrick Haney, Jacqueline Nowak, Yuyan Wang

Instructors: H. Fernando Burga, Ph. D, Chris Desroches
Local State of Freight

Freight for the Future

The movement of freight through the Ports of Savage is complex. Each port ships its own specific goods including grain, rock, fertilizer, and salt. Some ports ship their products downstream while others have their products delivered from downstream. Goods come in and out on land via truck and rail. Maintaining the efficiency of an integrated rail, road, and river transportation system is critical to keeping local industries competitive. What are current operations at the Ports of Savage?

What is the scale of goods moving through the Ports of Savage?

- **20%** of Total Twin Cities Freight
- **16%** of River Freight in MN
- **3%** of River & Lake Freight in MN

How many trucks do the Ports of Savage keep off roads annually?

- **160** Fertilizer
- **114** Aggregate
- **80** Salt

How many trucks are kept off the road with one barge?

- 1 barge = 16 railcars
- 1 rail car = 2.5 semis

about 70!

What are current operations like at different port sites; how are they similar and different?

**Mosaic Crop Nutrition & Cargill**
- Two independent ports share a common site
- They store fertilizer and salt in covered open air structures
- Trucks transport goods from barges to storage
- Rail (including unit trains) bring large amounts of goods
- They sell salt to MnDOT and other entities for maintaining roads
- They sell fertilizer to farming co-ops
- Independent farmers bring grain in their own trucks
- Grain products require inspection
- Grain stored in enclosed structures
- Grain shipped out via barge
- Active rail lines to sites
- Grain primarily travels to New Orleans
- End buyers are global commodity traders

**CHS, Inc.**
- Site exclusively handles grain
- Low traffic onsite
- Opportunity for innovation district improvements

**Superior Minerals**
- Processing and distribution center for rock too small for other uses
- Empty and clean barges to be grain ready
- Store rock in open piles prior to processing
- Grind rock down onsite for resale
- Buyers of rock products contract fleet services to pick up rock via truck
- End buyers are local asphalt shingle producers and animal feed companies
- No use of rail for shipping
- Sites contain a single industry
- Material transferred onto or removed from barges via conveyor system
- All site functions significantly limited by flooding

We know the scale of freight traffic in and out of the ports of Savage and how it is transported. Now we turn to freight and autonomous vehicles at the state level and how traffic congestion might change in the near future.
Regional State of Freight

Freight for the Future

The Twin Cities regional economy relies on the successful operation of its freight system. Businesses of all types send and receive freight regionally and across the country as part of their business operations. There are many components to the Twin Cities freight system, and the system faces potential challenges that might undermine its successful operation. **What are private and public sector groups doing to prepare the freight industry for CAVs?**

The Twin Cities’ Metropolitan Freight System

- **750 MILES of Railroad Track**
  - Four out of the seven Class I freight railroads in the United States operate in the Twin Cities.
  - Multiple providers create price competition for shipping.
  - Any change to the freight system will need to coordinate with rail.

- **900 MILES of Highway System**
  - Trucks in the Twin Cities operate on almost every major road and in every industrial area.
  - Will be most affected by autonomous technology implementation.
  - Expensive in terms of emissions, congestion, and roadway degradation.

- **229,440 metric tons of cargo pass through MSP in 2017**
  - Airplanes carry freight primarily into the Minneapolis - Saint Paul International Airport, but six other reliever airports can also provide service.
  - Airports provide long distance, but energy-intensive shipping.
  - Do not directly compete with ports for shipping.

- **1,811 MILES To PORT of NEW ORLEANS**
  - The Twin Cities is the furthest point commercial river freight can go on the Minnesota and Mississippi Rivers.
  - The Mississippi River system forms a path for more than half of U.S. grain.
  - Maintenance of the Ports of Savage by the Army Corp of Engineers allows farmers in rural Minnesota and Wisconsin to ship their crops at competitive prices.

What is the state government’s role in the freight industry?

- The Governor’s Advisory Council on Connected and Automated Vehicles is consulting with stakeholders about the impacts and requirements of CAVs on infrastructure, data privacy and security, registration and regulations, economic development and equity.

- MnDOT has released a CAV Challenge RFP which requests projects that develop and demonstrate CAV technologies.

- Freight will be significantly impacted by new technologies. Testing of new technologies in freight systems is critical to their success and the continued strength of freight industries in Minnesota.

- An Innovation District around the Ports of Savage can create opportunities to test technologies and replace lost freight training and education facilities.

Now that we understand the regional freight system, let’s look at the state of freight and CAV **innovation** across the country.

**NEX**

**STOP**

PA 5211: Land Use Planning
Shannon Engstrom, Patrick Haney, Jacqueline Nowak, Yuyan Wang| Instructors: H. Fernando Burga, Ph. D, Chris Desroches
Wow...problems in freight could really impact my job at Amazon...and at the ports.

The freight industry is facing serious challenges: CAVs will solve and exacerbate some of them. Now that we understand current freight challenges, let’s review our findings, our process and then look at how we can apply some solutions to the Ports of Savage.
Findings and Process

Freight for the Future

Literature reviews, in-person interviews and site visits were critical to our understanding of freight operations at the Ports of Savage. Below we review our process to propose the special innovation district. Given the lack of examples for CAV-oriented port/freight innovation districts, our observations were in the form of many questions. What is the relationship between the Ports of Savage and the surrounding community? How will freight change in rural v. urban America? How can CAVs improve rural transportation network challenges? What are the existing issues at the ports from each stakeholder’s perspective (company, government, resident)?

Literature Review

We narrowed our focus for the literature review to local and state documents.

Site Visits

Three Port operators gave us tours of their facilities so we could better understand their facilities and the operating challenges they face. Port staff gave us personal tours which helped give us insight into how CAVs may change their facilities. Below we highlight each of the three visits and how they are potentially impacted by CAVs.

<table>
<thead>
<tr>
<th>Site Visit #1: CHS, Inc.</th>
<th>Site Visit #2: Superior Minerals</th>
<th>Site Visit #3: Mosaic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grain elevators already have some automation, but how might CAVs increase this?</td>
<td>Crane removes rock from barges and places it on conveyors. This minimizes labor costs which also may happen with CAVs.</td>
<td>Trucks are weighed at stations in a largely automated manner. Could CAVs automate this even further?</td>
</tr>
<tr>
<td>Vast paved surface lots may be repurposed with the introduction of CAVs due to decreased land requirements.</td>
<td>Rock is automatically dispensed into trucks based on codes entered by drivers. This process could be completely automated in the future.</td>
<td>Fertilized is dispensed in an automated manner after manual loading of dispensers. CAVs could continue this automated process.</td>
</tr>
<tr>
<td>Safety is a top priority for the ports and CAV technology may improve safety even further.</td>
<td>Rock is loaded via human-driven loader into machines that grind and separate it by size. This task could be automated in the future.</td>
<td>Mosaic and Cargill share a site and entry from TH 13. CAVs destined for both companies can take advantage of shared infrastructure.</td>
</tr>
<tr>
<td>Currently farmers own and operate their own trucks. Will CAVs change this model?</td>
<td>Sensors on the conveyor automatically prompt it to move once the pile gets too high. CAVs will similarly have automatic adjustments to their environment.</td>
<td>A chaotic environment could be made safer by CAVs.</td>
</tr>
<tr>
<td>Trucks are driven over grates to dump their grain. Will those trucks no longer need drivers in the future?</td>
<td>Rock piles are in constantly changing locations. CAVs will be able to adapt to their location in any situation.</td>
<td>Up to 600 trucks a day may enter the site. Directions currently given to humans might better be given to CAVs.</td>
</tr>
</tbody>
</table>

Our next posters offer a schematic proposal for MnDOT’s CAV Challenge. Now that we understand our process and initial findings, let’s take a look at the existing conditions.
Numerous challenges are present at and around the CHS site. Solutions brought forth by the innovation district can help improve traffic safety, freight operations, and environmental protection in the area. Next, let’s take a look at some specific design scenarios and how they can be implemented over time.
The Ports of Savage could face dramatic changes over the next several decades as CAV technology develops. There are many ways the sites may change and not every port site in Savage will undergo the same treatment. Rather, design and operational changes can be selected on a case-by-case basis. These changes will be implemented in stages as new technology is introduced. How could these types of implementation occur in the innovation district?

**Goals/Purpose**

<table>
<thead>
<tr>
<th>Phase</th>
<th>Phase 1: Pre-CAV</th>
<th>Phase 2: Intensive CAV Testing</th>
<th>Phase 3: CAVs Commercially Available</th>
<th>Phase 4: &gt;70% Market Share</th>
<th>Phase 5: CAV Fleet Companies Emerge</th>
<th>Phase 6: Public CAV Fleet Acquisition</th>
<th>Phase 7: Future CAV Innovation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Preparation for CAVs</td>
<td>More capital intensive projects can be done in the longer term while CAV technology is still being tested. More efficient use of land and more technologically advanced infrastructure can occur at this stage.</td>
<td>Phase 2: Intensive CAV Testing</td>
<td>Phase 3: CAVs Commercially Available</td>
<td>When automated vehicles have almost universal adoption, governments can change infrastructure such as road lanes due to the precision of automated vehicles. Intersection controls will be fully automated.</td>
<td>Phase 4: &gt;70% Market Share</td>
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</tr>
<tr>
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<td>After wide scale CAV implementation, private industry can begin to develop new uses for CAVs to improve efficiencies and reduce costs.</td>
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<td>Phase 6: Public CAV Fleet Acquisition</td>
<td>At the final phase new and innovative forms of vehicle technology can be implemented that benefit private enterprise and the public.</td>
<td>Phase 7: Future CAV Innovation</td>
</tr>
</tbody>
</table>

**At each phase, we might expect...**

- **Phase 1: Pre-CAV**
  - Preparation for CAVs can start today and there are several treatments that can start before CAV are widely adopted.

- **Phase 2: Intensive CAV Testing**
  - More capital intensive projects can be done in the longer term while CAV technology is still being tested.
  - More efficient use of land and more technologically advanced infrastructure can occur at this stage.

- **Phase 3: CAVs Commercially Available**
  - When automated vehicles have almost universal adoption, governments can change infrastructure such as road lanes due to the precision of automated vehicles. Intersection controls will be fully automated.

- **Phase 4: >70% Market Share**
  - When automated vehicles have almost universal adoption, governments can change infrastructure such as road lanes due to the precision of automated vehicles. Intersection controls will be fully automated.

- **Phase 5: CAV Fleet Companies Emerge**
  - After wide scale CAV implementation, private industry can begin to develop new uses for CAVs to improve efficiencies and reduce costs.

- **Phase 6: Public CAV Fleet Acquisition**
  - Public transportation could be improved once CAV trucks are perfected and new uses for the vehicles are sought.
  - Private industry will likely lead the way with encouragement or subsidy by the government.

- **Phase 7: Future CAV Innovation**
  - At the final phase new and innovative forms of vehicle technology can be implemented that benefit private enterprise and the public.
The proposed changes to the Ports of Savage within the innovation district are exciting but by no means guaranteed. Fortunately, a request for proposal put out by MnDOT could allow for changes to be implemented. Next up, let’s look at how this proposal fulfills goals put forth by MnDOT.

With implementation of incremental change complete, the area surrounding the Ports of Savage will be transformed. What was once an overlooked yet instrumental area will be a hub for learning about connected and autonomous vehicles and the importance of freight transportation. What might the Ports of Savage look like in the future of connected and autonomous vehicles?

**Freight for the Future**

With implementation of incremental change complete, the area surrounding the Ports of Savage will be transformed. What was once an overlooked yet instrumental area will be a hub for learning about connected and autonomous vehicles and the importance of freight transportation. What might the Ports of Savage look like in the future of connected and autonomous vehicles?

**Pedestrian Infrastructure**

No pedestrian infrastructure currently exists surrounding the ports. Adding an elevated pedestrian and bike trail around the ports sites, along TH 13, and adjacent to nearby wetlands will help connect pedestrians to both the ports and natural areas.

**Green Open Space**

Much of the land surrounding the ports is wetlands and is not needed for operation of the ports. This space can be better used by transforming unused paved surfaces to natural plantings and whenever safe, opening up the space for the public.

**Education Center**

As CAVs will reinvent how we look at transportation in the region, an educational component to using and understanding CAVs will serve Scott County well. A museum and educational space can help community members understand the changes and train people to use CAVs. The center can also tie into new outdoor pedestrian spaces near the river.

**New Intersection**

The conversion to CAVs will change the infrastructure needs of the surrounding area. CAVs will reduce the amount of paved surface dedicated to transportation and new intersection controls will be needed to connect with vehicles.
Conclusion

Freight for the Future

CAVs will cause significant changes in transportation in Minnesota. The Ports of Savage can be reconsidered to adopt CAVs and the changes they will cause. In this poster we connect our previous analysis and proposal to MnDOT's CAV RFP goals.

Minnesota Department of Transportation CAV Challenge

MnDOT has a RFP for a CAV Challenge to study CAVs on state roads and facilities. The Ports of Savage offer a great opportunity to study CAV and the impact freight can have on the regional transportation system. Below are the 5 principles that MnDOT proposes for their RFP and how they connect to our proposal.

1. How can Minnesota leverage P3s to advance transportation opportunities?
   The private function of the ports and the public RFP are an example of a public-private partnership. We demonstrate this link throughout our posters.

2. How can Minnesota prepare its infrastructure, policy, and workforce for CAVs?
   Poster 2 shows how Scott County can begin to prepare Minnesota for CAV technology.
   Our phasing of infrastructure improvements for the ports shown in Poster 8 give an example of how the site can prepare the infrastructure required for CAVs.

3. How can the public better understand the benefits and limitations of CAV technology? How can the state provide opportunities for the public to give input, experience CAV technology firsthand, and provide feedback?
   Scott County residents will be able to give input and feedback to CAV related changes as related in Poster 2.
   Scott County residents will be able to give input and feedback to CAV related changes as related in Poster 2.
   Our findings shown in Poster 6 explain how the benefits and potential impacts of CAV technology will impact the site.
   The education center shown on Poster 9 can be a hub for teaching new information related to CAVs.

4. What ways can the state allow private industry opportunities to test and deploy advancing CAV technology?
   The Ports of Savage are privately owned and Poster 3 shows how they can benefit from opportunities to deploy CAV technology.
   The national concerns of the freight industry shown in Poster 5 demonstrate how private industry can aid from CAV technology.

5. How can the state accelerate implementation of CAV technology?
   As shown in Poster 4, the regional freight system can benefit from an accelerated implementation of CAV technology.
   The existing conditions of the ports can be challenging as displayed in Poster 7 and the accelerated implementation of CAV technology can assist.

CAVs change the freight community. Scott County along with the Ports of Savage can benefit when adapting to these changes by planning ahead and considering phasing in policy and infrastructure improvements. Preserving the surrounding natural environment and providing an educational component to the area will ensure Scott County has a successful transition as the technology is adopted.
Planning for Disruption
The Journey Begins

Equitable CAVs on Washington Avenue and Lake Street

The American Planning Association predicts that highly and/or fully Connected and Autonomous Vehicles (CAVs) could represent a quarter of our vehicle transportation systems within 15 years, yet cities have been slow to plan for CAV deployment. Minneapolis is no exception. The general manager of Metropolitan Transportation Services recently stated that “any change in investment to autonomous vehicles is a long way off and priority will remain on... preservation of our current infrastructure.” With CAV implementation approaching, now is the time for Minneapolis to consider opportunities and vulnerabilities to ensure optimal outcomes.

Project Goal

CAVs are only mentioned once within one policy of the Minneapolis 2040 Plan. This project illustrates how Minneapolis can leverage the adoption of CAV technology to further their 2040 Comprehensive Plan Goals.

Moving Forward

We will develop design scenarios showing AV adoption along Washington Avenue (T6) and Lake Street (T5), accompanied by policy recommendations for the Minneapolis 2040 Plan. The design scenarios will be informed by an analysis the Minneapolis 2040 Plan in relation to CAV adoption and the current demographic and physical conditions of the key corridors. This approach allows the consideration of the equity impacts of CAVs-driven changes in each context.

The Corridors

Washington Avenue

The Transect 6 analysis is of the Washington Avenue corridor between Hennepin Avenue and I-35. This section of Washington runs through a dense urban core that will likely be an early adoption site for CAVs. The Minneapolis 2040 Plan envisions this corridor as one of the densest parts of downtown, a destination area with diverse uses. As CAVs play a larger role in access, Minneapolis must consider who will be included and who will be left out of innovation.

Lake Street

The Transect 5 analysis is of the Lake Street corridor from Chicago Avenue to Hiawatha Avenue. This section of Lake Street is a commercial corridor running through urban neighborhoods with a high percentage of immigrants, people of color, and low-income residents. It is a destination for surrounding residents to access local businesses, services, and transit options. These characteristics create opportunities to adopt CAVs by supporting local businesses and serving people who are often left out of the planning process.

Guiding Questions

How will CAVs challenge current policy and planning strategies?
Why is it important to consider CAV adoption in comprehensive plans?
What aspects of the Minneapolis 2040 Comprehensive Plan can benefit from CAV adoption?
What opportunities does CAV adoption present for increasing equity?

How will CAVs alter current activities and land uses?
What are each area’s demographics?
What commercial, cultural, and transit hubs exist along each corridor?
What are current conditions regarding transit, land use, public realm, and green space?

What future policy solutions are available?
What are examples of positive CAV-driven changes to the public and private realm along each corridor?
How can these changes be phased in the short, medium, and long-term?
What policies are needed to promote the realization of these scenarios?
Planning for Disruption

Comprehensive Planning

How can comprehensive planning guide the forthcoming CAV disruption?

Despite the imminent arrival of CAVs, few comprehensive plans currently contain CAV policy language. Some cities include CAV-related policies in their transportation plans; however, the potential disruption caused by CAVs extends far beyond transportation.

The American Planning Association (APA) defines a comprehensive plan as “the foundational policy document for local governments. It establishes a framework to guide public and private decisions about future growth, preservation, and change within a municipality or county over the next 20 to 30 years... discussing a wide range of economic, environmental, and social topics that affect the sustainability of a community.”

Potential Outcomes of CAV Disruption

Experts predict that CAVs will operate under a shared fleet model; they will require fewer and narrower lanes than driven vehicles and that they will be electric. These assumptions frame the potential for wide ranging impacts on areas traditionally included in comprehensive planning.

<table>
<thead>
<tr>
<th>Potential NEGATIVES</th>
<th>ANALYSIS</th>
<th>Potential POSITIVES</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Land Use:</strong></td>
<td>Increased sprawl due to ease of travel</td>
<td>While the nature and impacts of CAV rollout are largely unknown, planners and policymakers can guide their adoption towards positive outcomes.</td>
</tr>
<tr>
<td><strong>Environment:</strong></td>
<td>Increased VMT &amp; emissions due to ease of travel</td>
<td>Land Use: Repurposing formerly car-dominated spaces</td>
</tr>
<tr>
<td><strong>Transportation:</strong></td>
<td>Less funding for transit systems</td>
<td>Environment: Rideshare, electrification reduce VMT &amp; emissions</td>
</tr>
<tr>
<td><strong>Health:</strong></td>
<td>Negative public health impacts due to decreased in active transport</td>
<td>Transportation: Reclaimed public right of way for pedestrian/bike/transit</td>
</tr>
<tr>
<td><strong>Equity:</strong></td>
<td>Unequal adoption locations that increase disparities in transportation access</td>
<td>Health: Positive public health impacts due to improved traffic safety, better active transport infrastructure, and increased public green space from reclaimed ROW</td>
</tr>
</tbody>
</table>

Precedent Policies and Standards

While precedents for comprehensive plan policies addressing CAVs are lacking, there is guidance from transportation experts at the national and state levels. The concepts derived from these documents guide our thinking throughout this project.

Planning for Autonomous Mobility: This APA report synthesizes current research on the benefits, challenges, and opportunities that CAV adoption will create, and suggests ways that planners can respond.  

US DOT Comprehensive Guide: The Guide provides a framework and multimodal approach for the safe integration of CAVs into the Nation’s broader surface transportation system.

NACTO Blueprint for Autonomous Urbanism: The Blueprint illustrates policy goals for CAVs using renderings and diagrams, providing alternative visions for the future.

MNDOT Advisory Council: The Governor established a task force that has completed recommendations for various policy adjustments throughout Minnesota to prepare for CAV deployment.

Chandler AZ Zoning Code: Local municipalities are beginning to rethink parking requirements and to develop pick-up and drop-off zones ahead of CAV deployment.

Comprehensive Planning Policy Implications

By considering CAV adoption in comprehensive planning, cities can ensure that the introduction of CAVs supports rather than hinders the achievement of comprehensive planning goals. Next we turn to the analysis of the corridors that define our transect zones. Afterwards, we investigate how CAV adoption can support the goals of the Minneapolis 2040 Plan and how we can apply an Equity Lens to planning for a CAV future.
Planning for Disruption

Land Use & Built Form Analysis

The Future Land Use and Built Form maps in the Minneapolis 2040 Plan illustrate the city’s vision for the use and scale of future development, in pursuit of the of housing, employment, transportation, and transit access goals for all by 2040. The Future Land Use map guides types of uses allowed on a parcel, and the Built Form map guides the scale of development allowed on a parcel. CAV policy must consider the guidance of the 2040 Plan to insure that CAV-driven changes enhance the anticipated future conditions of the area.

Washington Avenue Maps (T6)

Two mixed-use categories along the corridor:
- **Destination Mixed Use**: commercial retail at street level
- **Public, Office, Institutional**: Offices; public/semi-public uses (museums, hospitals, civic, etc.); multi-story residential permitted, mixed-use encouraged

CAV Implications

This stretch of Washington Avenue is mostly designated “Destination Mixed Use,” surrounded by Public, Office, and Institutional uses. The requirement for street-level commercial retail, and the high-density built form types, allow continued development into a destination corridor with high traffic from pedestrians, transit riders, and drivers throughout the day. CAV implementation creates opportunities to further improve multi-modal transit infrastructure, enhance the pedestrian experience, increase and diversify business and housing types, expand green space, and create a more pleasant environment for those who live and spend time in the area.

Lake Street Maps (T5)

Three mixed-use categories dominate the corridor:
- **Destination**: Commercial retail at street level
- **Community**: Active, public uses at street level
- **Urban Neighborhood**: Residential; scattered institutional, semi-public uses

CAV Implications

This stretch of Lake Street is designated as “Mixed Use” types, surrounded by “Residential Urban Neighborhood”. While considerably less dense than Washington Avenue, the 10- and 6-story height allowances of the “Transit 10” and “Corridor 6” districts will allow increased residential and business density along what is already a local destination corridor. CAV implementation creates opportunities to reclaim auto-dominated space for bike infrastructure, improved pedestrian and business environment, recreational and social spaces, and improved transit access for surrounding residents.

Land Use & Built Form Policy Implications

CAV policy for both corridors should support a “Complete Street” vision that prioritizes active transportation and transit over single-occupancy vehicles, requires safe and efficient pick-up and drop-off zones, and ensures that improvements to the public realm support local businesses and make streets more accessible and welcoming to all users. We will explain these concepts further in Posters 9-20.
Planning for Disruption

Washington Corridor Analysis

The current conditions of Washington Ave will inform where CAV impacts will be most positive or negative in the corridor. In this poster, we analyze transportation, land use, and open space conditions in the corridor to identify locations for our design scenarios.

Transportation & Mobility

With highway access near both ends of the corridor, Washington is a major thoroughfare for cars, express buses, and freight. CAV implementation can decrease car traffic and increase efficiency for the other transportation modes. There are various uses and destinations along and adjacent to the corridor that increase local bus, bike, and pedestrian access. There is an opportunity to establish pick-up/drop-off zones for CAVs that coincide with transit hubs.

Land Uses & Frontages

Land uses define travel behaviors and destinations along Washington. Office, institutional, and residential uses generate traffic at typical rush hour periods of the day. However, commercial and mixed uses generate traffic throughout the day into the late evenings. We can look at frontage types to inform where the pedestrian experience can be improved.

Pavement & Green Space

If CAVs decrease pavement requirements, they could create more substantial green spaces along the corridor to improve pedestrian experience. Though Gold Medal Park is just a block away, it does not compensate for the abundance of surface concrete along Washington. As the required right-of-way shrinks, there is also potential to include natural storm water treatment systems along the corridor to protect water quality of the Mississippi River.

Washington Corridor Analysis Implications

The maps presented in this poster will inform the locations and goals of our design scenarios. There are many characteristics in the Washington corridor that could be improved by CAVs.
Planning for Disruption

Lake Street Analysis

The Lake Street corridor runs from the edge of St. Louis Park in the West to the Mississippi River in the East. We have selected a small segment of the larger corridor to analyze from the perspectives of land uses, transportation infrastructure, and green space. Due to challenges described in previous posters, we will be using the following analyses to understand how this area is likely to be impacted by CAVs and inform the design scenarios in later posters.

Transportation & Mobility

The Lake Street corridor runs from the edge of St. Louis Park in the West to the Mississippi River in the East. We have selected a small segment of the larger corridor to analyze from the perspectives of land uses, transportation infrastructure, and green space. Due to challenges described in previous posters, we will be using the following analyses to understand how this area is likely to be impacted by CAVs and inform the design scenarios in later posters.

Land Use & Frontages

Lake Street has minimal lots with residential uses but large numbers of commercial, industrial, and institutional uses. The surrounding neighborhood is heavily residential making walkability to these locations critical to ensure the access. As evident by the frontage conditions, walkability could benefit from the activation of pedestrian space and the reduction of auto traffic. The frontage types vary from industrial and commercial developments that have sealed frontages and porous frontages that have intentional public uses (such as the Midtown Global Market).

Pavement & Green Space

The volume of parking spaces along the corridor indicates that the area is car-centric. When compared to that of Washington Avenue, the amount of green space along Lake Street is minimal, and not necessarily accessible to the populations in the area (such as a graveyard and a high school track). The increase in permeable and green space with the advent of CAVs could improve the green space along the Lake Street corridor, but equity concerns about gentrification and increased rents for local businesses would need to be considered.

Lake Street Corridor Analysis Implications

Due to the businesses, transportation, and central location, Lake Street is a popular destination within the midtown area. If CAVs bring increased mobility and green space, local stakeholders should be engaged to identify new policies and strategies. Policies involving CAVs would benefit from using existing infrastructure and other local resources in addition to the design of new informal spaces, and the increase of green space along the corridor.
# Washington Demographics

Who will benefit from the CAV disruption on Washington Avenue?

## Photographic Timeline

Lithograph of the Mill District ca. 1895 | View of the west side Mill District looking north ca. 1904 | Surface parking along the north side of Washington Avenue looking east ca. 1907 | The Mill District in mid-development in 2007 | New residential units along Washington Avenue looking west.

## The Industrial Heart of Minneapolis

This poster examines S Washington Avenue from the end of Cedar Avenue over 35W heading northwest until Hennepin Avenue. As part of the former Mill District, the area was the center of Minneapolis' flour milling industry and the home of working class residents. Washington Avenue was demolished during the “Urban Renewal,” of the 1960’s. The rail lines that once served the mills were severed by the construction of the Metrodome in 1979 and by 1990, the area was lined with surface parking lots. In the late 90’s the city focused on revitalizing the area, turning old factories into expensive lofts and offices.

## Race

<table>
<thead>
<tr>
<th>Population Density by Race</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
</tr>
</tbody>
</table>

## Poverty

<table>
<thead>
<tr>
<th>% of the Population Below 150% of the Poverty Line</th>
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</thead>
<tbody>
<tr>
<td>&lt; 17%</td>
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</table>

## Education

<table>
<thead>
<tr>
<th>% of the Population with a Bachelors Degree or Higher</th>
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<tbody>
<tr>
<td>&lt; 9%</td>
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## English Fluency

<table>
<thead>
<tr>
<th>% of the Population with Limited English Proficiency</th>
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</thead>
<tbody>
<tr>
<td>&lt; 2%</td>
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</table>

## Demographic Findings

Washington Avenue is sparsely populated, but there are concentrations of white residents on the west end in condo developments across Hennepin Avenue. **Other populations an even mix of white and black residents** in South Downtown and the heavily Somali Cedar Riverside neighborhood.

While most of downtown is relatively affluent, the areas across I-35W and in South Downtown have high levels of residents living below 150% of the poverty line.

## CAV Implications

The impact that CAVs have along Washington Avenue will effect how it relates to the less prosperous communities around it. Currently, **development has focused on serving the wealthy and white population of Downtown**.

If Washington Avenue is redeveloped with increasing spacial equity and affordability in mind, it can become a diverse destination for all of Minneapolis.

Washington Avenue is not primarily a residential district, and will be the destination rather than the origin of CAV trips.

### Washington Avenue Demographic Analysis Implications

Recent development around Washington Avenue has created a place with income and racial disparity. Will AV networks serve areas where low-income people of color in Minneapolis live, work, and play? Or will their expensive prices further isolate these communities from harnessing them?

If the area is adapted for CAVs without equity goals in mind, marginalized groups will continue to closed off from downtown. In our design scenarios we will explore this question through the voice of our equity figure, Jerome Clark.
Planning for Disruption

Lake Street Demographics

Who will benefit from the disruption of CAVs on Lake Street?

Industrial Past

In the late 19th century, Minneapolis underwent a wave of immigration from Norway, Greece, Sweden and Denmark. In 1881, the Chicago, Milwaukee, St. Paul and Pacific Railroad Corridor, a railroad system used to transport goods in the midwest, was built near Lake Street. Manufacturing, industry, and wholesale goods turned Lake Street into an immigrant gateway. Over the 20th century, many immigrants established their own businesses—some of which still exist today.

In the late 20th century, there was an influx of Latino and East African immigrants who sought refuge or migrated to Minnesota. During this period, Lake Street was stigmatized by poverty and crime. Community and economic development strategies were deployed to deal with that stigma and uplift its people.

In 1997, Mercado Central was built establishing economic progress for Latinos residing near Lake St. Inspired by the Mercado Central, the community sought to create a place that would attract and retain Latino residents.

In the late 20th century, there was an influx of Latino and East African immigrants who sought refuge or migrated to Minnesota. During this period, Lake Street was stigmatized by poverty and crime. Community and economic development strategies were deployed to deal with that stigma and uplift its people.

In 1997, Mercado Central was built establishing economic progress for Latinos residing near Lake St. Inspired by the Mercado Central, the community sought to create a place that would attract and retain Latino residents.

Demographic Findings

The demographics around the Lake Street Corridor indicate that about 63% of the population are people of color, who are living below the poverty line. About 57% of the population are foreign born, as compared to 15% overall foreign born in Minneapolis, who are not naturalized and mostly Latino. It is reasonable to assume that a large portion of the population are undocumented and documented immigrant population living along Lake Street.

CAV Implications

CAVs will effect the lives of immigrants, documented and undocumented, who live and work along Lake Street. Immigrant businesses in particular, may be impacted by CAVs. Planning policy should ensure the sustainability of immigrant businesses, and foster economic growth. Redesigned areas along Lake Street should not be commodified in a way that makes Lake Street inaccessible due to potential gentrification. Lake Street should preserve its cultural integrity.

CAV Implications:

CAVs will effect the lives of immigrants, documented and undocumented, who live and work along Lake Street. Immigrant businesses in particular, may be impacted by CAVs. Planning policy should ensure the sustainability of immigrant businesses, and foster economic growth. Redesigned areas along Lake Street should not be commodified in a way that makes Lake Street inaccessible due to potential gentrification. Lake Street should preserve its cultural integrity.

Lake Street Demographic Analysis Implications:

The Lake Street corridor has been, and currently is, an immigrant destination filled with a diverse population and immigrant-owned businesses. The introduction of CAVs will impact the current population and landscape of Lake Street Planning Policy must be implemented to ensure an equity. Our Equity Figure, Linda will help us understand the equity implications of CAVs and our design scenarios.
Planning for Disruption

CAV Equity Goals

In coordination with our corridor and demographic analyses, we developed an equity lens to inform the forthcoming design scenarios and uplift the concerns of our equity figures. The equity lens is derived from the Minneapolis 2040 Comprehensive Plan, an Equity Outcome Framework and CAV Implications.

**Mpls 2040**

According to the Minneapolis Director of Long Range Planning, the 2040 Plan aims to **Increase Agency in the City.** This refers to dignifying marginalized communities by increasing their ability to engage with their public officials, advocate for themselves, and have access to choices. Agency is improved with access to housing, work, and transportation. In addition, the 2040 Plan aims to “[eliminate] deep rooted disparities in wealth, opportunity, housing, safety, and health” among race and ethnicity as stated in Goal 1: Eliminate Disparities.

**Equity Outcomes**

Equitable outcomes must be preceded by equitable processes. First, we must realize Inequity is the result of government policies and citizen action. The inequities need to be specifically identified and placed within society. Then, the Communities harmed by those inequities must be involved in creating potential solutions. Lastly, solutions must be Reparative actions comparable to the harmful actions that created the inequity.

**CAV Implications**

Poster 2 described the potential positives and negatives of CAV Impacts. There are several pros and cons concerning land use, the environment, transportation, public health, and equity. It is important for policy makers to have these effects in mind to steer CAV deployment toward beneficial outcomes and avoid pitfalls.

**Equity Goals**

The design scenarios will be guided by the imperative to address socio-economic disparities in Minneapolis and achieve equitable outcomes. We have identified 5 Equity Goals that CAV deployment can impact on as well as their tools:

- **Improve the Environment**
  - Policies that include the fair treatment and meaningful involvement of all people regardless of race, color, national origin, disabilities, or income with respect to the development, implementation, and enforcement of environmental laws, and regulations.
- **Support Existing & Diverse Economies**
  - Policies and programs that prioritize community based financial intelligence, sustainable wealth creation, and high quality job opportunities to prevent unwanted displacement of residents and small businesses from low-income communities and communities of color.
- **Increase Housing Access**
  - Policies that allow families of all income levels to access safe housing that costs no more than 30% of household income.
  - **2040 Comp Plan Goals**
    - Affordable and Accessible Housing
    - Healthy Safe and Connected Communities
    - Complete Neighborhoods
    - Healthy Sustainable and Diverse Economy
- **Improve Public Health**
  - Policies that support the distribution of money, power, and resources at local levels to affect social determinants of health which are responsible for health inequities present today.
  - **2040 Comp Plan Goals**
    - Affordable and Accessible Housing
    - Healthy Safe and Connected Communities
    - Complete Neighborhoods
- **Increase Mobility**
  - Transportation policies develop walkable, livable, and affordable land use practices that enhance healthy living within low-income communities and communities of color.

**Next Steps**

We will place the equity goals and their tools in the design scenarios to promote ways to address equity. Now we turn to the Design Scenarios for Washington Avenue and Lake Street.
Planning for Disruption

Washington Design Scenarios

This poster introduces the design scenarios for Washington Ave and illustrates how they will uphold the Equity Goals. We aim to demonstrate a systematic approach that links land use, built form, demographic analysis and equity towards the visioning of design proposals.

**Equity**

- Housing Access
- Environment
- Public Health
- Mobility
- New & Diverse Economy

This map locates the equity goals along the built environment in Washington Ave.

**Walkability: Redesigning the Public ROW**

Walkability refers to pedestrian mobility such as walking. We will refer to the Public Right of way (Public ROW) as sidewalks, curbs, and the roads in the street. The implementation of CAVs will reduce the width of the streets, and widen the curbs. To further strengthen walkability we propose a scenario on Washington Ave that increases mobility, incorporates housing access, and increases public health benefits.

**Mobility: Reconfiguring the Internal ROW**

Mobility focuses on the Internal Right of Way (Internal ROW), which is characterized by alleys inside blocks. On Washington Ave, we propose design scenarios that promote green spaces and more pedestrian passages to increase mobility, and public health benefits for people. We also consider the opportunity to increase housing access in light of population growth.

**Adaptation: Rethinking the Parcel**

In this scenario, we focus on the parcel. The parcel is defined as private or public land. CAVs offer the opportunity to repurpose existing parcels by increasing their capacities and extending their use into the Public ROW. These design adaptations will focus on increasing housing, economic, and environmental equity.

**Temporality: Activating Open Space**

This section focuses on surface parking lots. Open space along Washington Ave tends to be used for parking, rather than green spaces such as parks. With CAVs on the way, the need for multiple driving lanes is reduced. These design scenarios illustrate ways in which surface parking lots can be transformed into open spaces that promote greater environmental, health, mobility, and economic equity.

In the following posters we demonstrate the design scenarios for the Public ROW, Internal ROW, Parcel, and Open Space along Washington Ave. With the help of the Equity Figure, we will highlight opportunities as well as concerns that may arise due to disruption of CAVs.
Planners can reconsider the public ROW, including permanent structures within the existing ROW and increasing sidewalk width.

**Comprehensive Planning Policy Implications**

- Promote high-quality pedestrian-oriented, business-friendly environment through updated street design guidelines (Goal 6. High-quality physical environment)
- Apply unused spaces for uses promoting equity by applying Community Benefit Agreements and BIDs to fund public realm improvements (Goal 9. Complete neighborhoods)
Planning for Disruption

Mobility
Reconfiguring the Internal ROW on Washington

The Internal ROW refers to alleys. CAVs will reconfigure land uses and movement patterns along the Internal ROWs of blocks. For alleys located inside blocks on Washington Avenue, we propose design scenarios that increase mobility options for all residents, promote green spaces, consider public health benefits, and increase alternative forms of micro-housing.

CAV Land Use Implications

Commercial Uses in the Internal ROW
With CAVs, there will be a greater need for alternative residential and commercial spaces that are connected pedestrian and pick-up or drop-off zones. Parking proximity will be devalued, transforming parking structures that potential commercial spaces allow businesses to capitalize on customers arriving via ride-sharing services or by foot. This development can also provide space for informal and sharing economies.

Residential Uses in the Internal ROW
Reconfiguring existing structures to create micro-housing along the internal right of way could alleviate displacement or homelessness challenges by providing temporary shelters, services and programming activities.

Other Auxiliary Uses in the Internal ROW
 Alleys could continue to be used for freight and deliveries in dense areas like Washington Ave. They could also provide public gathering spaces or recreation areas for the entire community.

Equity Goals
We propose the following design scenarios for our Equity Goals (see poster 8). By proposing these changes, we aim for residents to have equal access to improved neighborhood amenities and resources.

Internal R.O.W. Opportunities:

- Provide zones for pick-up and drop-off from CAV’s, ride-sharing, and delivery services and reduce congestion on main right of ways, improve mobility between internal and main right of ways, increase walkability with a dedicated lanes for pedestrians.
- Transform parking structure into new types of housing to meet increasing demands for affordability.
- Activate current parking infrastructure as alternative commercial or office space to meet new, tactical economic demands or for storage of CAVs with minimal cost for retrofitting.
- Reduce stormwater run-off using permeable pavers, planter boxes, and other green infrastructure best practices. Placing electric charging stations (for CAV’s and personal vehicles, when relevant) can reduce emissions in the downtown area. Reclaiming the internal right of way as green space would also improve environmental conditions.
- Improve the health of existing communities by increasing walkability and healthy lifestyles in urban space.

Comprehensive Planning Policy Implications
Incentives should be placed to reduce the amount of parking needed for preexisting and new development. Incentives can include activated pedestrian spaces, pick-up/drop-off lanes and use of existing parking for new types of commercial or residential uses. These initiatives should all be community-driven and involve local organizations.
Adaptation: Rethinking the Parcel on Washington

As the need for vehicles decreases, the capacity to build on surface parking lots and in the public ROW increases significantly. How can we capitalize on this increased capacity to meet the needs of future Minneapolis residents and visitors?

### Increased Capacity for housing and businesses

Without a need for parking, developers will eventually be able to completely phase parking out from existing parcels. This translates to more building capacity for much needed housing. Downtown will continue to be an attractive place to live because of proximity to services and amenities.

### Leave room for small pocket parks

Parcels used as parking lots can be turned into privately-owned parks that serve as a semi-public amenity and function as on-site stormwater mitigation.

### Focus on Frontages

Building frontages along Washington are inconsistent. Because the ROW will become more pedestrian oriented, building frontages will become necessary to attract retail clientele and create a cohesive character.

### Field work spaces

With increasing technology in the workplace there will be an increasing need for incubator spaces for entrepreneurs. These spaces can be small, flexible and cheaply built. The city could lease these spaces to minority business owners and others to promote retail incentives.

### Flexible living spaces

Minneapolis can use the spaces left over in the public realm for much needed micro-housing. This could be transitional housing for those needing a place to stay that is cheap and short term.

### Design Outdoor Rooms

The city can use the remaining ROW to program flexible outdoor spaces for informal pop-up events and gatherings.

### Comprehensive Planning Policy Implications

- **Allow for the creation of proto-parcels in the ROW and consider the tool of a Community Land Trust to provide options for ownership or leasing through the city (Goal 1. Reduced disparities).**
- **Allow a wider range of flexibility in land uses on the ground floor and within the new ROW proto-parcels to support uses such as craft production and processing businesses (Goal 12. Healthy, sustainable, and diverse economy).**
Planning for Disruption

Temporality: Activating Open Space on Washington

Open space along Washington Avenue is overwhelmingly used for parking. CAV rollout will create opportunities to transform unused parking lots into open spaces for pedestrian vitality, to diversify the economy, and to enrich the city culturally.

Open Space Design Scenarios

The illustration to the right shows the capacity for added green space on the central section of Washington Avenue. The following scenarios explore the transformation of three sites from parking-oriented use to public and semi-public open spaces.

New & Diverse Economies

- Revitalize public space
- Urban agriculture jobs
- Small business promotion

Environmental Resilience

- Carbon capture
- Access to fresh produce
- Encouraging pedestrian travel

Food Truck Parklets

Food-oriented parklets equipped with seating and table space can be deployed on street parking vacated during the adoption of CAVs. Food trucks parked nearby can take advantage of this amenity. With the seating facing the sidewalk, the focus is oriented towards the active streetlife of pedestrians.

Urban Farm

Large former parking areas located behind buildings can be used for non-pedestrian oriented uses such as urban farming. Urban agriculture contributes to our city’s food security and food safety, and increases the total amount of food available to people living in cities. It also allows fresh, high quality vegetables, fruits, and other food products to be grown and produced for urban customers.

Festival Space

The impervious surface of large parking lots on corner lots can be reused for temporary pop-up events. The cultural life of the street can benefit from seasonal festivals celebrating diversity in Minneapolis. Leaving some of the pavement allows for interior “streets” that naturally break up the space into distinct areas.

Comprehensive Planning Policy Implications

Maintain a culturally and economically diverse program for the pop-up festival space. A Community Land Trust ownership model is needed for the urban farm to ensure produce is available and affordable to local and low income residents.
Planning for Disruption

Lake Street Design Scenarios

This poster introduces the design scenarios for the Lake Street corridor and illustrates how each scenario will uphold the Equity Goals. We aim to demonstrate a systematic approach that links land use, built form, demographic analysis and equity goals towards the visioning of design proposals.

Equity

- Housing Access
- Environment
- Public Health
- Mobility
- New & Diverse Economy

This map provides an overview of the equity goals along Lake Street.

Walkability: Redesigning the ROW

To improve walkability on Lake Street, we will look at the Public ROW. This scenario will focus on how the implementation of CAVs will reduce the width of the streets and widen the curbs. To further strengthen walkability and the pedestrian experience, we have designed a scenario on Washington Ave that will increase mobility, incorporate housing access, and increase public health benefits in the public ROW.

New Retail: Reclaiming the Internal ROW

This design scenario will look at the Internal ROW. We will look at alleys and CAV garages. With the implementation of CAVs, these spaces will have to be repurposed. The design scenarios for the Internal ROW will demonstrate how we can change land use, in a residential area and transform alleys to improve residential and commercial uses.

Equity: Re-envisioning the Parcel

With the implementation of CAVs, parking spaces along Lake Street will become obsolete. This gives planners the opportunity to rethink how parking can be re-imagined to promote equity for those living along and around Lake Street. The design scenarios for the parking lots will incorporate ways to promote economic, housing, health, and environmental equity.

Greening: Enabling Green Space

Open spaces such as green spaces, do exist in the surrounding neighborhoods near Lake Street but seem to be absent along the corridor. The loss of interest in personal car ownership after the implementation of CAVs proposes a reconsideration of rooftop parking lots, street-side parking, and small parking lots along Lake Street, into green spaces that promote health equity and environmental resilience.

In the next posters, we demonstrate the design scenarios for the Public ROW, Internal ROW, Parcel, and Open Space along Lake Street. With the help of the Equity Figure, we will highlight equity concerns that may arise with the disruption of CAVs.
Lake Street prioritizes cars. CAVs provide policymakers an opportunity to redesign the Public ROW to prioritize pedestrians. In this poster we explore how to implement these changes.

Medium-term Change Scenario
In the short to medium term, the number of lanes can be reduced. This implementation can happen incrementally through tactical changes to the street section and it can be done with relatively little expense.

Long-term Change Scenario
Once CAVs become the dominant form of transportation, there will be little need to design streets for personal cars, allowing additional usable space. For Lake Street this means additional space as a business corridor by increasing pedestrian space.

Comprehensive Planning Policy Implications
Prioritize Lake Street streetscape improvements through Community Benefits Agreement or a Business Improvement District which relies on input from local businesses and also provides city assistance to small businesses. Utilize tactical urbanism to test future uses along Lake Street that reflect the needs and preserve the character of the neighborhood (Goal 7. History and culture, 6. High-quality physical environment).
Planning for Disruption

Reclaiming the Internal ROW on Lake Street

Lake Street has an extensive system of alleyways for both commercial and residential purposes. In the future these alleyways and the garages fronting the alleys will have less utility. CAVs provide an opportunity to rethink what the Internal ROW could look like and how it is used.

Potential Changes in Land Use along Internal ROW

- **Residential Uses:**
  - As housing demands continue to increase, Accessory Dwelling Units (ADUs) should continue to be implemented. With a pedestrian-oriented internal ROW, this space becomes a new 'frontage' for the units facing the ROW.

- **Commercial Uses:**
  - With technological advances, there will be a greater need for home workplaces and affordable incubator spaces for start-ups. Alleys can become home to new and diverse businesses in the form of commercial and work-live spaces. Spaces that sell goods could be located closer to public ROWs to capitalize on foot traffic.

- **Other Auxiliary Uses:**
  - Homeowners may choose to use their accessory buildings for other uses such as storage or workshops.

Greening of Alley: ✨

There is potential to convert pervious pavement to impervious pavement because there will be less wear with fewer car use, leading to benefits such as on-site storm water management.

- **Improve Connections:**
  - Because internal ROW will not be used for cars, there are opportunities to improve and formalize bike and pedestrian connections through internal ROW from the existing Midtown Greenway to Lake Street.

- **Dropoff of Goods:**
  - The internal ROWs will serve as drop off zones for goods.

- **Design Opportunities:**
  - Allow for flexible uses to allow makers to use spaces along alley especially small commercial uses which may attract customers using the access point to midtown greenway.
  - Preserve the rear access for drop off of goods to existing commercial uses, which integral to culture of Lake Street.
  - Preserve the series of murals and also allow other arts and culture installations along commercial alleys to promote interest for residents and visitors.

- **New & Diverse Economies:**
  - With technological advances, there will be a greater need for home workplaces and affordable incubator spaces for start-ups. Alleys can become home to new and diverse businesses in the form of commercial and work-live spaces.
  - Spaces that sell craft goods could be located closer to Public ROWs to capitalize on foot traffic.

- **Other Auxiliary Uses:**
  - Homeowners may choose to use their accessory buildings for other uses such as storage or workshops.

Comprehensive Planning Policy Implications

Transition alleys to be designated as pedestrian priority. Allow flexibility in land use for accessory units fronting alleys, so as to allow the new and diverse businesses to take advantage of underutilized space. Explore the option of a Community Land Trust to allow for ownership of accessory dwelling units.
Planning for Disruption

**Equity**

Re-envisioning the Parcel on Lake Street

With the arrival of CAVs, parking will become unnecessary, so we need to consider what to do with the existing parking space. In this poster, we offer three scenarios that provide alternatives for parking lots.

**Capacity for Change**

Currently, there is at least one surface parking lot on each block along Lake Street. These lots are utilized for retail purposes. Each lot can accommodate approximately up to 100 vehicles. More than 1,200 vehicles can be parked on these lots.

If a typical vehicle needs 180 square feet of space to park, 1,200 vehicles would need at least 216,000 square feet to park. Due to the CAVs, vehicles will no longer need to park and space of 216,000 square feet would be free to use.

**Re-envisioning the Parcel on Lake Street - 3 Scenarios**

### A: Focus on Curbside Management

Parking lots could be used as easily accessed CAV pickup/drop off zones. For example, Bloomington Avenue has a large parking lot, which would be a great location for the CAVs to stop. CAVs could easily enter or exit either from Bloomington Avenue or 15th Avenue.

### B: Envision Charging CAV Hubs

If the power source of the CAVs is electricity, CAVs would need a place to be charged. Some lots can be utilized as CAVs charging hubs. There are companies designing wireless charging stations for CAVs including a technology based on inductive charging, which involves electricity being transferred via an air gap between two magnetic coils. This process is similar to how wireless phone chargers work.

### C: Increase Mixed Use Residential

Freening up parking space may enable businesses to develop along Lake Street. Current retail buildings may have opportunities to expand. Also, the freed parking lots could be used to develop new buildings for affordable mixed use building types. This rendering image from Elliot Avenue and Lake Street transforms a 16,740 sqft parking lot to approximately 40-70 unit apartment building–as four to six floor developments are reasonable in Mid-town.

**Comprehensive Planning Policy Implications**

Transition alleys to be designated as pedestrian priority. Allow flexibility in land use for accessory units facing alleys, so as to allow new and diverse businesses to take advantage of underutilized space. Explore the option of a Community Land Trust to allow for ownership of accessory dwelling units.
Planning for Disruption

**Greening** Enabling Green Space on Lake Street

CAV adoption will lead to underutilized parking, which can be converted to uses that contribute to health equity, environmental resilience, and enhancing the local economy.

**Health Equity**
- Improved walkability
- Space for social connection
- Increased community satisfaction

**Environmental Resilience**
- Protection from heat and flooding
- Wildlife and plant habitat

**Local Economy**
- Improved environment for local businesses along the corridor

**Green Space Scenarios**

The map to the right shows the capacity to transform existing parking lots and structures into green space on a six-block section of Lake Street.

Below are examples of green space transformations that could contribute to our identified Equity Goals at right, and 2040 Plan Goals (5, 6, 8, 9, 10, see Poster 8).

As CAVs reduce the need for parking, rooftop parking lots can become green roof parks for people who work or live in the repurposed parking structures, as well as members of the public. Green roofs also provide environmental benefits such as stormwater infiltration, building insulation, native plant and pollinator habitat, and space for agriculture.

Many street-side parking lots exist along Lake Street that can be transformed into multi-use open spaces that include seating for restaurants, tree cover and native plants, pathways connecting to alleys, and space to relax and socialize. As CAVs allow for an expanded pedestrian zone (see Poster 15), transforming these spaces can enhance the pedestrian and business environment.

Smaller parking lots can be transformed to rain gardens or other green infrastructure that mitigates flooding, provides native plant and pollinator habitat, and adds beauty to the streetscape. Additionally, rain gardens can be programmed for environmental education. These spaces can also incorporate pedestrian connections between main and internal ROWs.

**Comprehensive Planning Policy Implications**

The city should develop policy to guide the transformation of parking lots and structures in conjunction with public realm improvements (see Posters 15, 16). Community Benefits Agreements can empower communities to negotiate these transformations as Lake Street develops, densifies and responds to CAV adoption.

---

**Key: Equity Goals**
- Health Equity
- Environmental Resilience
- Local Economy
- Mobility
- Housing
- Environment
- Public Health

**Existing**
- Street-Side Courtyard
- Rain Garden

**Transformed**
- Street-Side Courtyard
- Rain Garden

**Existing Street-Side Courtyard**
- Parking lot between 12th and 13th Ave. on Lake

**Transformed Street-Side Courtyard**
- Parking lot between 12th and 13th Ave. on Lake

**Existing Rain Garden**
- Parking lot behind St. Vincent De Paul on 12th Ave.

**Transformed Rain Garden**
- Parking lot behind St. Vincent De Paul on 12th Ave.
Planning for Disruption

Phasing and Outreach

The CAV disruption in Minneapolis will require phased infrastructure and policies in the short-term to simultaneously accommodate both manually driven vehicles and CAVs. How Minneapolis plans for the transitional period could determine the level of disruption, who is impacted, and the level of CAV adoption.

### Rethinking the Street

<table>
<thead>
<tr>
<th>Short Term Options</th>
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<tbody>
<tr>
<td><strong>Keep existing curbs</strong></td>
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<tr>
<td>- Upgrade street infrastructure and test out street section innovations</td>
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<tr>
<td>- Maintain existing curbs and gutter systems and shift to the construction of semi-permanent sidewalks</td>
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<tr>
<td>- Narrow streets at a lower expense until there is funding for a long-term solution</td>
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<tr>
<th>Medium Term Options</th>
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<tbody>
<tr>
<td><strong>Test and Update Street Design</strong></td>
</tr>
<tr>
<td>- As streets are upgraded, introduce CAV infrastructure needs</td>
</tr>
<tr>
<td>- Include policy incentives that allow CAV-related innovations to complement regular maintenance and new infrastructure/utility updates</td>
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<tr>
<th>Long Term Options</th>
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<tr>
<td><strong>Update infrastructure incrementally</strong></td>
</tr>
<tr>
<td>- As streets are upgraded, introduce CAV infrastructure needs</td>
</tr>
<tr>
<td>- Include policy incentives that will allow for CAV-related innovations to complement regular maintenance or new infrastructure/utility updates that are in the area</td>
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### Rethinking the Block

<table>
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<th>Short Term Options</th>
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<tbody>
<tr>
<td><strong>Translating into Green Alleys</strong></td>
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<tr>
<td>- Introduce permeable pavers and other green infrastructure</td>
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<tr>
<td>- Encourage community investment</td>
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<tr>
<td>- Reduce lane sizes to incorporate more pick-up drop off space as a temporary solution to encourage pedestrian uses of the alleys</td>
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<th>Medium Term Options</th>
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<tbody>
<tr>
<td><strong>Bike ped infrastructure</strong></td>
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<tr>
<td>- Incorporate alleys into bicycle and pedestrian networks by creating intentional connections to existing bike lanes, greenways, and walking paths</td>
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<tr>
<td>- Install permeable pavement in spaces that transition between car-centric and pedestrian uses</td>
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<tr>
<th>Long Term Options</th>
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<tbody>
<tr>
<td><strong>PEDESTRIAN INVESTMENT</strong></td>
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<tr>
<td>CAVs create opportunities for investment in the pedestrian experience. Asking communities to test ideas and develop permanent designs</td>
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### Open Space

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<tr>
<th>Short Term Options</th>
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<tbody>
<tr>
<td><strong>Parklets</strong></td>
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<tr>
<td>- Use tactical urbanism approaches such as parklets, movable planters, and street furniture to experiment with potential uses for underutilized parking lots</td>
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<tr>
<td>- Update City’s Parklet guide to meet the needs of new parklet types</td>
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<th>Medium Term Options</th>
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<tbody>
<tr>
<td><strong>Program Potential Open Spaces</strong></td>
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<tr>
<td>- Offer “Open Spaces Programs” to nonprofit organizations to partner with artists to create temporary open space</td>
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<th>Long Term Options</th>
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<tr>
<td><strong>COMMUNITY EVENTS</strong></td>
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<tr>
<td>Weekly #PlanningForDisruption community events</td>
</tr>
<tr>
<td>- Engage the community and the Minneapolis Tactical Urbanism Committee in CAV disruption</td>
</tr>
<tr>
<td>- Embrace the idea that traditionally auto-centric spaces (ROW, parking lots, etc.) are transforming and will increasingly be available for new uses</td>
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### Public Outreach Ideas

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<th>Medium Term Options</th>
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<tbody>
<tr>
<td><strong>Design competitions - ask the community</strong></td>
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<tr>
<td>- Engage expert designers and developers through design competitions to develop ideas for new building types</td>
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<tr>
<td>- Engage with trusted community groups/leaders throughout the process to inform and judge the final designs</td>
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<tbody>
<tr>
<td><strong>COMMUNITY EVENTS</strong></td>
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<tr>
<td>Weekly #PlanningForDisruption community events</td>
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<tr>
<td>- Including music, food, and opportunity for interaction can establish an empty lot as a community center</td>
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<tr>
<td>- Photo above is from Off The Grid event in San Francisco</td>
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### Scenario Examples

**INSURGENT BIKE LANE**

When biking in Mexico City they were tired of waiting for the city to paint bike lanes, they took matters into their own hands. While the action may not be one to be replicated, the idea behind using paint as quick and cheap way to create priority in lane type is.

**ALLEY GREENING**

This example of alley greening from a multifaceted competition in urban prototyping to test new uses along a major street. Some of the designs are so successful, they become permanent. (Photo credit: SF Gate)

**PEDESTRIAN INVESTMENT**

CAVs create opportunities for investment in the pedestrian experience. Asking communities to test ideas and develop permanent designs.

**OPEN SPACE PROGRAMS**

Program events in potential open spaces such as group exercises like this example from Philadelphia.

**DESIGN WEEK**

Events like San Francisco Design Week use a design competition in urban prototyping to test new uses along a major street. Some of the designs are so successful, they become permanent. (Photo credit: SF Exploratorium)

The ideas that are built during these transitional periods will determine the kinds of solutions that will dominate over the longer term and will also set up goals for long-term future policy, infrastructure, and equity decisions. These long-term solutions will be presented in the next poster. The equity goals/opportunities outlined throughout this project should be consistent throughout all stages of CAV adoption.
To take full advantage of the Equity Goals introduced in Poster 8, we recommend the following:

**Mobility**
- Prioritize Complete Streets models in redesigning for CAVs; clearly define where CAVs fall in the modal hierarchy.
- Develop a phasing protocol for the overlap between CAVs and traditional cars to manage how modes interact regarding curb access and pick-up/drop-off zones.
- Develop policy guidance to redesign internal ROW for pedestrians and bikes to facilitate bike/ped connections through alleyways.
- Ensure that **CAV technology is deployed to all areas in the city equally** to avoid deepening disparities in transportation access and to ensure that all residents can access CAV technology.

**Environment**
- **Incentivize the installation of green infrastructure technology** (rain gardens, bioswales, permeable pavement, green roofs) in reclaimed main and internal ROW, parking lots, and parking structures.
- **Facilitate the transformation of unused parking lots, parking structures, and paved surfaces** into publicly accessible open space that fills a community need or desire and contributes to health equity.

**Public Health**
- Prototype street configurations that allow CAVs to improve, rather than detract from, the biking and walking environment so as to continue encouraging active transportation.
- Identify areas that lack public open space, green space, tree cover, or food access and prioritize converting paved lots into open space, green infrastructure, or agricultural space, to increase environmental resilience and health equity.

**Housing**
- Adapt zoning to allow housing to be built in the right of way as the necessary number and size of lanes diminishes.
- Incentivize or fund the creation of small-scale affordable housing in these spaces.
- Investigate the conversion of parking structures into housing, and require newly built parking structures to be easily convertible to housing or other uses once parking becomes unnecessary.
- Expand allowable use of ADUs (currently only allowed on lots with dwellings that contain 1 or 2 units) to incentivize the conversion of garages to housing.

**Economy**
- Adapt zoning to allow flexible-use structures in the ROW for small-business incubators, work space, pop-up events.
- Allow flexible commercial uses in ADUs and garages that no longer house cars.
- Investigate the conversion of parking lots and structures into commercial flexible space.
- Use reclaimed space to improve building frontages for a more pleasant and walkable commercial environment.

**Conclusion**
CAV introduction will have different implications for Washington Avenue and Lake Street due to the corridors’ varying conditions, demographics and development goals (see Posters 3-7). Given the variety of possible uses for reclaiming the space that CAV disruption will make available (see Posters 9-18), Minneapolis should develop policy mechanisms to enable community agency and ownership over these transformations in order for CAV disruption to promote the Equity Goals identified in Poster 8. Given the imminent arrival of CAVs, now is the time to begin acting on the strategies above in order to ensure equitable outcomes from the coming CAV disruption.
The CAV Urban Village
Recalibrating the Canterbury Park Master Plan

This project considers the implementation of Connected and Autonomous Vehicle (CAV) technologies master planning practices. Subdivision planning could be improved by exploring best practices that recalibrate the public and private realms. We consider this challenge through the following question case study: How can Canterbury Park recalibrate the master plan to prepare for a CAV-oriented future?

CAVs: Coming Soon to a Street Near You
CAVs may be incorporated into our transportation systems sooner than we realize. Yet 95% of the 500 largest U.S. Cities have no AV policy or plan. The City of Shakopee’s 2040 comprehensive plan, Envision Shakopee, briefly mentions preparing for CAV technology but does not address specific policies or subdivision development guidelines.

Canterbury Park is an area in Shakopee, MN, a southwest outer-ring suburb of the Twin Cities. The area includes a new development, a casino, and a horse racetrack. Canterbury Holdings, Inc., which owns the park, plans for the new development to draw new commercial development. Developers aspire to enhance the “Canterbury Experience.” As CAVs become more available, the city and developers will need to consider how to incorporate CAV technology into their plans and address how this technology will affect land use.

Actors
Government Agencies
These agencies control and regulate how development can occur. How will government plan for a CAV future?

Job Centers
Primary decision makers about how the plan is laid out. How will the plans be affected by CAV technology?

Development Partners
Large employment centers draw people from around the metropolitan area. Will the new development allow people to live near their jobs? If not, how will they commute to their jobs?

Equity in Canterbury
Will everyone benefit equally from the implementation of CAV technology in Canterbury Park? What steps can planners take to ensure marginalized groups are not left behind? Ed, an Asian-American single dad who works at a restaurant at Canterbury Park as a server, will express his opinions about the recalibration along with the posters, tweeting his commentary.

The Canterbury Experience
The “Canterbury Experience” is the unique feeling visitors, residents, and employees have when they are in Canterbury Park. Everyone who visits Canterbury should know that Canterbury is a special place in Shakopee and within the Twin Cities metro. The “Canterbury Experience” should provide a unique place for people to have recreational, cultural and shopping experiences in a CAV urban village, to create memories and encourage people to visit time and time again.

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Introduction
Urban Village
Policies/ Principles
Guide for Redevelopment
Current Conditions
Master Plan
Neighborhood Plan
External ROW
Internal ROW
Conclusion

Emily Houser, Koehl Simmons, Forrest Steinhoff, and Ari Del Rosario | Professor Fernando Burga, T.A. Christopher Desroches
Introducing the CAV Urban Village

The CAV Urban Village

As CAV technology increases and demand for parking declines, planned subdivisions can be developed in their place. We introduce CAV Urban Village recalibration principles and suggest how they can be used to re-imagine the parking lots as CAV urban villages.

Toward a CAV Oriented Urban Village

Our recalibration principles suggest the new subdivision development should focus on envisioning an urban village that upholds the "Canterbury Experience." An urban village is a mixed-use, dense development with a variety of business, office, and residential uses that feature public spaces and transit.

The CAV Urban Village features a dense, mixed-use, walkable center with plenty of public space, allowing people to live, work, and play in the vicinity. Public spaces activate the village and create a sense of place. The Urban Village is specifically designed for people and experiences with less of a focus on CAVs.

Public spaces provide spaces for parks, green space, and recreational and cultural opportunities. These parks and plazas can also provide locations for special events such as farmers markets, concerts, and pop up events. With more space made available by decreased demand for auto-oriented land uses, the extra space can be used to create a memorable atmosphere.

We envision a multi-modal corridor through the urban village. This corridor features bus lanes, bike lanes, and pedestrian plaza. A dedicated bus lane allows buses to run periodically up and down the street and provides a convenient way to transport large numbers of people to and within the urban village.

Mixed-Use Development

Green Space

Residential Density

The CAV Urban Village

CAV Pickup/Dropoff Stations

Multi-Modal Transportation

As CAV technology is adopted and parking lots become obsolete, land can be redeveloped into more productive land uses to create new opportunities for urban form, business, leisure, and housing options.
Guiding Policies and Principles

The CAV Urban Village

What is a Master Plan Recalibration?

In this poster, we present our adjustments to the existing Canterbury Park Master Plan by adopting key design elements for the introduction of CAVs. We establish assumptions about the adoption of CAV technology, identify land use policy benefits, and put forth our CAV design framework to inform recalibration principles.

Assumptions

- By 2040, most CAVs will have Level 5 Automation (fully autonomous). [1]
- CAVs will be powered electrically. [2]
- Due to prohibitive cost, CAVs will be largely shared, not privately owned. [3]

Recalibration Principles

- Human-scale urban design
- Green space
- Mixed-use development
- Residential density

Land Use Policy Benefits

- Human-powered and public transportation provide environmental and public health benefits by using less fuel and encouraging people to exercise and get outdoors.
- Green space in urban environments benefits the health and well-being of residents by providing ecosystem services such as filtering air, removing pollution, attenuating noise, cooling temperatures, infiltrating storm water, and providing food. [1]
- Mixed-use zoning provides a number of benefits, including improving access to employment opportunities, enhancing pedestrian mobility, attracting retail amenities, and promoting healthy lifestyles through functional public spaces. [2]
- Many cities are experiencing population growth, including the City of Shakopee, which is projected to see 29% population growth by 2040. [4] Cities should ensure that a proportion of new development is denser, and/or affordable housing, perhaps considering employer-sponsored affordable housing so that employees can afford to live near their workplaces.

CAV Design Framework

- CAVs will require less space on roadways due to less drift than human drivers. Parking needs could be reduced by up to 90%.
- CAVs will be powered electrically. Cities may consider solar charging stations where CAVs can be stored when they are not in use.
- Residential dwellings will not need garages, driveways, or parking spaces, but curbside pickup and dropoff will become more important.

The advent of CAV technology and projected population growth provide an exciting opportunity for the cities to reconsider subdivision planning and recalibrate master plans.

PA 5211: Land Use Planning
Emily Houser, Koehl Simmons, Forrest Steinhoff, and Ari Del Rosario | Professor Fernando Burga, T.A. Christopher Desroches

References:
[1] Ed Chen (2018, December 7). It would be really convenient if a #CAV just dropped me off in front of work. I wouldn’t have to worry about my son getting frostbite! Twitter, Twitter. https://twitter.com/itsedwardchen81/status/1071731676301824769
[4] Policies/Principles

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Scott
Redmond Community Project
University of Minnesota
The introduction of CAV technology will mean that existing land uses will need to evolve. In this poster, we provide a framework using the land use policy principles and CAV Design Framework from Poster 3 to show how existing land use can evolve by the incorporation of CAV technology.

Street and Site Design Policies
Planners should develop policies and street design hierarchies that prioritize pedestrian, cycling, and transit infrastructure over CAV technology. This approach will allow planners to diversify land uses and retrofit spaces which will be rendered obsolete as CAV technology becomes more prevalent.

**Human-scale urban design**

**Goal 1:** Design complete streets to incorporate multiple modes and lanes of transportation that reflect the context and goals of the street.

**Goal 2:** Encourage active transportation and transit ridership. Discourage single occupancy and CAV ridership.

**Goal 3:** Design and incorporate varied lane textures and instruments to assist disabled users.

**Goal 4:** Provide mid-block crossings to allow more convenient and safer crossings for pedestrians.

**Green space**

**Goal 2:** Use permeable surfaces when possible to facilitate storm water infiltration.

**Goal 4:** Establish green space minimums for all new developments.

**Mixed-use development & Residential density**

**Goal 1:** Improve access to employment opportunities and create additional housing options.

**Goal 2:** Provide an attractive and dense location that encourages pedestrian, cycling, and transit use and discourage CAV use.

**Goal 3:** Create Flex Zones allowing former street parking spaces to be used as CAV drop-off/pickup locations, transit stops, parklets, and pedestrian space.

**Goal 4:** Transform obsolete on-street parking spaces into new transportation uses such as bus or bike lanes or walking paths.

There is an exciting opportunity to incorporate new policies and design principles for streets as we transition to a CAV future.
The 45-acre parking lot is providing little benefit to Canterbury Park or its surroundings. A CAV-oriented future in which the demand for parking is greatly decreased creates an opportunity to address a number of issues, including those identified above.
The Canterbury Park Master Plan

The CAV Urban Village

The current subdivision master plan shows a separation of land uses (i.e., residential and commercial, including specialty retail, family entertainment, and community gathering places), with new luxury housing already under construction. The new housing to be built includes market-rate apartments and senior housing. The preliminary site concept plan states that “both [high density residential structures] will have a 3-level enclosed parking garage with 315 heated parking spaces and 194 surface parking stalls. This amount equals 1.65 stalls per unit, well above the current market demand of 1.3-1.4 stalls per unit.”

Site Concept Plan

1. **Parking**
   - There are currently 10,000 parking spaces in the parking lot, with plans to add an additional 509 spaces. In a CAV-oriented future in which individual parking spaces are not needed, these spaces will need to be re-purposed.

2. **Housing**
   - Housing under development includes senior housing and high-end apartments. There is demand for affordable housing for those who work in the community.

3. **Traffic**
   - Infrastructure improvements, such as roundabouts, will help support traffic flow and event traffic. In a CAV-oriented future, infrastructure should be redesigned to accommodate multiple modes of travel.

4. **Zoning**
   - The site is zoned MR - Major Recreation Zone. This allows for a high degree of land use compatibility and requires the planning of the entire parcel. To redevelop the site, it would need to be re-zoned to allow residential uses and mixed uses.

5. **Business**
   - Businesses in the area could make use of CAV technology if it is well utilized and infrastructure is updated to accommodate a CAV-oriented future.

6. **Transit**
   - Minnesota Valley Transit Authority (MVTA) operates Route 499 which directly serves Canterbury Park. In a CAV future, improving transit access should be prioritized, allowing people to move more efficiently.

Site Concept Plan from Stantec. The parking lot, highlighted in yellow, serves as the location for our neighborhood plan.

A CAV Future?

Canterbury Park has a large area of land devoted to surface parking, and the developer plans to add more surface parking and heated parking stalls. This use will be increasingly rendered obsolete as we transition to CAVs. If CAVs are largely shared, which scholars predict they will be, there will be less demand for parking. How else could these empty parking lots be used?

The City of Shakopee and Canterbury Holdings, Inc. are working to increase density to accommodate an influx of new residents and businesses. While the current site concept plan begins to address these opportunities, we argue that it does not go far enough and that CAVs present further opportunities in subdivision planning that are not addressed in the master plan.

Ed Chen @itsedwardchen81
So that's what they're planning! The development looks nice but I could never afford to live there #affordablehousing
2:52 PM - 7 DEC 2018, from Minneapolis, MN
The CAV Urban Village

The 45 acres of parking freed up by the diminished need for parking as CAVs become prevalent mode of travel will allow for development of new housing and job creation. This development will enhance the tax base and provide cultural and entertainment amenities in an urban village. In this poster, we present a land use plan and map analysis for the urban village.

**Proposed Neighborhood Plan**

**Commercial Frontage**
Red lines show major commercial frontages within the CAV Urban Village. Across the street from the northern boundary of the village is industrial use, so that area is zoned for commercial use.

**Civic Zones/CAV hubs**
Areas shown in blue are civic zones and CAV hubs where people can congregate in public space, and where they can catch a CAV.

**Roadways**
- Major roadways
- Secondary roadways
- Alleyways
- Greenways/Pedestrian walkways
- Pedestrian arcades

**Green Space**
Green spaces are highlighted in green, showing several parks and a green pedestrian and bicycle path.

The 45 acres of parking freed up by the diminished need for parking when CAVs are the standard mode of travel will allow for development of new housing, amenities, and cultural corridors in an urban village.
Design Scenario: External Right-of-Way

The CAV Urban Village

In this poster, we present a design scenario: The external arterial road of the CAV Urban Village. Incorporating our recalibration principles, our design scenario furthers the “Canterbury Experience” by providing a unique, place-based experience in Canterbury Park. We focus on the external right-of-way arterial in this poster because it represents a major transitway typology, which incorporates many of the innovations brought forth by the introduction of CAV technologies.

Current Conditions

Our Proposal

CAV Recalibration:

**Human Scale Urban Design:** With a reduction in auto-centric infrastructure, we can incorporate larger sidewalks and bike lanes. These human scale amenities encourage people to get out and have a positive effect on public health.

**Green Space:** with less space devoted to cars, we can fit a public park in a space previously devoted to parking. In addition, because fully-autonomous CAVs are not subject to drift, the space between tire treads can be filled in with vegetation, reducing runoff and pollution.

**Mixed-Use Development:** Our proposal seeks to make Canterbury a place for people to live, work, and play. We do this through both mixed land uses and supporting infrastructure. One of the hallmarks of our proposal is a large amount of mixed-use buildings.

**Housing Variety:** Coupled with high-end apartments and senior living currently being built in nearby Canterbury Commons, our proposal includes multi-family housing options in a variety of densities.

What do the streets of the CAV Urban Village look like? In the next poster, we explain how we utilize our CAV recalibration principles to design a Canterbury Park CAV recalibration at a street level.
Design Scenario: Internal Right-of-Way

The CAV Urban Village

In this poster, we present a design scenario for an internal road of the CAV Urban Village. Incorporating our recalibration principles, our design scenario furthers the “Canterbury Experience” by providing a unique, place-based experience in Canterbury Park. We focus on the internal right-of-way in this poster to showcase some of the diverse land use innovations brought forth by the introduction of CAV technologies.

Current Conditions

Our Proposal

CAV Recalibration:

- **Human Scale Urban Design:** In part due to larger sidewalks and bike lanes, the area is much more pedestrian friendly. This enhances the “Canterbury Experience” by providing multiple modes of transportation and encourages people to use the space more frequently.

- **Green Space:** With the need for parking eliminated, in addition to green roads we are able to fit more trees into the parking lot; improving greenery reducing Canterbury’s carbon footprint.

- **Mixed-Use Development:** Both sides of the street now include mixed-use developments with residents built above street level businesses. These mixed-use buildings will bring more jobs, residents, and business to Canterbury, enhancing the local shared economy.

- **Housing Density:** Coupled with high-end apartments and senior living currently being built in nearby Canterbury Commons, our proposal includes multi-family housing options in a variety of densities.

The 45 acres of parking freed up by the diminished need for parking when CAVs are the standard mode of travel will allow for development of new housing, amenities, and cultural corridors in a CAV Urban Village.
A Bright Future for Canterbury
The CAV Urban Village

In this project, we considered the master plan for Canterbury Park in the context of a rapidly approaching future in which Connected and Autonomous Vehicles (CAVs) dominate the transportation landscape.

Due to a revolutionary decrease in the amount of parking needed by CAVs as compared to human drivers, Canterbury Park’s 10,000-space parking lot will be rendered obsolete. This presents an opportunity to rethink the possibilities for this space.

Our neighborhood plan incorporates the design principles of people-centered design, green space, mixed-use development, and diversity of housing options, in order to enhance the “Canterbury Experience.” We evaluated the existing master plan, articulated a CAV design framework, and applied it to create a neighborhood plan for an urban village in what is currently the parking lot.

Canterbury Park: The Urban Village of the Future
The arrival of CAVs will give Canterbury Park an opportunity to reshape its parking lots into an urban village that will benefit the surrounding community by providing a diversity of housing options, green space, mixed-use development, and people-centered design. Our recalibration of the Canterbury Park master plan may serve as a case study for other metropolises facing redevelopment opportunities in the advent of a CAV-oriented future.
Paving the Way

Re-envisioning Pedestrian Safety for CAVs

The advent of connected and autonomous vehicles (CAVs) marks a great transition in transportation networks, with reports estimating 50% of cars will be fully automated by the year 2040. Planning for these new technologies can help communities realize future benefits and anticipate unintended consequences.

How can Scott County coordinate the design, engineering and construction of its transit network to ensure pedestrian safety, maintain mobility, and promote comfortable interactions between pedestrians and CAVs?

We explore the implications of CAV technologies on pedestrian safety in Scott County by examining crosswalk scenarios inspired by an existing school crosswalk in the city of Shakopee.

Pedestrian safety is an important concern for cities and transportation planners. Recently, Scott County installed a series of Rectangular Rapid Flashing Beacons (RRFBs) at pedestrian crossings near four schools located along HWY 16. RRFBs have received Federal Highway Administration approval and are a common method for emphasizing pedestrian crossings at previously non-signaled crosswalks.

The exact timing of how and when the region’s transportation networks will transition to an automated future is unknown. Human drivers and self-driving vehicles will share the road together during this transition. Some CAV models already exist and will become more common in the future. It is imperative that the planning for these new scenarios continues to emphasize safety, accessibility and equity for all.

The potential for CAV technology to improve pedestrian safety and efficiency will lead to changes in the transportation network, including impacts on infrastructure, policy, land use and the environment.

What will this mean for pedestrian safety in Scott County and other cities across the region?
Re-envisioning Pedestrian Safety for CAVs
Paving the Way

Pedestrian road safety ensures that residents feel safe and empowered to walk freely in their communities without fear of vehicles colliding with them. This poster explores the key issues, benefits, challenges and opportunities of pedestrian safety and begins to lay a framework for incorporating AV technologies into future pedestrian safety best practices.

Principles, Metrics & Characteristics for Pedestrian Safety

<table>
<thead>
<tr>
<th>Land Use</th>
<th>Infrastructure</th>
<th>Behavior</th>
<th>Policy</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Ensure there is space for pedestrians to walk and cross</td>
<td>• Determine best practices for road and intersection design</td>
<td>• Determine how CAVs will affect parking needs during transition to a CAV future</td>
<td>• Identify key issues for CAV policy at local, state and federal levels</td>
</tr>
<tr>
<td>• Promote land use that fosters connectivity and active streetscape</td>
<td>• Identify and monitor access management</td>
<td>• Identify metrics for evaluating pedestrian behavior</td>
<td>• Determine how policy can promote safe and equitable CAV deployment</td>
</tr>
<tr>
<td>• Ensure site plans account for pedestrian safety</td>
<td>• Learn how CAVs will impact the streetscape</td>
<td>• Learn pedestrian perceptions of CAV technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Ensure infrastructure changes are adaptable to CAV needs</td>
<td>• Consider impacts of CAVs on streetscape</td>
<td></td>
</tr>
</tbody>
</table>

Key Issues

- Determine measures for assessing pedestrian behavior in relation to CAVs and land use type
- Detemine impacts of CAV technology on land use

Challenges

- Determine measures for assessing pedestrian behavior in relation to CAVs and land use type
- Detemine impacts of CAV technology on land use

Opportunities

- Develop a multi-modal system where no individual mode of transportation is prioritized
- Prioritize land uses that are capable of adapting to AV technologies

Benefits of Pedestrian Safety and AVs

<table>
<thead>
<tr>
<th>Social</th>
<th>Health</th>
<th>Environment</th>
<th>Economic</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Promotes increased pedestrian safety</td>
<td>• Multimodal transit promotes active lifestyle</td>
<td>• Lessens reliance on fossil fuels</td>
<td>• Walking and biking are affordable transportation options</td>
</tr>
<tr>
<td>• Opportunity to expand green space</td>
<td>• Walking or biking lowers health risks and helps manages chronic disease</td>
<td>• Lowers individual carbon footprint</td>
<td>• Improved real estate values correlate with improved walkability</td>
</tr>
<tr>
<td>• Encourages ride-sharing</td>
<td>• Expanded greenspace improves wellbeing</td>
<td>• Reduces impervious surface</td>
<td>• Active streetscape bolsters local economy</td>
</tr>
<tr>
<td>• Improved mobility connects residents to community services</td>
<td></td>
<td>• Improves air quality</td>
<td></td>
</tr>
</tbody>
</table>

It is imperative to understand current issues, challenges, benefits and principles of pedestrian road safety as we plan for CAVs. Poster 3 provides context regarding the key facts of pedestrian safety at the Federal, State and local level.
Pedestrian Safety in Context

The Twin Cities region is expected to grow by more than 800,000 residents and add 500,000 new jobs by the year 2040. Scott County has grown dramatically over the past half century and so has its transportation network. This poster contextualizes pedestrian safety at the Federal, State and local levels, illustrating how various data trends influence pedestrian safety needs. A 2017 content analysis of 432 academic articles related to automated vehicles issues identified less than 20 that addressed pedestrian safety in any substantive way.

USA
- 40,100 Motor Vehicle Fatalities (2017)
- $212 B Traffic Accident Costs (2012)
- 5,984 Pedestrian Fatalities (2017)
- 90% Accidents due in part to human error

Minneapolis
- 392 Motor Vehicle Fatalities (2016)
- 35 mph Roads have the most accidents
- 8 Motor Vehicle Fatalities (2016)
- 1,355 Total Car Crashes (2016)
- 112 Pedestrian Fatalities (2014-2016)
- 75% Fatalities Occur at Night
- 904 Injuries on State Roads (2015)
- 738 Bicycle Fatalities (2017)
- 8 Motor Vehicle Fatalities (2016)
- 10 Bicycle Fatalities (2016)
- 3/4 Fatalities occur in rural MN areas

Scott County
- MANY SCOTT COUNTY COMMUNITIES ARE FAMILY ORIENTED
- 2.89 AVERAGE HOUSEHOLD (Regional average is 2.5 persons)
- 1,128 Motor Vehicle Fatalities (2016)
- 11,112 Pedestrian Fatalities (2017)
- 75% Fatalities Occur at Night
- 3/4 Fatalities occur in rural MN areas

Scott County Crash Incidents
- Crash incidents remain relatively constant and a fairly high in Scott County. The implementation of CAV technology is expected to help reduce the likelihood of crashes in the future.

Scott County Population Growth
- Scott County’s population has increased over the years, in addition to having one of the lowest percent populations over 60 in the region. CAVs can still benefit an aging community by promoting accessible transit options. The aging population is expected to increase by 8.3% in 2020.

NEXT STOP
The next poster explores how to anticipate the impacts of CAVs, and how current best practices can be leveraged to envision a CAV-oriented multi-modal transit network in urban, suburban and rural areas.
Best Practices in Envisioning CAV-Oriented Pedestrian Safety
Paving the Way

Planning for pedestrian safety is never easy. This poster addresses best practices in planning for pedestrian safety in urban, suburban and rural communities. These best practices are analyzed through three phases of AV implementation: the present, in transition and the future. We also identify metrics for pedestrian safety that can be used to plan for CAV-oriented pedestrian safety.

Planning for Pedestrian Safety and CAV Environments

When it comes to planning for pedestrian safety, context matters. Although best practices may overlap, different geographies require an analysis tailored to their unique needs and circumstances. The table below illustrates some of the current recommendations for pedestrian road safety (MnDOT) in rural, suburban, and urban areas. The table also considers emergent best practices in planning for pedestrian road safety with an eye towards an automated transportation system.

### Pedestrian Safety Metrics

These metrics can help planners and engineers understand the impacts of CAVs and help inform decisions related to planning for these emerging technologies.

**What is V2X?**

V2X technology is a general term for the technology that enables communication among traffic-related elements in an intelligent network. V2X will be a critical link in the hive of Connected and Automated Vehicles and help ensure this technology is safer and more efficient than existing transportation.

**STANDARDS**

- Promote walkability
- Consider transit dependent populations
- Parking needs
- Property values
- Residential and business feedback

**Operations**

- Daily traffic counts/speeds
- Intersection queues
- Travel time
- Impacts on VMT...
- Higher or lower?
- Bike/pedestrian counts

**Safety**

- Traffic speed
- Percent drivers Crash frequency/rate
- Perceived level of pedestrian safety
- Accessibility: connecting people to services

Understanding best practices will help forecast how CAVs can be implemented in different geographic contexts. Poster 5 explores changes in policy, land use, infrastructure and the environment throughout the phasing of CAVs.

Who knew that CAVs could have such an impact! I hope they come to rural areas as soon as urban areas!

PA 5211: Land Use Planning

Lynda Chao, Dan Mclntil, Elliot Mohler, Isaac Hase-Raney | Professor Fernando Burga Ph.D. | T.A. Chris DesRoches
### Driver & CAV Transition Timeline Matrix

#### Paving the Way

The matrix below provides an idea on changes to expect in the different phases of CAVs.

<table>
<thead>
<tr>
<th>Drivers Only</th>
<th>Driver Dominated</th>
<th>CAV Dominated</th>
<th>CAV Only</th>
</tr>
</thead>
<tbody>
<tr>
<td>Some sidewalks have truncated domes.</td>
<td>Installation of truncated domes and cross signals with audio and visual cues.</td>
<td>Greater opportunity for accommodations for residents who are visually or auditorily impaired, are without smartphones, or that are undocumentuated.</td>
<td>CAVs will be designed to accommodate for residents with disabilities, those without smartphones, or residents who may be undocumentuated.</td>
</tr>
<tr>
<td>Pedestrians and bicyclists walk to the cross at designated roads.</td>
<td>The implementation of CAVs will begin to give more space to pedestrians and bicyclists, as streets are designed around pedestrian safety.</td>
<td>Pedestrians and bicyclists begin to prioritize the right of way as crossings are more frequent and give more time for pedestrians to cross.</td>
<td>The right of way is for pedestrians and bicyclists. Crossings don’t need to be designated as CAVs will detect pedestrians.</td>
</tr>
<tr>
<td>Cars are prioritized as streetscapes were designed around the automobile.</td>
<td>Lane reduction gives way to increased greenspace, increased parcel distance from roads, and changes in the direction buildings face.</td>
<td>Lane reduction gives way to increased greenspace, increased parcel distance from roads, and changes in the direction buildings face.</td>
<td>Due to increased efficiency and choice, multimodal streetscapes will allow for higher density in suburban parcels.</td>
</tr>
<tr>
<td>Physical signs guide drivers between locations with information such as, laws, location, and conditions.</td>
<td>Physical signage communicates speed limits, road conditions, and location.</td>
<td>Potential for RRFBs to phase out as CAV systems will be readily designed to accommodate residents with disabilities, those without smartphones, or those who may be undocumentuated.</td>
<td>V2X technology makes RRFB systems obsolete. CAVs will use V2X technology to aid in better detection of pedestrians and bicyclists.</td>
</tr>
<tr>
<td>Trail systems are designed to accommodate residents with disabilities, those without smartphones, or residents who may be undocumentuated.</td>
<td>Trails permeate into urban and suburban areas.</td>
<td>Trails integrate with roadways, resulting in more trails in urban and suburban areas. Lighting is installed on trails and roads for safety.</td>
<td>Trails connect urban, suburban, and rural areas. Integration of roadways, green spaces, and trails enhances quality of life.</td>
</tr>
<tr>
<td>Green space integrate. Further reduction in infrastructure costs by using curbless streets and removing vehicle lanes.</td>
<td>Green space integrate. Further reduction in infrastructure costs by using curbless streets and removing vehicle lanes.</td>
<td>Greater opportunity for accommodations for residents who are visually or auditorily impaired, are without smartphones, or that are undocumentuated.</td>
<td>CAV systems will be readily designed to accommodate residents with disabilities, those without smartphones, or those who may be undocumentuated.</td>
</tr>
<tr>
<td>Stormwater management systems are both natural and manmade systems. Stormwater diverted to rivers through gravity powered piping, stored in retention ponds or absorbed into green space surrounding roadways.</td>
<td>Stormwater diverted to rivers through gravity powered piping, stored in retention ponds or absorbed into green space surrounding roadways.</td>
<td>Greater integration of stormwater management. Retention ponds exist as a form of stormwater management and animal habitat. Lane reduction adds more greenspace and permeable surfaces.</td>
<td>Full integration between the built environment and energy production. CAVs charge themselves at shared docking hubs.</td>
</tr>
</tbody>
</table>
Developing a CAV-Oriented Streetscape

Paving the Way

We will now explore the impacts of CAV technology on pedestrian safety in Scott County by envisioning four phases of CAV implementation at one intersection in Shakopee, represented through renderings that change over time. The analysis is displayed on the matrix in Poster 5 and represented graphically throughout the next several posters. We analyzed the impacts of CAV technology on land use, infrastructure, policy and the environment.

From Drivers Only...............................to CAVs Only

Paving the Way

In the next series of posters we will envision the transition to a CAV future by looking at the changes that may occur in policy, land use, infrastructure and the natural environment at one intersection in the city of Shakopee.

**POLICY**

- Policy at the local, state and federal levels will play an instrumental role in determining how CAVs will be implemented.
- Policy will determine who benefits from these technologies, how implementation models will be ADA compliant, what is required to ensure they are accessible to all, and where they will be prioritized.

**LAND USE**

- CAVs will present opportunities to reorient the streetscape and transition right of way away from automobiles.
- The advent of these emerging technologies may prompt changes in the design of suburban subdivisions such as reduction of curvilinear streets, expanded greenspace, a lessening need for garage space or homes built facing the street.

**INFRASTRUCTURE**

- Infrastructure is already being designed with an eye towards the future, but CAVs will dramatically change the look and feel of the built environment.
- Parking needs will be dramatically reduced in a shared use transportation system.
- Trails and sidewalks will have room to expand with reduce lane sizes.
- V2X technology and human machine interfaces will advance safety at crosswalks.

**ENVIRONMENT**

- CAVs have the potential to be electric vehicles and run on renewable energy sources.
- This technology provides opportunities to reduce fossil fuel consumption, improve air quality, reduce stormwater management costs, and improve habitat quality for wildlife.

**NEXT STOP**

In the next series of posters we will envision the transition to a CAV future by looking at the changes that may occur in policy, land use, infrastructure and the natural environment at one intersection in the city of Shakopee.
Paving the Way

Today's streetscape was designed around the automobile use. These spaces privilege automobiles at the expense of pedestrian safety. Parking takes up valuable space and transit stops are infrequent, making contemporary streetscape inefficient for traffic flow, unsafe for the pedestrian, and an ecological problem.

- Scott County has limited amenities for those who use public transit.
- The county has an opportunity to improve ADA compliance by installing truncated domes, visual and auditory crossing cues.

Despite the many problems of contemporary streetscape designs, the implementation of CAVs will provide opportunities to deal with their challenges. CAVs will usher in a new era focused on pedestrian safety without the compromise of efficient traffic flows.
The implementation of CAVs will bring changes to the built environment. Physical signage will begin to be digitized, CAVs will utilize V2X technology for communication with their surroundings, and energy production will be integrated in the built environment.

**POLICY:**
- **equity**
  - Important to consider V2X availability for low income, immigrant/refugee or youth populations.
  - Signs warn pedestrians about the presence of CAVs.
  - Signage will be used by human drivers and CAVs via connected technology.

**LAND USE:**
- **right of way**
  - Right of way continues to favor cars, but suburban communities begin to transition to multi-modal transit systems.
  - Opportunities for walking, biking and public transit with improved striping and trail connections.

**INFRASTRUCTURE:**
- **V2X**
  - V2X technology could digitize signage such as speed limits, line striping or crossings and transmit information to CAVs.
  - Shift towards being pedestrian and bicyclist-oriented streetscape.

**ENVIRONMENT:**
- **energy**
  - CAVs provide opportunities for regenerative braking energy production.
  - Renewable energy sources become more affordable.
  - Scott County continues to implement electric vehicle charging stations.

**NEXT STOP**
The transition to a CAV dominated world will be slow, with minor changes occurring in high density areas. The rollout of CAVs in a driver dominant world will require forethought in how to use this technology to our advantage and how to mitigate potential problems.
CAV-Oriented Streetscape: CAV-Dominated
Paving the Way

A CAV dominant transportation network will present unique opportunities and important challenges. CAV deployment will likely advance a shared mobility model similar to Uber or Lyft. This will improve accessibility, lead to changes in the urban design of suburban areas, require the development of pick up locations (CAV hubs), and significantly reduce the need for parking space.

As streets become safer and less car-centric, suburban homes begin to embrace arterial streets. Neighborhood streets may be reduced and sometimes replaced with greenways.

Child Walker (@safety1st)

Learn more about shared mobility challenges by examining #sharedmobilityforall posters

9:12 SCOTT

PA 5211: Land Use Planning
Lynda Chao, Dan McNiel, Elliot Mohler, Isaac Hase-Raney | Professor Fernando Burga Ph.D. | TA. Chris DesRoches
Road conversion is introduced to Scott County, in-place options continue to replace lost pavement. Pavement technologies emerge for cost-effective drainage.

Transportation systems become more efficient, fewer lanes will be needed. Multi-modal transportation prioritized. Transit stops serve as drop off and pick up locations for ride sharing CAV services. Transit providers have fully transitioned to CAV technologies. Transit services operate CAVs and are potentially better able to assist transit-dependent populations with disabilities affecting their mobility.

CAV deployment will be determined based upon how effectively communities are able to plan for these emerging technologies. In the next poster we summarize the benefits of CAV technology and offer key considerations for planning a CAV transportation network.

**POLICY:**
- **equity**
  - CAV technology improves quality of life for transportation disadvantaged populations.
  - Residents are better able to access health care, education, and employment opportunities.

**LAND USE:**
- **parcel**
  - Due to increased efficiency and choice, multimodal streetscapes will allow for higher density in most suburban parcels.
  - Suburban homes continue to reorient towards arterial streets and neighborhood roads become reprogrammable areas.

**INFRASTRUCTURE:**
- **lane size**
  - Road systems are more efficient with fewer lanes.
  - V2X technology creates new opportunities for multi-modal transportation.
  - The connected system allows for the integration of bike lanes and shared transitways.

**ENVIRONMENT:**
- **storm water**
  - Improved gray water and stormwater retention, reduction of impervious surface, improved natural landscaping.
  - Expansive green space allows for opportunities to increase permeable surfaces via rain gardens, retention ponds, or native plants.

CAV-Oriented Streetscape: CAV-Only

A CAV only streetscape is still a distant reality and nearly impossible to plan fully. This rendering envisions a dramatically different streetscape where pedestrians have the right of way within a multi-modal transportation network.

CAV-Oriented Streetscape: CAV-Only

Paving the Way

Learn more about CAVs and the future of urban mobility by examining this poster and others at the event.
Paving the Way

Conclusion and Recommendations

The deployment of CAV technology marks the next great transition in our transportation networks. These emerging technologies will dramatically change how people travel and will transform our daily lives in myriad ways. Transportation systems will have the potential to become more accessible, more equitable, more cost effective and more environmentally friendly.

Benefits of CAVs

- Enhance pedestrian safety and well-being
- Provide reliable and affordable transportation to places and jobs
- Enable reliable transportation networks that prioritize safety and efficiency
- Reduce impervious surfaces and lower costs related to stormwater management
- Improve air quality and reduces traffic noises
- VMT: Electric vehicles operating on renewable energy sources

Key Considerations

Policy

- Shared mobility: A multi-modal transportation network can provide an array of benefits to the community. It’s critical to consider the needs of transportation disadvantaged individuals.
- Accessibility: As transit transitions to CAVs existing services are more affordable. Opportunity for CAVs to serve as first mile / last mile compliment to existing transit.
- Equity: Need to address ADA requirements prior to CAV deployment. Understand impacts on immigrant populations, youth and seniors, low income and underserved populations.

Land Use

- Right of Way: The right of way will transition from automobiles to pedestrians. Opportunity to promote shared mobility and multi-modal transportation networks.
- Suburban Design: CAVs result in reductions to curvilinear streets, allow for expanded greenspace, lessen the need for garage space and reorient homes to face street.
- Streetscape: Curb extensions, refuge islands, natural landscaping, street and trail lighting will help transition to a multi-modal transportation network that promotes pedestrian safety.

Infrastructure

- V2X: V2X will be instrumental in ensuring pedestrian safety in a CAV future. Critical to consider accessibility and equity issues prior to implementing V2X technology.
- Lane Size: CAVs will require less lane width than human drivers. Consider environmental, social and economic impacts of reducing lane size.
- Signage: CAVs won’t require major infrastructure changes, but signs and striping will be retrofitted to create a connected transportation network for pedestrians and CAVs.

Environment

- Greenspace: There are significant opportunities to reduce maintenance and operations costs by planting natural landscapes and reducing impervious surfaces.
- Energy: CAVs have the potential to use renewable energy sources. Scott County can look to implement rapid charging stations to prepare for a CAV future.
- Stormwater: A reduction in impervious surfaces has the potential to reduce stormwater management costs and improve habitat quality for wildlife.
Shared Mobility for All?
CAVs and Intellectual Disabilities in Scott County

To provide transportation for its residents, Scott County has traditionally relied on shared mobility systems such as limited fixed-route buses and SmartLink Dial-a-Ride services. However, the county has recently witnessed increasing denial rates for these services, resulting in decreased independence and overall mobility for senior residents and persons with disabilities. This project considers the research tools planners can use to engage senior citizens and persons with disabilities to envision the future of connected automated vehicles (CAVs). We begin our investigation by highlighting the demographics for three Scott County communities along the Highway 169 corridor that represent the key stakeholders for our analysis.

RESEARCH QUESTIONS

Original Research Question
How can planners include the voices of senior citizens in planning for a future with CAVs?

Reformulated Research Question (following fieldwork)
How can planners include the voices of the elderly, developmentally and physically disabled, and low-income public transit riders outside regularly-serviced metro areas in planning for a future with CAVs?

BELLE PLAINE
Belle Plaine has the largest senior population in Scott County, and offers its residents irregular access to a private automobile, a fixed bus route, and the Dial-A-Ride service.

- Residents: 6,700
- Use Public Transportation: 1.1%
- Senior Residents: 9.3%
- Persons with Disabilities: 7%

Belle Plaine is inadequately prepared to offer residents public transportation. The Dial-A-Ride service is the only option for residents without automobiles.

JORDAN
Jordan has the largest population of persons with disabilities in Scott County, but offers the fewest public transportation options for its residents.

- Residents: 6,000
- Use Public Transportation: 0.6%
- Senior Residents: 8.5%
- Persons with Disabilities: 9%

In Jordan, the only option for residents without regular access to automobiles is the Dial-A-Ride service. Steps must be taken to improve public transportation.

SHAKOPEE
Shakopee is the largest city along Highway 169. The city is a hub for commercial and industrial activity and offers residents the most public transportation options within the county.

- Residents: 39,700
- Use Public Transportation: 1.4%
- Senior Residents: 7.4%
- Persons with Disabilities: 7%

Even though the city offers multiple bus routes and direct routes to Minneapolis, very few residents commute by public transportation on a daily basis.

In the following posters, we will consider the challenges and opportunities of conducting outreach through qualitative research for the implementation of CAVs. We will explore the challenges of applying survey tools to engage elderly residents, persons with disabilities, and low-income residents in transportation planning. In the right, we introduce our equity figure: Ellen Johnson, a planner from Scott County. Ellen will tweet about the challenges and opportunities in conducting outreach and qualitative research with under-represented communities. We begin in the next poster by looking at the challenges Scott County currently faces.
The first step in developing an outreach/qualitative research plan is to understand Scott County’s challenges in serving older and disabled populations. In this poster, we explore Scott County’s existing ride sharing landscape.

The Ride Sharing Landscape
Understanding the Complexity of Current Mobility Options

Scott County’s challenge is in finding the optimal mix of services and simplifying their execution. In the next poster, we will explore existing research and case studies for examples of successful shared mobility services. This scan will also inform the creation of the qualitative research plan.
During the early stages of CAV implementation, special consideration must be paid to elderly residents, persons with physical and mental disabilities, and low-income residents. To maintain independence as older adults lose their ability to drive, we suggest that Scott County implement shared mobility options. In this poster, we develop shared mobility recommendations through a review of best practices.

**SHARE MOBILITY DEFINED**
Shared use of a vehicle, bicycle, or other low-speed travel mode as a transportation strategy enabling users to have short-term access to transportation options on an as-needed basis.

**Options for shared mobility**
Scott County will best serve residents by offering multiple modes of shared mobility carefully coordinated for efficiency. This will include planning for fixed-route buses, specialized shuttles, infrastructure that encourages carpooling, and partnerships with rideshare companies such as Lyft. While the various options may ideally meet the needs of a diverse population, redundancy and confusion for elderly residents must be avoided.

**Transition options for aging drivers**
Scott County will best serve residents by providing a mobility transition plan for those who can no longer drive. Older adults are more likely to travel to their destinations in private motor vehicles. This dependency becomes more pronounced in rural communities due to infrequent, inaccessible, or limited-route public transit services. Providing mobility transition plans would help elderly residents stay mobile and independent as they age.

**Extending the age for active living**
Scott County will best serve residents by planning for safe bike paths and space for specialized biking services. Bike share programs can include tricycles, e-cycles, and recumbent bikes that allow for more stability for elderly users. Non-pedal tricycles are an innovative solution in health promotion and expanding transportation options for older adults. Local initiatives offer adaptive, tandem, and trishaw bike services.

**IMPLICATIONS**
Shared mobility has broad implications for transportation, zoning and land use, urban and rural design, housing, economic development, and environmental policy. Shared mobility can aid planners in leveraging positive impacts and taming negative influences of access to transportation for underserved populations.

This review informs the following questions for our outreach/qualitative research approach: What are the current transportation modes for senior and disabled residents? Where are they travelling? What are their barriers to using shared mobility options and mobility restrictions? And how do they feel about CAVs? In the next poster, we look at municipal policy initiatives to inform these questions.
Municipal Policies

Shared Mobility for All?

Planning for a shift in how the elderly and persons with disabilities access transportation requires an analysis of municipal policies. The following four cases highlight governance practices, collaboration, transparency, and innovation.

**DAYTON, OH**
- **Governance**: Montgomery County; 3 rural towns SW of Dayton
- **Regional Transit Authority**
- **Revenue**: Operations, govt grants
- **Partnerships**: Lyft, Montgomery County Board of Developmental Disabilities

**Special Features**
- RTA runs a **free group shopping shuttle**, with reliable fixed hours of operation, but it is only available to those who are **ADA paratransit eligible** who live within 5 miles of the grocery store they frequent.

Dayton provides reliable transport for personal errands like grocery shopping for rural residents. Scott County should implement similar shopping programs for their residents in need.

**PORTLAND, OR**
- **Governance**: Clackamas, Multnomah, & Washington Counties
- **30-year non-profit**
- **Revenue**: 96% grants, contracts
- **Partnerships**: dozens of partners support transportation, access, fare relief, and more

**Special Features**
- Ride Connection’s outreach efforts include **ride ambassadors**, **travel options counselors**, **travel trainers**, and **informational transit boards** in convenient locations. All services are free.

Portland shows great creativity in their outreach and educational efforts. Scott County should expand their travel trainer program to include options such as counselors & ride ambassadors.

**SAN DIEGO, CA**
- **Governance**: San Diego & Imperial Counties
- **SANDAG**
- **Revenue**: grant, sales tax
- **Partnerships**: Caltrans Emerging Priorities Program, Imperial County Transportation Commission Services

**Special Features**
- SANDAG has prototyped **mobility hubs for 8 locations**, the plans for which are openly available. Mobility hubs act as converging points for public transit and an integrated suite of mobility services.

San Diego provides transparent planning documentation for implementing mobility hubs. Scott County should utilize these plans to begin planning for a mobility hub in Shakopee.

**MINNEAPOLIS, MN**
- **Governance**: Hennepin County; Downtown and west metro
- **30-year non-profit**
- **Revenue**: 64% grants, 21% fees
- **Partnerships**: Jewish Family & Children’s Service of Minneapolis, Jacob Garber Transportation Services

**Special Features**
- In addition to the entire west metro and downtown, they also provide transportation to three significant hospitals outside those areas. They offer home visits to enroll new riders.

Minneapolis exemplifies **long-term, sliding fee scale services** that rely on volunteer drivers. Scott County could work directly with this program to learn about volunteer driver retention.

The previous posters inform the creation of a survey to be delivered to riders aboard the morning SmartLink commute. The outreach/qualitative research process is explained in the next several posters.
Outreach/Research Process

Shared Mobility for All?

Our outreach/qualitative research approach was developed to capture the input of a variety of stakeholders. In this poster, we explain the value of qualitative research and various data collection methods as a tool for authentic outreach efforts.

THE QUALITATIVE RESEARCH PROCESSES

Qualitative research methods explore the complexity of human behavior, attitudes, and beliefs. Qualitative research participants are sometimes called stakeholders. They may be a program beneficiary, staff member, volunteer, funder, or community member. Their involvement in research ensures that the results will have value. Stakeholder input can be collected in a number of ways. The methodology we’re recommending for Scott County combines interviews, focus groups, surveys, and participatory mapping. By carrying out this approach we ensure the inclusion of rider’s experience beyond this aggregation of numbers.

Data Analysis

Qualitative research is not a linear process; instead each part of the process will overlap and influence the other. Data analysis can take place throughout the entire research. After every step, a written reflection should take place to produce texts that will shape research findings and influence the research.

Focus Groups

A focus group is a small group of people with common characteristics that relate to discuss a specific topic. They gather together to suggest or react to ideas, clarify potential options, recommend a course of action, or make a decision/plan. Focus groups are often conducted in addition to interviews, either with a subset of interviewees or a separate group with similar characteristics of interest. Group interaction and synergy is what makes focus groups distinctly different than interviews.

Surveys

A survey consists of questions asked to help understand thoughts, opinions, feelings, knowledge, and behaviors. Surveys can be administered in a variety of ways (e.g., telephone, online, in person). Survey findings can be used to draw conclusions or further research questions.

Participatory Mapping

Participatory mapping is a set of approaches and techniques that combines the tools of modern cartography with participatory methods to represent the spatial knowledge of local communities. Participatory maps often represent a socially distinct understanding of landscape and include information that is excluded from mainstream or official maps. Maps created by local communities represent the place in which they live, showing the elements that communities themselves perceive as important.

Next Stop

The next poster details the implementation of our outreach/qualitative research process and considers challenges and opportunities to improve community engagement and data collection in the future.
In this poster we share our initial findings and detail the challenges we encountered in collecting qualitative data.

In addition to investigating barriers that Smart Link riders face in Scott County through online sources, we conducted phone interviews and rode on a Smart Link bus the morning of November 7th, 2018 to interview riders.

The Participatory Mapping Survey

The Task
We asked participants to draw their route for the day on a map, starting at their destination points; however, all participants were riding the same, fixed route buses. Thus, routes were very similar unless the participant was transferring. We also neglected to ask what the stars represented on the map and why they were traveling there. Another barrier was the unexpected population being surveyed. Some riders could not comprehend the exercise and others left it blank. Participants could also elect not to answer any question they wished.

Unexpected Findings
Our interactions with this population was critical in opening up a dialogue about transportation services to low income and disabled persons. We found surveys need to be edited and designed for persons with all types of disabilities. Recommendations for how this could be accomplished are described in Poster 10. Missing data, for instance, could be the result of varying types of data collection (verbal versus written) or a lack of understanding the questions.

The Stakeholder Interviews
We developed a set of 14 open-ended questions. The interactions with our target populations varied between the three of us. The conversations were less formal (as in a semi-structured interview) and more conversational (as in a key informant interview). This enabled participants to offer us a more candid response. Stakeholder input will be crucial to planning for the mobility of the target populations, especially since some of them cannot advocate or speak for themselves. Scott County should greatly expand on these initial interviews, and structure them as key informant interviews.

Surveys, participatory mapping, and stakeholder interviews should continue in Scott County. Ideally, focus groups will also be conducted to confirm or deny the results found with the other methods. The next poster makes specific recommendations for improving the survey and mapping exercise.

Demographics at a glance

 unexpected population being surveyed. Some riders could not comprehend the exercise and others left it blank. Participants could also elect not to answer any question they wished.

The Limitations
Scott County indicated that a senior citizen population was their primary interest, but they arranged for the data collectors to ride a bus filled by persons with disabilities who were largely younger than 60 years old. The survey was not designed with an intellectually impaired audience in mind.

Next Stop
The survey was not designed with an intellectually impaired audience in mind.

Research Implementation
Shared Mobility for All?

The rest of this poster highlights some of the demographic characteristics of our riders and interviewees. It also details the challenges we faced throughout the process and gives recommendations for future use of this qualitative research tool.

Research Implementation

PA 5211: Land Use Planning | Corrin Bemis, Isaac Hase-Raney, Shanda Hunt, Emily Reno | Instructor: H. Fernando Burga, Ph.D. | TA: Chris Desroches

THE RESEARCH TOOLS

3 Phones
3 Laptops
50 Printed Surveys
2 Dial-A-Ride Buses

The Participatory Mapping Survey

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Demographics at a glance

7 participants
3/4 White
4/5 < 60 Years Old
3/4 Earn < $15,000 per year
7/7 Ride the Bus to Work
6/7 Ride the Bus 1 hour per day
4/7 Pay with Waivers

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Surveys, participatory mapping, and stakeholder interviews should continue in Scott County. Ideally, focus groups will also be conducted to confirm or deny the results found with the other methods. The next poster makes specific recommendations for improving the survey and mapping exercise.
Assumptions
We asked participants to mark a star where they began their transit route and place a circle at their final destination with a line connecting the two. We hoped to see trends in the direction of travel among the riders. Urban centers were chosen based on their size and proximity to the 169 Highway Corridor.

Challenges
Most riders on the bus began and ended in the same location, capturing only a small sample and distance of ridership travel patterns. This exercise was produced under the assumption that riders would know how to map their routes. Many riders did not understand the map. We had to draw the lines for them after asking about their route. Scott County should consider the facilitation of participatory mapping and assess appropriate data collection methods for people with intellectual disabilities.

Next Stop
In the next poster, we consider the notes from our observations in relation to the audiences we surveyed on a morning bus trip from Belle Plaine to Shakopee.
Field Notes

Shared Mobility for All?

Having described the **assumptions and challenges** that we encountered with the delivery of our graphic survey, we move into the **synthesis of our fieldnotes** based on **direct observations**. Three of us split up between two buses, but ended at the same final destination. This poster describes our experience through several stops.

**STOP 1:**
Marshall Transit Station
7:30 a.m.
Shakopee, MN

Upon arrival at Marshall Transit Station, we sat in the lobby for about fifteen minutes before realizing that we needed to ask for the travel trainer at the window. We had the impression from conversations with Scott County employees that the bus riders would be primarily seniors. While waiting in the lobby we noticed that most of the people around us were rather young, which made us worried that our survey might not gather meaningful data. There was a **tangible feeling of relief** when we realized that the people in the lobby were not passengers on the Dial-a-Ride bus that we would be taking that day. We convened with Scott County’s travel trainer on our way to Shakopee to pick up the first group of riders.

We first stopped at an assisted living facility. A second bus pulled up and we decided to split up so that we could get more survey participation. All three of us were surprised to find that most riders could not enter the bus by themselves because of physical or mental disabilities, they needed help boarding with the lift gate for their wheelchairs, or needed the assistance of a caregiver. Some caregivers double-checked to make sure that riders were prepared with blankets in case the bus broke down. In this moment we all realized that our survey might not have the impact we anticipated because of the riders’ intellectual disabilities. Nevertheless, we proceeded to attempt data collection and introduced ourselves and the project and asked if anyone was willing to participate. A few riders refused immediately, some opened up to informal conversation, others decided to take the survey when they saw others completing it, and some riders were noncommunicative. Having gone into the process expecting between 15 and 30 surveys, we were disappointed that we only collected 7 surveys, many of which were incomplete.

**STOP 2:**
Assisted living facility

The bus made multiple stops at private residences during our bus ride. Sometimes the rider’s family members would get on the bus to ensure that they had everything they needed for the day. Others were able to board the bus themselves, and appeared to have cognitive disabilities. We learned that most riders were on their way to a **workforce development center**, and that the Dial-a-Ride bus was their primary means of transportation to work. This finding corresponded to initial commentary during our phone interviews; riders not living in assisted living facilities were much less likely to have access to Dial-a-Ride services. It also **refuted our assumption** that riders would be senior citizens.

**STOP 3:**
Private residence in suburban neighborhood

Next, we arrived at a parking lot where a minivan was waiting for us. The driver talked with the rider’s family member like old friends. This was one of many moments when we realized that the **driver’s role went well beyond simply arriving at designated locations and collecting fares**. Most riders appeared to know each other, and had informal seating assignments. We moved seats as riders told us that we were sitting in their spot. This made us question **how comfortable new riders might feel** if they were to secure a ride. Aside from the assisted living facility, only one individual was picked up at a time, which varies considerably from the experience of urban transit users.

**STOP 4:**
Parking lot

Our penultimate stop brought us to a **workforce development center**, which was the primary destination for most riders. We found that other riders who needed to get to Minneapolis using Dial-a-Ride anticipated being late to their appointments because of how many transfers they needed to make. These riders have continued to use the service, however, in excess of ten years because **few alternative options exist**. This reinforced the travel patterns we had discussed with Scott County employees. Many residents of Jordan and Belle Plaine commute to Shakopee.

**STOP 5:**
Workforce development center

Recognizing the **setbacks we experienced** through this process, we dedicate the final poster to an **interpretation of our outreach/qualitative data collection** and **provide recommendations** for how Scott County and future researchers working on this project may consider improvements.
Synthesized Findings

Shared Mobility for All?

While limited, the results of the surveys, stakeholder interviews, and field notes were coded to develop emergent themes and categories. The data were analyzed by applying descriptive statistics and reviewing responses to questions according to distinctive themes. In this poster we highlight significant findings from the surveys, stakeholder interviews, and field notes.

Survey Findings

Participants over 60 years old

Participants with annual income under $15,000

Participants who pay for transportation with county waivers

Excited by idea of expanded services

Do not use Lyft or Uber for transportation

Limited job opportunities due to schedule

No credit cards or smartphones

Bus often makes them late to work

Survey Findings

Stakeholder Interview Findings

Senior Transportation

Many senior citizens in Scott County do not use public transportation. Most drive their own vehicles or get rides from friends and family. The seniors who do use the public transportation system are those on fixed incomes residing in assisted living homes.

Assisted Living Facilities

Wealthier assisted living facilities can afford to hire privatized transportation companies, but those whose residents are paying for services on a fixed income cannot. The staff at one assisted living facility are arranging transportation for seniors, when it is not part of their job.

Use of CAVs

Most participants did not fully comprehend the concept of CAVs. One participant had a more positive view of CAVs after hearing about increased mobility and safety. Most riders would not be able to use CAVs by themselves.

Passengers with Disabilities

2/3 of riders were persons with cognitive and physical disabilities who needed assistance from a caregiver and/or bus driver to enter and ride the bus.

Travel Trainer Program

There is one travel trainer for all of Scott County. The full potential of a travel trainer program is not being addressed. Professionals who are trained in community outreach should be hired to supplement and expand the program.

Field Notes Findings

The final poster names six distinct themes to improve shared mobility in Scott County. We also recommend a timeline of actions the county should take to better serve elderly residents, persons with physical and mental disabilities, and low-income residents.

Dial-A-Ride Services

Scheduling difficulties, cancelled trips, limited destinations, infrequent trips, and driver retention are barriers using public transportation. Volunteer drivers are not reliable, especially in the more rural areas such as Belle Plaine.

Shared Biking Programs

A bike sharing program would be exciting, but not as a form of transportation. The cost of such a program would also make it out of reach due to fixed incomes. A Minneapolis non-profit adaptive bicycling program is eager to expand to more rural areas. They serve people with TBI, cerebral palsy, MS, paralysis, dementia/Alzheimer’s, etc. None of their current clients rely on them for transportation.

Feelings about CAVs

4 nervous

2 neutral

2 excited

“What would make you trust driverless vehicles?”

Safety Features

Testing

Nothing

Scott

Next Stop

Stop

Next

The final poster names six distinct themes to improve shared mobility in Scott County. We also recommend a timeline of actions the county should take to better serve elderly residents, persons with physical and mental disabilities, and low-income residents.

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Scott County Minnesota

Best Practices
Future Recommendations

Shared Mobility for All?

We conclude by offering recommendations to improve shared mobility through Smart Link's services. Given our outreach efforts and qualitative research, our recommendations reflect the fact that persons with intellectual disabilities are largely nonexistent in conversations about mobility for the elderly and CAVs.

THE INTELLECTUAL DISABILITY CHALLENGES

The most underrepresented Dial-a-ride riders are not seniors, but persons with disabilities and low-income residents.

Recommendation: Scott County would best serve its residents by shifting focus to planning for the mobility of low-income and disabled residents.

Unreliable transportation is severely limiting low-income and disabled residents' ability to work and run errands.

Recommendation: Scott County should expand Dial-A-Ride hours, better coordinate ride requests, and focus on driver retention.

Unreliable transportation is severely limiting low-income and disabled residents' ability to work and run errands.

Recommendation: Scott County should expand Dial-A-Ride hours, better coordinate ride requests, and focus on driver retention.

Support staff are likely in low-paying jobs, yet those jobs require a high degree of performance and emotional engagement.

Recommendation: Ensure financial compensation, proper training, emotional support, and collaborative efforts for support staff.

“Abled does not mean enabled. Disabled does not mean less abled.” — Khang Kijarro Nguyen

CHALLENGES

Unreliable transportation is severely limiting low-income and disabled residents' ability to work and run errands.

Recommendation: Scott County should expand Dial-A-Ride hours, better coordinate ride requests, and focus on driver retention.

Unreliable transportation is severely limiting low-income and disabled residents' ability to work and run errands.

Recommendation: Scott County should expand Dial-A-Ride hours, better coordinate ride requests, and focus on driver retention.

There is currently no successful partnership between Scott County and privatized transportation services.

Recommendation: Conduct a cost/benefit analysis to partner with privatized companies to provide reliable transportation to residents.

Unreliable transportation is severely limiting low-income and disabled residents' ability to work and run errands.

Recommendation: Scott County should expand Dial-A-Ride hours, better coordinate ride requests, and focus on driver retention.

Unreliable transportation is severely limiting low-income and disabled residents' ability to work and run errands.

Recommendation: Scott County should expand Dial-A-Ride hours, better coordinate ride requests, and focus on driver retention.

INCORPORATING CAVs ALONG HWY 169

The introduction of CAV technology will not solve the problems explored in this project. Before addressing the relationship elderly residents have with CAV technology, Scott County must improve the relationship elderly residents, residents with disabilities, and low-income residents have with public transportation. The timeline below offers a suggestion for Scott County to move forward.

Creative Funding Initiatives

Tap into unique funds by partnering with assisted living facilities to bring in revenue for transit services and utilizing RFPs or RFIs to crowd-source ideas and solutions to complex design scenarios.

2

Forge New Partnerships

Engage Populations with Intellectual Disabilities

Work with caregivers and participants' families to ensure the questions are being asked in meaningful and useful ways to assess the situation. Design with disabilities in mind by using supportive conversation techniques.

3

Informing CAV Development

For CAVs to support all public transit riders, wheelchair accessibility, seating for caregivers, space for equipment (i.e., walkers), alternative payment options, and limited internet access must be considered during the design process.

4
This project explores how connected autonomous vehicles (CAVs) may improve regional transportation connectivity between Minneapolis and rural Minnesota. We will look at the journey within 10 miles of U.S. Highway 169 from Minneapolis to the new site of the Minnesota Renaissance Festival, located outside of Jordan, MN. Our analysis begins by highlighting the different jurisdictions in this transit network and introducing our equity figure.

**U.S. Highway 169** is the main route in our transportation network. The large graphic on the right represents an abstraction of this geography.

**The Metropolitan (Met) Council**: is a Metropolitan Planning Organization (MPO) that creates policy for transportation, wastewater, affordable housing, parks, and comprehensive plans in the 7-county region. It is the primary transportation governing authority for the region and has the statutory purview to influence overarching plans and policy for CAVs in the transit network.

**Scott County**: Our analysis begins in Hennepin County, but the majority of Hwy. 169 is located in Scott County. Transportation services in the county are offered via SmartLink Transit, a dial-a-ride service. Scott County has the authority to enact ordinances related to transportation as long as they remain in compliance with Met Council policy.

**Renaissance Festival**: How all of these jurisdictions work together to regulate CAV technology will be critical for the future of tourist destinations like the Renaissance Festival. Private tourist destinations may partner with local, county, and state government to fund the infrastructure needed for the introduction of CAV technology.

**Municipalities**: Similar to states and counties, municipalities can enact ordinances related to transportation. Municipalities have their own jurisdictions and can enact ordinances as long as they remain in compliance with Met Council policies. Their local zoning ordinances will impact the use of CAVs.

**Next Stop: U.S. Highway 169 Transect Analysis**

When planning for transportation it is important to ensure coherence across jurisdictions. Transportation coordination is important to provide a system that functions along an entire route without disruption when crossing borders. In the next poster we will place each of these jurisdictions into a transect and explore design scenarios from the urban core to rural areas, like the new Renaissance Festival site.
Next Stop: Introducing our Project Proposals

Planning and development are heavily influenced by density. The transect shows that as density changes, infrastructure must change to accommodate human settlement. With each transect zone now defined, we shift our focus to the proposals of CAV transportation hub. Each CAV hub focuses on a different point or zone in the transportation network to address the key questions for each location.

Urban Core Zone

Highest density and height, with the greatest variety of uses, apartments and civic buildings.
- CAVs will be first implemented in this zone

Urban Center Zone

Higher density mixed-use buildings accommodating retail and office space.
- CAVs will reduce the gap of transit options between the urban core and urban center

General Urban Zone

Wide use of building types, mixed-use but primarily residential.
- Many of these residents are accustomed to driving to public transit hubs. CAVs would affect this dynamic

Sub-Urban Zone

Low-density residential adjacent to some higher density zones with limited commercial.
- CAVs could offer public transit for residents who don’t have alternative options

Rural Zone

Sparsely settled land dotted with agricultural buildings.
- CAVs will be implemented last in this zone

Key Question: How will CAVs impact the site planning of destinations such as the Renaissance Festival?
- We will investigate this question in posters 10 and 11

Key Question: How can infrastructure be improved to provide access to rural zones for CAVs?
- We will investigate this question in posters 8 and 9

Key Question: There is already a transportation network that operates between transects T6 and T5. Could CAVs provide a system that connects these transects to less dense transects?
- We will investigate this question in posters 4 and 5

Key Question: How could CAVs improve regional connectivity in suburban and rural areas?
- We will investigate this question in posters 6 and 7
Next Stop: Suburban CAV Hub Analysis

In the next posters we focus on each CAV hub in our network. For each hub we provide an analytical poster and a design proposal poster.

The Suburban CAV Hub: Transforming Parking Structures

Our first hub design proposal focuses on the Heart of the City Park and Ride in Burnsville, Minnesota. Located just outside Scott County’s borders, this structure serves as a connector between traditional cars and local buses. In posters 4 and 5, we will:
- Investigate how CAVs could transform this structure to improve regional connectivity
- Propose retrofitting parking structures for CAV use and the creation of office space

The Rural CAV Hub: Reclaiming the Surface Park & Ride

The next CAV hub is a park and ride lot in Jordan, Minnesota is a small rural town with limited to no conventional public transportation, making it virtually impossible to travel long distances without a personal vehicle. In posters 6 and 7, we will:
- Discuss the need to connect this rural area to the region
- Explore how underutilized surface lot park and rides can be reclaimed for CAVs oriented uses
- Present a new scenarios to function as a connector for local vehicles and the regional CAV network

The Networked CAV Hub: Adapting Rural Intersections to 5G Connectivity

Our third CAV hub is a 5G connectivity hub. In rural areas of Scott County the county infrastructure accommodates low population numbers. Rural parts of Scott County are connectivity “dead zones,” with no connectivity to 4G and 5G networks. In posters 8 and 9, we will:
- Consider the challenge of “dead zones” that will likely result in obstacles with implementing new technology in rural areas
- Highlight infrastructure changes needed for CAVs to work
- Propose a design scenario for the intersection of Highway 169 and Delaware Avenue with CAV infrastructure

The Maintenance Hub: Converting Private Parking Lots

Finally, we consider how the new Renaissance Festival site will be the final point in the CAV transportation network. Among the site planning opportunities will be a drop-off/pick-up station for CAVs as well as creating a maintenance hub. In posters 10 and 11, we will:
- Illustrate how the CAVs will reduce the need for parking at the Renaissance Festival site
- Recommend converting unused parking space into a CAV maintenance hub

CAVs provide an opportunity to connect more people to different areas within the Metro region. A central concept in this system is the CAV transportation hub (CAV Hub). CAV hubs act as anchors for local transportation networks and connect those networks to each other as well as the region. The CAV hub is defined by the following typologies: urban, rural, networked, and maintenance based. We apply the concept of CAV hubs to propose designs that connect Minneapolis to Scott County and more specifically, the Renaissance Festival site.
In this poster we examine how retrofitting parking structures, such as the Heart of the City Park and Ride in Burnsville, MN can prepare suburban zones for CAVs and provide a connectivity node to urban cores.

The Heart of the City Park & Ride is located in downtown Burnsville. The 90,000 sq ft structure is a 3 story parking garage with 370 spaces.

Our proposed site plan converts the park & ride garage into a mixed use CAV hub. The garage will be retrofitted to include a CAV pick-up zone, traditional parking, storefronts and office space.

The Challenge: Retro-fitting Parking Standards

- In a survey conducted for the 2040 Comprehensible Plan, Scott County residents identified transit connectivity as the biggest challenge.1
- With the implementation of CAVs, parking structures will shift away from parking and adopt alternative functions.
- The Heart of the City Park & Ride, currently used solely for parking. Once CAVs are on the road, parking will become less important and this structure will become obsolete.

Retrofitting the Future

- Architectural firms are beginning to design for parking structure retrofits. Garages that can be converted into housing can be seen in Denver, Cincinnati and Atlanta, with many more in the schematic design stage.
- Scott County has a growing and changing population with a need for an increase in the amount of required workspace. It is estimated that the demand for office spaces will increase by over 700,000 sq ft by 2040.2
- Retrofitting unused parking garages will be a way to reuse existing infrastructure to address the new demand for office space in Scott County.

Next Stop: Design Proposal for the Urban CAV Hub

Retrofitting parking garages and using them for office space will increase connectivity to suburban areas like Burnsville and Shakopee, and to urban centers like Minneapolis. In the next poster we will discuss details of the retrofit.
The design of retrofitted parking structures will differ depending on the specific cases. Our emblematic sections serve as a starting point for future discussion. As parking demand decreases, upper levels of parking garages can be retrofitted for office space or any other use the designer sees fit. The lowest level will almost always be used to store cars, CAVs, and also acts as a CAV/ride share pick-up and drop-off station.

The following pictures are examples of retrofitted parking garages in Atlanta, Denver and Cincinnati.

The outside area of the lower level can be used for store fronts, restaurants or other commercial uses.

Separate entrances for CAVs and driver operated vehicles.

The examples above are parking ramps that have been retrofitted into residential and commercial space. Our design proposes closing off the top of the ramp to create office space.

The current parking structure is three stories tall with 370 stalls. As demand for parking shrinks, spaces in the parking ramp will become underutilized.

Our design proposes closing off the top of the ramp to create office space. As demand for parking shrinks, additional levels will be retrofitted for other commercial or residential uses.

While suburban areas such as Burnsville retrofit existing parking structures to transition to CAVs, rural areas such as Jordan, Minnesota can greatly improve their connectivity by reclaiming surface lot park and rides. In the next poster we discuss how the transportation network can include a surface lot park and ride in municipalities like Jordan, Minnesota.
Rural CAV Hub Analysis
Transportation Renaissance

Getting around rural areas is nearly impossible without a privately-owned vehicle. How can CAVs transform this? By reclaiming surface lot park and rides as a rural CAV hub, a rural public transportation station can service residents by concentrating CAVs at their location. These stations would be equipped with ride calling stations for residents who may not have access to a smart phone or lack fast internet connectivity.

The park and ride in Jordan, MN is a small surface lot located right off of U.S. Highway 169. There are no regular bus routes that service this lot.

The proposed site plan will transform the current surface lot into a CAV pick-up and drop-off zone with a CAV call station, limited traditional parking and a small cafe.

The park and ride described above strive to connect rural areas to the regional transportation system. These lots will not be able to function if the infrastructure around them is not prepared for CAVs. In the next poster we will consider the updates for the road infrastructure in preparation for CAVs.

The Challenge: Future Rural Growth

- While much of Scott County is rural, it has the fastest growing population among counties in Minnesota. Although the majority of this growth will be in more dense areas like Shakopee, Scott County’s rural areas will also experience growth. In fact, many areas that are now considered rural are zoned as an “Urban Expansion Zone” in the 2040 comprehensive zone.
- Park and rides, like the one in Jordan, already have the location and the infrastructure to support transportation connectivity between rural growing populations and the rest of the region.
- With CAVs, surface lot park and rides will no longer be needed for parking. Their use as a CAV hub offers an opportunity where local CAV fleets connect to the regional CAV networks.

Future Need for Rural CAV Hubs

- According to the 2040 comprehensive plan, one of the greatest challenges for Scott County community members is housing, second only to transportation. These surface lots offer a solution to this challenge by providing for housing, including affordable housing.
- Transportation hubs that de-emphasize the need on CAV dependency and potentially liberate parking requirements to zoning designations. By liberating parking requirements building can add ?? to proposed developments.

Next Stop: Design Scenario for Rural CAV Hubs

The surface lot park and ride described above strive to connect rural areas to the regional transportation system. These lots will not be able to function if the infrastructure around them is not prepared for CAVs. In the next poster we will consider the updates for the road infrastructure in preparation for CAVs.
Rural CAV Hub Scenario

Transportation Renaissance

Our previous design scenario for the suburban CAV hub would be convenient for residents living in Scott County’s northern suburban areas, but what about those living in the rural areas? When the regional CAV network expands to rural Minnesota, there will need to be infrastructure to connect rural residents with regional transportation networks. In this poster, we envision a rural CAV hub located at a surface lot park and ride in Jordan.

Existing Section

The current site only includes parking spaces that are underutilized. We propose developing a pick-up/ drop-off structure on the north end of the lot.

Proposed Section

The structure’s width will be able to accommodate up to three CAVs at once but will also be small enough for traditional cars to park on the east side of the lot.

CAVs enter on the east side and exit on the west side.

The pick-up/drop-off structure includes a kiosk to summon CAVs for riders without mobile access.

The structure includes a cafe as well as seating for commuters to work and socialize as they wait for their CAV.

Traditional cars park on the far east side of the site.

Next Stop: Local Roads

Rural CAV hubs will be an important step in increasing CAV accessibility in the rural parts of Scott County. The local infrastructure will need to be ready for the rural CAV hubs. In the next posters, we shift our focus to local roads and highlight the new infrastructure needed to accommodate CAVs.
Networked CAV Hub Analysis

Transportation Renaissance

Rural areas will need to upgrade their road infrastructure in significant ways to accommodate CAVs. In this poster, we explore the intersection of Highway 169 and Delaware Avenue in Saint Lawrence Township, Minnesota to consider the introduction of 5G cells required for CAVs to operate. We also highlight the changes needed to ensure that CAVs will not deteriorate existing concrete.

The Challenge: “Dead Zones”

- Connected autonomous vehicles will rely on 5G coverage to operate. In isolation, these small cells behave like WiFi hotspots than large 4G cell towers. Any given area will need to install several small cells for 5G to work effectively.
- This issue poses a problem for areas like Jordan, which have smaller populations. It will take more devices to provide coverage for the same number of people.
- This technology moves to rural areas only certain areas will be connected to the network, thus creating “dead zones.” This challenge presents a rationale for CAV park and rides in this region.

Roads for CAVs

- As a result of human error, cars drift slightly. CAVs are so precise in navigation that drift is reduced to less than a half of a centimeter. This will result in ruts. To prevent this, roads will need to be constructed with reinforced concrete. Reinforced concrete, which will be able to withstand the constant use created by CAVs.
- Intersections represent another aspect of infrastructure that will change with the implementation of CAVs. Currently, most intersections have infrastructure and signage to aid and direct drivers, however, in the case of CAVs, simple is better.
- A recent study by MIT found that CAVs will use a slot-based system to pass through intersections, allowing them to travel at maximum speed without any accidents. As shown in the graphic on the right, for the slot-based system to be efficient, the intersection should be simple, with the least amount of built infrastructure.²

Next Stop: Designing Local Roads

5G cells will need to be added to the intersection of Highway 169 and Delaware Avenue and reinforced concrete will need to be installed to accommodate CAV travel in rural regions. With these changes, we also foresee commercial use demand to rise along with the expected population growth. But what exactly will all of these ideas look like in practice? Our next poster will answer this question.
Networked CAV Hub Scenario

Transportation Renaissance

Once the **proprietary technology and road infrastructure is installed**, rural Minnesota will be able to join the future regional CAV network. In this design scenario, we consider the intersection of U.S. Highway 169 and Delaware Avenue as an example of what **this transition could look like**. This intersection is located just outside Jordan and is near the new Renaissance Festival site.

**Before**

U.S. Highway 169 currently has two lanes going both ways at this intersection. In our proposal, we use one side of the highway and convert it to a CAV-only road.

**After**

Along this side of the highway we also add a sidewalk to increase walkability. This is possible given the increased safety of CAVs. Sensor poles are added for the installation of 5G small cells.

**Left image:** The initial transition: Two 5G small cells are installed allowing CAVs to access Highway 169. New commercial development begins, but Delaware Avenue does not contain CAV infrastructure.

**Bottom image:** Intermediate transition. More 5G small cells increase CAV traffic and spur development. CAVs now can travel on smaller roads like Delaware Avenue.

**Right image:** Once there is more density, a CAV-only street can be installed on Delaware Avenue.

**Increased connectivity jump starts new development.**

In a transition period, CAVs may travel roads without reinforced concrete, especially less-traveled roads like Delaware Ave.

**One side of 169 will be CAVs-only to increase efficiency.**

To complement increased development, a large sidewalk is added along the CAV-only side of 169.

Next Stop: Maintenance Hub

This design scenario could be applied throughout all rural contexts where connectivity is needed. There is no reason rural America should be left out of the CAV revolution. We now turn our attention to the last CAV hub that will complete the regional transportation network for CAVs. The final two posters will present the CAV maintenance hub.

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Ian Corder, Kathryn Leys, Eric Molinari, Ben Schneider and Ari Del Rosario
Maintenance Hub Analysis

Transportation Renaissance

With the introduction of a regional transportation network defined by CAVs hubs, there will be a need to designate storage and maintenance space for CAV fleets. Our last CAV hub proposal focuses on the maintenance hub. We discuss why we consider the Renaissance Festival site as a desired location, why it benefits the festival, and the purpose it will serve.

The Challenge: Parking at the Festival

- In response to one of the biggest issues at its current site, the new Renaissance Festival site contains a large amount of space for parking. **90% of the entire site is planned for parking.**
- With the implementation of CAVs, many more people are expected to be dropped off, as an alternative to parking.
- A recent study analyzing CAV parking determined that CAVs will **reduce the size of parking spaces by 62% on average.** As a result, even if the number of parking spaces at the festival were to remain at 15,000 ft, the amount of physical space used by these parking spaces would be reduced significantly.¹

New Uses for Old Parking

- CAVs will lead to less individual vehicle ownership and therefore decreased parking. There will be a need to store CAVs while not in use and keep up on maintenance. The space that is currently planned for parking at the new Renaissance Festival site could be used as a storage and maintenance hub for a fleet of rural CAVs.
- Rural/Suburban areas are ideal for maintenance hubs. They are close enough to larger population centers, but far enough so that they do not take up space on high valued land used for offices and housing.

Next Stop: Maintenance Hub Design Scenarios

We propose to use the excess parking space that will not be needed after the transition to CAVs as a maintenance hub for CAVs. This hub will store CAVs that are either not in use or need fixing, upgrade any CAVs that may need it and also serve as a pick-up/drop-off spot for CAVs and ride-share services.

¹ Source: Nourinejad, Mehdi, Sina Bahrami, and Matthew J. Roorda, “Designing parking facilities for autonomous vehicles,” 2018
Maintenance Hub Scenario

Transportation Renaissance

If extra parking space becomes available at the Renaissance Festival, we propose a CAV maintenance hub. The design scenarios we lay out in this poster could be replicated in other rural areas where excessive parking will become obsolete.

**Existing Section**

The current plan for the Renaissance Festival includes traditional parking surrounding the event location. In most cases, there will be a long distance between a parked car and the festival entrance.

**Proposed Section**

The proposed site plan for the maintenance hub focuses on a CAV pick-up/drop-off location that connects to a CAV transit hub. This design will make the entrance more accessible.

- CAVs enter and exit the hub on the West end of the hub. Inside the hub, CAVs charge and receive updates in individual docks.
- The CAV hub will also provide commercial office space.
- The CAV hub connects directly to the entrance of the Renaissance Festival and a pick-up/drop-off location.
- This is the CAV Maintenance facility on the East side of the CAV hub.

**Conclusion**

In the last 11 posters, we have addressed how locations from urban to rural could prepare themselves for a CAV future by using the transportation hub as a model. Each transect zone faces its own set of challenges and offers a unique CAV hub vision tailored at contextualizing the problem. Much remains unknown about the changes that will come with CAVs, however we believe the research and design suggestions described above will inspire the first step towards a connected autonomous vehicle future.