Planning for Automated Vehicles: How to Plan for an Unknown Future

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Overview

Transportation planning attempts to predict the future, forecast trends, and identify transportation investments that promote a safer, more efficient system. With the unknown future of timing and rates of automated vehicle and automated driving system deployments, it is difficult for planners to understand what investment recommendations to make and what future trends will look like. With investments that can last 50-100 years, transportation and planning organizations use scenario planning and other approaches to plan for these uncertainties.

This daylong workshop at the 2020 Automated Vehicles Symposium explored the challenges facing transportation planning and discussed methods to plan for an unknown future. This work helps transportation organizations, planners and industry understand how to plan for a multi-modal automated transportation system and how to use innovative planning tools to address regional and demographics and specific transportation needs impacted by connected and automated vehicles (CAVs).

Goals

The goals of the workshop were to:

1. Discuss difference between ADAS, connectivity, and AV and the range of uncertainties for transportation planning
2. Understand transportation investment practices, including how public organizations plan and invest in transportation infrastructure
3. Introduce participants to federal automated vehicle scenario planning methodology
4. Understand how states and regions have adapted future scenarios to meet regional planning goals, demographic, and population changes
5. Participants will immerse themselves in a scenario planning exercise to understand how to suspend reality and plan for an AV future
6. Provide feedback on AV future scenarios to develop more uniform long-range transportation planning recommendations to ensure consistency in AV transportation planning

Key Takeaways

- **Scenario planning is critical:** Scenario planning is a tool that allows stakeholders to envision both their desired future and possible alternative futures, and determine how to ensure the greatest

benefits while mitigating for potential challenges. Scenario planning can help "future proof" plans and projects.

- **Communities must be involved:** Desired outcomes and priorities must be set with the community and stakeholders, to ensure scenario planning achieves the maximum benefits for all. Equity, environmental sustainability, economic vibrancy, and other goals must be incorporated into each scenario, to ensure assessment and evaluation of potential impacts towards those goals
- **Tools are available:** There are numerous national (FHWA, US DOT) and local resources and examples for scenario planning, as well as tools and software to help with the process.
- **Clarity and guidance is needed** from a national level to create the most likely potential scenarios. Uncertainty about standardized technology and data requirements makes scenario planning for CAV particularly difficult
- **CAVs present potential impacts on equity, both positive and negative.** While the possible implications are widely discussed, ensuring better mobility equity for communities- through access, health, safety, and quality of life- will require collaboration, time, and funding.
- **Long term planning is susceptible to uncertainty,** especially as technology evolves rapidly. Scenario planning can be a tool to help ensure long-term plans remain relevant and responsive to short term needs, and that tradeoffs between decisions are considered in alignment with community goals. However, shorter planning timelines are needed for CAV planning.

Bacground

Transportation planning attempts to predict the future, forecast trends, and identifies transportation investments that promote a safer, more efficient system. States and regional planning organizations are required by law to develop 20-year and 50-year plans for regional transportation systems, which is extremely challenging to do with the uncertainties when connected and automated vehicles (CAVs) will be deployed. With the unknown future and rates of adoption unclear, it is difficult for planners to understand what investments to make and what future trends will look like. With many infrastructure investments – like interstates, roads and bridges - that can last 50-100 years, transportation and planning organizations use scenario planning and other approaches to plan for these uncertainties.

Planners, MPOs, federal government, consultants, and state DOTs hosted a day-long workshop at the 2020 Automated Vehicles Symposium to explore the challenges facing transportation planning and discussed methods to plan for an unknown future. This work helps transportation organizations, planners and industry understand how to plan for a multi-modal automated transportation system and how to use innovative planning tools to address regional and demographics and specific transportation needs impacted by connected and automated vehicles (CAVs).

The workshop answered the following questions:

- How do public organizations plan and invest in transportation infrastructure?
- What is scenario planning and how is it important to government, industry and researchers for planning the unknown future of CAVs?
- What do some of these potential futures look like?
- What are the challenges, opportunities of these futures and what actions do we need to start taking and planning for to leverage the opportunities and mitigate risks?
- How do you conduct scenario planning exercises with government, industry, researchers and communities?

- How does this work advance safety, equity, access, efficiency and sustainability?

Participants in the workshop were from metropolitan planning organizations (MPOs), state DOTs, and local government (42%), 42% were from federal/national governments, and the remaining participants were from the consultants, industry, commercial developers. Over half had little to no experience with scenario planning, while 40% had "heard of it".

Part 1 – Introduction to Transportation Planning and Scenario Planning

The workshop began with an overview of transportation planning, from federal, state, and MPO perspectives. Presenters included John Harding, Connected/Automated Vehicles and Emerging Technologies team Lead, FHWA Office of Operations, Phillip Schaffner, Director of Statewide Planning, Minnesota DOT, and Brett Fusco, Director of Long-Range Planning, Delaware Valley Regional Planning Commission. Key takeaways include:

- The US DOT "Automated Vehicle Concept of Operations" is a 15-year strategy that will help us understand the mixed fleet environment, identify multi-modal (and micro mobility needs), and engages stakeholders to begin to define what it means to be "ready" for CAVs. This "ConOps" looks to 2035's mixed fleet environment and includes stakeholder feedback.
    - ***Automation readiness requires a collaborative understanding of the future***. It may even require less future scenarios to support automated driving systems (ADS).
    - ***The first phase of AV readiness is 2020-2035***. There will be a mixed fleet environment, where there are different modes (including micro-mobility), different jurisdictions and the need for uniform and flexible implementation.
    - ***User-based needs*** - We need to understand that different roadway users have different needs, with different types of AVs, different timelines and different service types.
    - ***4-Steps to a Safe Systems Approach*** - The ConOps has a safe systems approach focusing on: (1) Communities, businesses and travelers; Infrastructure systems (signals, etc.); (3) Institutional systems (state DOTs and other owner-operators); and (4) Vehicles systems (e.g. manufacturers, suppliers)
    - ***A collaborative vision of readiness*****.** After stakeholder engagement and collaboration strategies are identified, in the future we can create a shared roadmap and vision and then implanting strategies to prepare for the future

- State DOTs and infrastructure owner operators (IOOs) are required to develop 20-year and 50-year transportation plans, that are challenged with the uncertainties CAV bring.
    - ***All states are must develop 20-year statewide long-range transportation,*** including multimodal plans, and plans on intelligent transportation systems (ITS), CAV, the Americans with Disabilities Act (ADA), transportation system management and operations(TSMO) and others.
    - **Planning combines technical analysis with public and community engagement.** These plans identify regional vision, goals, objectives and performance measures, and also direct funding, investment and priorities.
    - ***Engage public and stakeholders early and often.*** A specific challenge for planning for AVs is timing. Most construction projects are planned 10-years out and are expected to last 50-100 years. It is difficult to change these projects to include CAV technologies**.**

    - ***Change happens fast***. It took 12 years between when the Model T was first manufactured and when horses were barred from streets.
    - ***Strategies to handle uncertainty*** include: (1) Focus on goals and objectives; (2) Risk assessments; (3) Trend analysis; (4) Scenario planning; (5) Regular plan updates, e.g. every 5 years.

- We need to take a systems approach, and use collaborative planning theory to help address the unknowns of CAV. We need to consider AV impacts on humans, infrastructure funding, land use, and current events – including equity and health.
    - ***We must consider all the factors that impact a CAV future***: (1) AVs will be designed for humans; (2) Taxes pay for infrastructure; (3) The way we build urban areas influences how AVs operate; (4) How people take trips; and (4) Current events, including COVID-19 and racial justice, impact this work
    - ***Equity, safety, active transportation, health, congestion, land use and environment*** are impacted by CAVs.
    - ***We need to take a systems approach.*** Systems are complex. They must be adaptive.
    - Collaborative planning theory helps address unknowns. Urban areas are complex, adaptive (sub)systems.
    - ***Social justice must be considered.*** Social transformation can be achieved through ongoing dialogue, a shared vision, and regular re-evaluation. An ideal decision is one that minimizes biases and maximizes information
    - ***Think big. Think beyond technologies like CAVs.*** What if Ubers and Teslas are just faster horses? What if the way to revolutionize transportation is to think beyond the car entirely?
- **Corridor planning is critical for states to coordinate with neighboring states, regions, and adjacent countries (e.g. Canada)**. There are some formal organizations that work specifically on interstate corridors. Some states, like Minnesota and New York, have international partnerships with Canada. Most corridor planning is done through coalitions on specific corridors, such as the Easter Transportation Coalition, formerly the I-95 Corridor Coalition.

Scenario Planning 101: How Federal, Regional and Local Organizations Can Develop Scenario Tools to Plan for an Unknown Future

The workshop introduced the basics of scenario planning from a federal, state, MPO and an equity perspective. Presenters included Phillip Schaffner, Director of Statewide Planning, Minnesota DOT, Jeremy Raw, Community Planner, Federal Highway Administration Office of Planning, and Lisa Kenney, Greater Buffalo-Niagara Regional Transportation Council.

- ***Scenario planning is a general term that covers the use of multiple future scenarios to inform decisions***. It originated with the military and private sectors, and is a flexible tool that can be used in different ways
- ***"Pick your preferred future" or "prepare for multiple futures"*** – Scenario planning includes two models. Pick your future (known as end state/normative planning) helps pick a desired future to build consensus on how to get there. Preparing for multiple futures (called exploratory or contingency planning) helps account for uncertainty and make better decisions
- ***Avoid overly optimistic scenarios.*** an "everything is awesome" future
- Create materials to create "a day in the life" to set the context. It is helpful to have fake news articles, videos, maps, and images to create a "day in the life" in the future.

- ***Create "personas" and pair workshops with AV demonstrations.*** Personas are fictional characters created from data and research to represent communities and users that use the transportation system. Ask communities and individuals what they think AVs will look like and where they will operate.
    - **Consortium for Scenario Planning is a great resource - http://www.scenarioplanning.io/**
- ***University courses, charrettes, and design workshops can be helpful tools*** in scenario planning, including the University of Buffalo course on scenario planning for emerging transportation technologies

Equity in CAV Planning

Courtney Ehrlichman, Founder, The Ehrlichman Group and Sahar Shirazi, AV and Emerging Mobility Policy and Planning Lead, WSP discussed the importance of viewing this work with an equity lens. Key takeaways include:

- ***To advance equity, we need to acknowledge the past.*** Opportunity rests on a bed of inequity that rests on our historic planning practices. We have an opportunity rethink mobility by thinking about equity
- ***Needs vary based on community demographics.*** Community voices must be directly involved in these conversations.
- ***Address health, equity, access and environment.*** Community health, social equity, access, public health and environmental justice should be addressed in every planning scenario.
- ***Equity mapping, meaningful participation, an equity lens, and equity stories are critical in this work.*** There are four key ways to advance equity in scenario planning:
    - Use equity empirically in mapping and analysis
    - Consider equity in collaborative, participatory activities. Pay participants living wages to participate because they cannot take time off work or leave children behind
    - Use an equity lens to evaluate planning proposals
    - Use equity scenarios and equity stories within the scenario planning process

Scenario planning offers the opportunity to be holistic in our planning. We also need to manage expectations about the future by working directly with communities by empowering them to identify the challenges we are trying to solve with CAV. Integrating community feedback is critical to planning for a future with CAVs. Community members and organizations need to be continuously and meaningfully involved through community "CAV ambassadors" or liaisons that work with transportation organizations and community members.

When working with communities, transportation organizations, researchers and industry must listen to them in an accountable and open way. Be authentic and honest. Do not make grand promises. Ensure people fell heard. During the Covid-19 pandemic and in the virtual environment this can be challenging to do, but it also provides an opportunity to phone call, use mailers, work with trusted community partners, advocacy groups, churches, religious groups, and cultural organizations.

When scenario planning and long-range planning for CAV, the three **biggest challenges are:**

(1) Balancing short-term opportunities with long-term need. For example, organizations must balance the need to fill potholes and address infrequent service while also planning for - and investing in - future technologies.

(2) **Finding ways to meaningfully engage with communities** that historically have not been a part of the conversation or have been actively left out; and
(3) **Equity.** Government, industry, and academia need more diverse voices and audiences to understanding the most probable future and prepare for it.

Part 2 CAV Futures Scenario Planning Workshop

Introduction to CAV Future Scenarios

The scenario planning workshop began with an overview of CAV scenario planning the scenario planning exercise. It is important to understand your audiences' familiarity with CAV in these workshops. When working with the public or communities who are unfamiliar with the technology, it is critical to present an overview of the technology (a "CAV 101"). Then it is important to provide an overview of what scenario planning is, and what participants will expect, including:

- Scenario planning is a general term for an exercise to help in making decisions when the future is unknown.
- It is important to understand regional specifics, including transportation modes, demographics, weather, social groups, ecosystems, and geography. These factors, like weather, are important to consider in scenario planning because technology needs to operate in all environments
- During the exercise, it is important to suspend reality and relate back to your individual scenario.

Participants broke into four breakout groups where they each reviewed and discussed one of four potential future CAV scenarios: (1) **advancing technology**, where CAV innovations only incrementally advance (which is unlike the current environment); (2) **connected infrastructure**, a future where the focus is on connectivity as opposed to automation; (3) **private automation**, where the private industry deploys AVs with little outside coordination, leading to congestion in some urban areas; and (4) **integrated mobility**, where CAV is widely available and serves everyone. In this future, on-demand CAV ride hailing and transit services expand and integrate with other modes of transportation through data sharing, policy, and connected infrastructure

Scenario 1 - Advancing technology

This "future" is arguably a relic of the past, as it envisions a slow transition from our current environment to a CAV future, which would help in developing uniform standards. If we do not continue to advance automation, it will increase inequities and make the technology too expensive to be accessible. If we do not advance automation and connectivity, we will see increased impacts of climate change.
Participants identified the major challenges, opportunities and actions we can take, including:

- Challenges
    - This would be a disappointing future
    - If we only incrementally advance CAV, it may increase equity divides. It is expensive to own an AV and/or ride and some communities, particularly rural ones, will have limited access to AV shuttles
    - Safety features must be available in all vehicles just as NHTSA rules require back up cameras
    - Truck traffic in rural areas could be very heavy to support urban growth

    - Limited advancements would do nothing to mitigate current congestion and climate challenges
    - This scenario aligns with the current culture in rural communities that heavily rely on personal car ownership models
- Opportunities
    - AV Shuttles would feel almost normal
    - More accessibility options would be available, with better quality of service and access for the elderly and others communities who face transportation barriers
    - Slower- scale adoption could help uniformity and the patchwork of regulations we currently face
- Actions
    - Conduct CAV scenario planning
    - Focus on the equity of the services
    - Redirect funding so community members don't have to live in a specific type of community or urban area to access the benefits of this tech
    - Enact data-driven policy around these issues to leverage the safety benefits
    - Further education and understanding about crash avoidance technology.
    - NHTSA must require collision avoidance technologies, starting with commercial vehicles
    - Require connected vehicle technologies in vehicles and along roadsides
    - Protecting the 5.9Ghz spectrum

Scenario 2 – Connected infrastructure

In this future scenario, connected vehicles and devices improve safety and efficiency. The public sector makes significant investment in connected infrastructure to encourage CAV adoption, which has lagged due to slower than expected development of automated vehicle technologies. Level 4 automation availability is limited, but industry readily advances. Participants' key takeaways included:

- Challenges
    - Advancing connected vehicles won't necessarily impact equity and may not advance impaired driving
    - Safety is at risk when only a limited number of cars are connected
    - Rural areas need to see the benefits of connected vehicles but companies won't likely enter these areas , leading to market failures without government intervention and public-private partnerships
- Opportunities: With more connectivity we could see changes in land use
- Actions
    - Uniform standards are needed to help data sharing, including 5G/DSRC) standards
    - Clear goas are needed for the future and what it should look like, including goals for pilots and deployments
    - Pilots are critical to gain experience
    - Consider a connected vehicle freight specification for onboard units (OBUs)
    - Consider modular zoning and curb management policies

Scenario 3 –Private automation

In this future, private industry proliferates AV deployments with a mix of private owned vehicles and competing on-demand providers, with little outside coordination. This leads to congestion in some urban areas and a lack of service in rural areas. Participants' key takeaways included:

- Challenges
    - If we don not coordinate on this work, equity will be negatively impacted, including accessibility
    - This could likely exacerbate a rural/urban divide
    - Forecasting the availability of higher levels of automation is critical
    - COVID-19 impacts and teleworking may impact the need for automated vehicles and the industry's desire to invest in CAV
    - This could lead to a furthered lack of trust of highly automated vehicles (SAE Levels 3-5) and cause over-reliance of Level 2 automated driving systems (ADS)
- Actions: Partnerships, collaboration and shared knowledge is critical if we want to avoid a future where industry deploys this technology without regard for government and communities.

Scenario 4 – Integrated mobility

In this future scenario on –demand CAV ride hailing and transit services are expanded and integrated with other modes through data sharing, policy and connected infrastructure. Level 4 vehicles are affordable and available to average income households and car ownership rates drop. Participants noted that this future could advance quality of life goals more than other futures that do not holistically look at connectivity and automation together as an integrated, multi-modal approach with government intervention and partnerships. Participants identified the major challenges, opportunities and actions we can take, including:

- Challenges
    - A future with more electric vehicles is important, but to meet environmental goals, we have to consider where the electricity is coming from.
    - Without policy, there could be negative impacts with more traffic on the road. If travel is easier, there may be more vehicle miles traveled.
    - If access to these vehicles is affordable and accessible, there could also be a risk for urban sprawl.
    - Need to address what we do with batteries in electric vehicles when they are at their end of life
    - With more transportation options, people may be less physically active and lead to physical health challenges.
- Opportunities
    - With increased amounts of data collection, it could lead to revenue generation if we can protect private data
    - This future could lead to less vehicle ownership, and a more active, multi-modal system
    - With fewer personally owned vehicles, we can rethink urban space. Fewer parking garages are needed.
    - This will advance some industries and the economy.
    - Mental well-being may increase with fewer hours behind a steering wheel and less driving stress. Conversely, individuals facing current transportation challenges may see less stress if transportation options are more widely available.
- Actions
    - Protect rural public transit to ensure access and transportation options

- Equity has to be considered. The Americans with Disabilities Act (ADA) requirements need to be updated to address CAV. We will also need to address equity for the unbanked and those without access to cell phones.
- Create multi-modal hubs (e.g. mobility hugs) and support trip planning and coordination
- Rethink regional land-use policies and development
- Address cashless payment alternatives to support equity

It is important to understand that these are only four of many multiple potential futures. It is important not to provide a "false sense of security" in planning, because with all the unknowns, we cannot guarantee any one outcome. However, you can build off these scenarios, incorporate other technologies, and consider other scenarios in your work. Critical actors and organizations to engage include: the US DOT, including FHWA and NHTSA, metropolitan planning organizations, diverse community Groups, private sector companies, all roadway users, journalists to educate and breakdown, public schools, manufacturers, dealerships to educate owners.

Conclusion

Scenario planning is a critical tool to help plan for CAV futures, but it requires a large commitment in staff and resources. While some leaders are reluctant to do scenario planning because they believe they know the future, scenario planning is a good investment when organizations and regions face competing needs and resources. Small group discussions and workshops are worthwhile because it helps participants learn about CAV, how the technology works, and envision the future. When scenario planning, people bring their own assumptions into what the future may holds for CAVs.

Participants felt that the scenario most likely to occur is scenario 1 (incrementally advancements). They felt that without government policy and partnerships, Scenario 3 (private automation) is the next most likely. When asked, "Which scenario do you most want to happen?" participants wished for Scenario 4 – Integrated Mobility.
You do not need a lot of modeling, significant resources, or consultants to do scenario planning. Start small. Attempt these exercises with a small group or your own team. You can use it as a community engagement technique it is important to learn from other organizations conducting similar planning efforts, including states like Delaware, Minnesota, New York, Ohio, Oregon, Pennsylvania and the City of Toronto. Consider other resources such as the Consortium for Scenario Planning, American Planning Association (APA) scenario planning knowledge base collection, or leading authors like Rob Goodspeed's work.

Regardless of what the future holds, it is important when doing this work to know *why* you are doing it and think about the purpose of your work. Remember that it is okay not to be as scientific and detailed as we typically are in the transportation sector. Embrace uncertainty.

Resources:

- https://www.nytimes.com/2020/07/09/opinion/sunday/ban-cars-manhattan-cities.html
- https://www.dvrpc.org/Products/20012
- https://www.vtrans.org/archive/vtrans2040
- http://www.metrolinx.com/en/regionalplanning/rtp/technical/NavigatingUncertainty.pdf
- https://www.planning.org/knowledgebase/scenarioplanning/

- http://www.scenarioplanning.io/
  - https://www.fhwa.dot.gov/planning/scenario_and_visualization/scenario_planning/scenario_planning_guidebook/
  - https://www.planning.dot.gov/
  - **http://cup.columbia.edu/book/scenario-planning-for-cities-and-regions/9781558444003**
  - AMPO resources: https://www.ampo.org/wp-content/uploads/2018/02/VTrans-Scenarios_AMPO2017_LParkins_v2.pdf
  - http://www.vtrans.org/long-term-planning/alternative-future-and-needs