Strategic Visioning Workshop for Automated Vehicles in Minnesota

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Summary Report

CENTER FOR
TRANSPORTATION STUDIES
UNIVERSITY OF MINNESOTA

Strategic Visioning Workshop for Automated Vehicles in Minnesota

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To the Reader

For years, the development and deployment of automated vehicles (AVs) has been the subject of much research, testing, discussion, and speculation. Many experts agree that AVs hold great promise for dramatically reducing traffic fatalities and serious injuries on roadways, for yielding substantial environmental benefits, and for influencing a paradigm shift in individual car ownership.

However, while the technology for vehicle autonomy is advancing rapidly, the supporting systems, policies, and regulations needed to support successful deployment are much further behind. The public sector must be prepared to plan, decide, implement, and adapt at a fast pace in this rapidly evolving environment.

To help design a framework for deploying AV technologies to the greatest benefit of Minnesotans across the state, we convened the Strategic Visioning Workshop for Automated Vehicles in Minnesota.

During this working meeting, about 100 diverse stakeholders from the public, private, academic, and nonprofit sectors came together for a time of listening and engaging, learning and teaching, defining and creating. MnDOT commissioner Charlie Zelle set the challenge for the workshop's participants, and for all those working with AV technology: Now is the time to shape our own future, and to determine what Minnesota's unique niche will be in advancing and deploying the coming technology. Participants were exposed to breakthrough thinking on the issues presented by AVs in order to stimulate effective and coordinated approaches for addressing them.

This summary is derived from workshop discussions and contains the presenters' and participants' ideas for advancing Minnesota's agenda for AVs, as well as action plans that focus on deployment and identify champions to lead key elements. The result is a document we hope will ensure support to achieve the goals put forth within.

Laurie G. McGinnis

Laurie McGinnis
Director, Center for Transportation Studies

The Great Transition: Shifting to an Active, Shared, Electric, and Automated Transportation System

Speaker: Tim Papandreou, Founder, City Innovate

While technology has sped along at a dizzying pace, the capability to manage mobility and transportation has lagged. That's about to change in a big way, according to Tim Papandreou, founder of City Innovate, which uses data to guide city governments on technologies.

Within one decade, the transportation landscape will change dramatically, with a shift from automobile ownership to a much greater use of shared mobility options. Many of those options will run on electricity and be automated, Papandreou said.

When automated vehicles (AVs) become commonplace, they'll turn the entire transportation system on its head, he added. City design will look different, as will freight movement and mobility management—only a few of the systems set to be transformed.

Until now, AVs and other new mobility systems have been slow to come to market. This has been due in part to the challenges of developing application programming interfaces (APIs), which are software-building tools. But API advancements mean transportation will become the "next big technology frontier," he said. "A lot of people are taking on the mobility space now."

The current mobility system, with its focus on automobile ownership, has been fraught with hardships. They include the death of 40,000 people in U.S. automobile crashes each year, huge swaths of pavement devoted to parking lots and roads, and limited use of shared-mobility systems such as trains and buses.

"But this system is starting to sunset, to be replaced by the dawning of integrated systems that are about choices based on the type of mode and the opportunities available," Papandreou said.

As transportation officials and developers determine how best to focus on the customer—via tools like apps, for example—more people will be willing to take buses, trains, and other shared-ride services, Papandreou predicted.

"Right now, public transit is becoming more robust in some cases, but is still losing ridership because we haven't figured out how to focus on the customer," he said. "This next generation is all about customer service. If you're not focused on the customer, you'll lose them."

In the future, riders will likely be able to request AVs to pick them up and take them to the nearest shared-ride station. Freight will be moved faster and more efficiently by automated haulers, since those systems don't need to stop for breaks or travel limited distances within a day as human drivers do.

Those changes, in turn, will affect how cities are developed, with less space given to freight loading and unloading areas, fewer roads and parking lots, and more room for stores and other destinations that make areas more walkable and errands easier to run, Papandreou said.

Users will have to pay for the benefits of these automated systems in some manner, but payment

Workforce Implications

The shift to AVs will create a need for new job types in the public sector: data scientists, behavioral scientists, and storytellers, Tim Papandreou said. "This is fundamental to how we're going to move forward...The AV tech companies already have these types," he said.

Behavioral scientists will be needed to understand potential AV customers and get them on board with the platform. Data scientists will be critical for understanding and integrating ridership and other data. They'll also determine how to best manage, store, and protect data and help others make sense of the sheer volume of information, Papandreou said.

Storytellers will be needed to explain to people how the transportation shift to AV is going to work, how they will be included and supported in the process, and how they may transition out of jobs that won't be needed in 15 to 20 years. Doing so in a straightforward and engaging way may facilitate acceptance. For example, support for narrowing driving lanes is difficult without explaining the benefit, Papandreou said. "We haven't told the story of *why* this [transition to AVs] is important," he said. "We need to understand the difference between storytelling and just telling."

models have yet to be determined. According to Papandreou, this is an important issue for social equity and access. Currently, most services require use of an app and credit card, and it will be essential to make sure people without access to these things are included, he said.

Papandreou also suggested that a fundamental change is needed in the way cities, states, and regions think about transportation. Instead of considering it independently, the future transportation system should be thought of as a platform within an ecosystem that includes land use, street design, parking management, and performance metrics; for the system to work, those components need to be connected.

Papandreou cautioned against thinking that the arrival of AVs will solve every problem. Because AV is an artificial intelligence technology, it does what it's told. "So if your land uses are still doing the old-school stuff...AV technology will just reinforce this for you," he said. "You have about a two-and-a-half to three-year window to get it right before [AV] starts rolling in....Everything you design in the next two years will stick with you for the next 50. And you don't want an obsolete city or region in the next 15 to 20 years."

In addition, when planning for the automated and electric future, it's important to keep the true cost of transportation in mind. This could include developing a baseline for what it actually costs to move people and things around in our system, Papandreou said.

Partnerships between government, industry, and academia will be essential for success. Without them, AVs will be of limited use, he cautioned.

"It's ultimately about people," Papandreou concluded. "We need to develop a shared vocabulary and a definition of the problem we're trying to solve with AVs to get the vision to bring this together."

Conversation Circle: Barriers, Challenges, Opportunities

Moderator: **Gina Baas**, Associate Director, CTS

During the workshop, participants took part in an interactive "conversation circle" discussion, responding to four questions. Following are key points offered by participants.

What does Minnesota gain by being a leader in the advancement of AVs?

- Leading is an opportunity to further demonstrate Minnesota's successful model for collaboration—across academia, government, and the private sector—in order to be competitive with other regions. This has already been demonstrated in some of the successful pilots taking place in the state—success the AV community can build on.

- If Minnesota takes a leadership position now, it could ensure the state's infrastructure works in the present and in the future. The technology doesn't create the infrastructure—technology goes into what is created. And what is created runs on public processes.

- AV technology has the potential to reduce the cost of transportation, increase access to jobs, address the equity gap, and attract a talented workforce to Minnesota. As a leader in ADA compliance, Minnesota could also be a leader in ensuring people with disabilities are included from the beginning when planning for AV. AV may improve access to employment, healthcare, and other services for seniors, people with disabilities, and mobility-challenged populations.

- By failing to take a leadership role, Minnesota runs the risk of letting AV developers determine the direction technology takes. Because AV is largely private, there's an opportunity to set the playing field for how the private sector should respond.

What challenges inhibit Minnesota from being a leader in this area?

- Minnesota has a tendency to stay comfortable and not embrace change. Its prosperity, innovation, and strong private industry could be liabilities. What's needed is a sense of urgency in AV innovation or other markets will beat Minnesota to it.

- Research is still using metrics around mobility rather than accessibility and around free-flowing traffic rather than getting people where they need to go when they need to be there. The AV community should define metrics around human-centered rather than technology- or machine-centered outcomes.

- Greater Minnesota currently lacks accessible transportation in many areas, such as transit service on evenings and weekends. The disability community wants AVs to be fully accessible and to have a level of standards from the beginning.

- AV technology presents complicated legal issues. Fleets will be more likely to use AV before passenger vehicles. Taxes on these fleets currently make it easier to operate them than to buy connected and automated vehicles. A financing system advantageous for fleet owners will thus be needed.

- Minnesota has a history of successful government partnerships. MnDOT, for example, partners with local governments, the Minnesota Freight Advisory Committee, and U of M researchers. All those could be leveraged on work with AVs.

- Organized labor will find ways to adapt and evolve, but it should be brought to the table early or it will be oppositional. The same is true of many other groups: they will feel threatened if they're not involved from the beginning. The AV community needs to recognize that there are industries whose existence relies on building roads, bridges, and transit systems.

- Elected officials must be brought along because they will listen to what their constituents are saying—and if their constituents are saying AV is threatening, officials will not be on board with it.

- Defining the problem AVs are meant to solve—whether that's equity or freight movement or safety or all of these things—could be a helpful starting point for identifying partners.

- Be one of the first to acknowledge the challenges for AV technology in rural areas and demonstrate how AVs can benefit everyone.

- Get out in front of AV development by adjusting regulatory language and creating public and private partnerships to test AV technology in a controlled environment. Other states are testing in warm climates; Minnesota could position itself to be a leader in cold-weather testing.

- Establish Minnesota's first AV corridor, possibly led by technology companies. The AV lanes could operate like high-occupancy vehicle lanes, cycling on and off as conditions dictate. Additionally, AV demonstrations should allow policymakers and the general public to "kick the tires" of the technology.

- Transform the economic model of today's mobility. Charging for road use may be a critical piece of the solution. Technology will bring expensive infrastructure changes that require novel financing methods. For example, land currently used to store vehicles could be developed collaboratively with the private sector to fund infrastructure.

- Adapt education for the next generation of AV users. Minnesota should prepare to meet the demand for senior technical teachers in civil, mechanical, and electrical engineering, and for people who know how to work with LIDAR and differential GPS. The University of Minnesota should concentrate expertise into a track that's easy to identify so that the institution is known as a powerhouse for AV technologies. And training at the vocational or technical level must educate students to maintain and repair AV infrastructure.

AV and Safety—A Framework for Safe Deployment

Speaker: Jason Levine, Executive Director, Center for Automobile Safety

Automated vehicle technology shows tremendous potential for improving safety and mobility, but the safety of the vehicles themselves must first be proven. The current lack of mandatory federal standards for AV safety is concerning, said Jason Levine, executive director of the Center for Automobile Safety, an independent nonprofit that advocates for auto safety, quality, and fuel economy.

"The development of AV is occurring on public roads without any demonstration of safety, without any regard for public exposure to the hazards they cause, and without comprehensive requirements for insurance or financial guarantees against the hazards presented by the technology," he said.

In addition to a lack of mandatory federal standards, there are currently no industry-wide standards for AV safety and no accepted process for confirming that AVs are conforming to manufacturers' announced standards.

The Center is also concerned that a potential rush to pass legislation on the federal and state level may compromise safety for consumers. "The public should not be unwitting participants in AV engineering development tests," Levine declared. "These tests should take place prior to deployment with the test plans worked out and available to all levels of governance."

Levine said it's critical to establish certain levels of safety before public deployment of these vehicles, "especially as their development and introduction has no precedent worldwide for lawmakers to look to."

One possible mechanism by which industry and the public together could establish the safety of vehicles before they get on the road is based on concepts regularly used in the safe development and deployment of many other new technologies: gated certification. Gated certification is the process of evaluating compliance with standards at different points in the development stage before development can proceed to the next stage. At each "gate," Levine explained, independent reviewers would evaluate developers to ensure they've met the gate's road safety standards.

The Center has proposed a set of principles for a gated certification process—such as requiring AVs to always defer to commands by a designated occupant, possess data recorders that provide sufficient crash data, and respond appropriately to emergency vehicles as well as pedestrians behaving unpredictably. In addition, developers should prove they have the financial resources to cover the risks—including death, injury, or property damage—that AV development testing and public use entail.

The Center acknowledges that gated certification is only one model to safeguard consumer safety. Another would be robust legislation.

"To say 'We'll figure it out later but let us test now' won't work," Levine said. "We don't do it with medical devices, we don't do it with toys for kids, and we shouldn't do it for AVs."

Local Industry Panel: Minnesota Private Sector and AVs

Moderator:
Chris Clark, Co-chair, Governor's Advisory Council on Automated Vehicles, and President, Xcel Energy, Minnesota

Panelists:
Bob Anderson, Vice President of Research & Development, Safety & Graphics Business Group, 3M
Alex Cattelan, Vice President of Engineering, Polaris
Gregory Treinan, Advanced Technology Marketing Manager, Daimler Truck North America

What is your organization's experience with AV so far?

Anderson: For 100 years we've been a translator between the vehicle and the infrastructure. But new cars are taking over some of the things we used to have to do. So we're looking at how we can do that economically with the existing infrastructure and gradually upgrade as the needs of AV take over—at how to manage the economic progression of technologies.

Cattelan: We have government and defense applications…and we're in people's warehouses delivering product. We're figuring out how to fit into on- and off-road infrastructures. We have materials-handling machines and a division of electrified low-speed vehicles. We can apply them in low-speed applications so safety functions are more managed in a controlled environment. On the defense side, we can take power sports and apply them to defense, which gives us the ability to go into places without putting peoples' lives at risk.

Treinan: We've been demonstrating [AV] technology for the past few years in Germany. Three years ago we unveiled our Freightliner Inspiration Truck, the first road-approved truck for autonomous operation, when it drove over Hoover Dam in Nevada. It was interesting to see reaction to that vehicle and to talk to our customers. When they hear about autonomous, they think "driverless." That's a common misconception. This is a level 2 automated vehicle that will be coming to market soon. The drive in Nevada gave us the opportunity to test automated steering, software algorithms, and advanced brake assist.

What will it look like when AVs are on the road?

Anderson: We've observed that people are skeptical about the technology but once they begin to see it they accept it more. It's connected vehicles right now to us—it's not autonomous yet. We think autonomous is more like 50 years out.

Cohabitation on the road is a real opportunity and problem: how to sequester certain vehicles to certain lanes and how cars and drivers will understand that. A lot of drivers out there want to have that driver experience. When we're stuck in traffic or there's road construction is where we could remove the frustration by automating some things sooner.

Cattelan: Collaboration is definitely the key… We're saying we get it, but let's not let the technology be the sole leader—let's do this in a collaborative fashion. Developers have many places to protect their [intellectual property], but they'll have to share use-case data, like the snow testing here in Minnesota. And there may be use cases where the data shows vulnerability. But we can work together to fix it.

Treinan: From a public perspective, seeing reduced accidents and less driver stress provides a lot of benefit. We're not taking the driver out of the equation any time in the near future. It's more like, as we advance up the chain in automation, there will be more changes to the way drivers interact with technology.

How do we provide better access to everyone in our communities?

Cattelan: By collaboratively understanding what the requirements are. What will make this technology work for large-scale adoption? What kinds of communication and data interfaces are required?

Don't let the manufacturers be the ones trying to guess what is needed. We need to work with them so we can provide what's needed in a strategic way.

Here in Minnesota we want to develop the core talent and capability to fulfill this sector. We need to make sure the state is developing the skill set for developing AV technology or AVs won't get developed here. The state, university, and private sectors will bring it forward together.

Treinan: From Daimler Trucks' perspective, it's not about dictating…We're in the safety system and automation development game to assist our customers in reducing accidents. It benefits us to be collaborative

"Don't let the manufacturers be the ones trying to guess what is needed. We need to work with them so we can provide what's needed in a strategic way."

—Alex Cattelan

as well in working with regulators, the public, and vendors as we develop this technology.

Anderson: Mobility is the language we hear about a lot today—not about autonomy but about mobility. When I'm asked what legislative bodies can do, I say they can have a compelling, great vision of where we can and should go…That's where leadership comes in—to go after certain problems in the state. Not everybody has the money or talent or space to do this, but collectively we do. And we need a bold vision that captures people's imagination about what we could do, not about the complexity about what we'll have to do.

Will large groups be out of work with deployment of electric, connected, and autonomous vehicles?

Treinan: That's one of the major concerns of our customer base. When we unveiled our Freightliner Inspiration Truck in 2015, we thought all the fleet drivers would be panicking. But now that they've gotten a better understanding—that it's about driver assistance and not trying to change them—they're good.

We've taken a building-block approach. We're not going from the active safety system to having the driver sleeping in the cab while the truck makes deliveries. Drivers will be able to learn along the way. It's about making the driver safer and more comfortable and reducing fatigue. As we start to think about higher levels of automation it's not about removing the driver but about shifting their role.

What markets are embracing AV development and getting ahead?

Anderson: The states we see as progressive are California and Texas, where they have to transport goods across dense cities. Pittsburgh is another leader because of Carnegie Mellon University. They're making a large investment in safety. They're contending for resources and leadership in the technologies and are progressive in making investments in people and experimental growth.

When new industries are being created and the old industry is evolving, one thing to think about is what will the engineer need to look like in the future. Traffic engineers will need to have new skill sets.

We need a bold vision that captures people's imagination about what we could do, not about the complexity about what we'll have to do.

—Bob Anderson

Vision Elements

As part of the small-group work during the workshop, participants were asked to identify elements of a 10-year vision for AV deployment in Minnesota by answering these questions:

Imagine that you are 10 years in the future and you have been asked by your boss, or your board or your constituents, to describe the state of AV deployment in Minnesota. In one sentence, what would that look like for you?

What progress will have been made in Minnesota to address people mobility, freight mobility, traffic operations and safety, land-use planning and development, and environmental considerations as they relate to AV deployment?

The statements that follow emerged as 10-year vision elements based on the small-group discussions. In varying degrees, each of these elements is reflected in the strategic action plans drafted during the workshop (see page 18) as well as in the strategic direction and additional considerations for success noted on page 16.

- Minnesota is acknowledged as a national leader in AV deployment for urban, rural, and closed-loop conditions with public acceptance and sustainable funding. Operational tests have established use cases for these environments.
- AVs and shared services facilitate more, and more affordable, mobility options and increase equitable access for all Minnesota residents.
- The state's transportation network is safer, with a significant drop in crashes, fatalities, and serious injuries aided by AV deployment.
- Connected and automated technologies enable conventional vehicles and AVs to navigate the transportation network together.
- Policy and regulatory conditions are in place to foster AV deployment. The public sector has the authority and resources to form mutually beneficial partnerships with the private sector.
- AVs and vehicle electrification help Minnesota mitigate environmental impacts from the transportation sector. Air quality improves as Minnesota's carbon footprint (including GHG emissions) is reduced with the deployment of AVs and EVs.
- Truck platooning and other automated vehicle applications improve the efficiency of freight movement.
- Best practices for land-use planning and roadway design are developed that incorporate and account for AV impacts.
- New revenue options are implemented to pay for transportation infrastructure based on an evolving shared, automated, and electrified environment.

What's Happening in Minnesota and Elsewhere

Introduction:
Jay Heitpas, Project Director, Connected and Automated Vehicles, MnDOT

Presenters:
Tim Burkhardt, Senior Transportation Planner, WSP USA, Minneapolis
Scott Shogan, Connected and Automated Vehicles Market Leader, WSP USA, Minneapolis

Far from lagging behind, Minnesota has been preparing for autonomous vehicles with numerous projects, such as the EasyMile Autonomous shuttle pilot, a connected corridor program, and the governor's executive order on AV, Tim Burkhardt began.

And Minnesota is experimenting with a variety of shared mobility platforms—models that AV could build on. Examples include Nice Ride's bike-sharing model, the ridesharing companies Uber and Lyft, and SW Prime, an on-demand transit service for the southwest suburbs and counties that's part of the "microtransit" trend in shared mobility, Burkhardt said.

A consortium of Twin Cities transportation leaders, agencies, companies, and nonprofits unveiled their shared mobility action plan in October 2017. It's intended to increase shared-ride transportation options and take 50,000 cars off the road within 10 years.

In advance of AVs, the Minnesota Department of Transportation (MnDOT) is considering how to collect revenue from shared-ride electric and autonomous vehicles, possibly by charging riders based on the miles they've traveled within the shared vehicles—the way Uber and Lyft currently do, Burkhardt said.

Minnesota is an ideal place to test how AVs can operate in the winter weather of northern climates. MnDOT tested a self-driving bus from the American company EasyMile in rural Minnesota this past winter to better understand what kind of infrastructure would need to be in place to support the shuttle and how well the buses would operate in cold and snow. In clear conditions, the vehicle performed as expected. It performed "pretty good" on ice, slippery pavements, and snow, Burkhardt added, but struggled to travel through blowing or falling snow.

Finally, to ensure the state government is prepared and regulations are in place for AVs, MnDOT established the Office of Connected and Automated Vehicles (CAV-X) to research, test, and deploy connected and automated vehicles. And last March, Governor Mark Dayton signed Executive Order 18-04, which established the Governor's Advisory Council on Connected and Automated Vehicles. It will prepare recommendations in statutes, rules, and policies to the governor and legislature by December 1, 2018.

To further flesh out state AV plans, Scott Shogan said, Minnesota leaders can "crib a page" from AV

What's the Rest of the World Doing?

Canada
- Heavy investment in CV trials and technology incubation
- Extensive scenario-planning efforts
- Focus on AV role in transit, including AV shuttle pilot and "trackless LRV" study

Europe
- Focus on truck/bus automation
- Significant emphasis on electric-infrastructure and pricing policies
- Transit authorities opening for third-party selling of tickets, resulting in new MaaS platforms

Middle East
- UAE pushing aggressively toward AV testing and adoption through regulation
- Dubai RTA testing AV pods
- Dubai Autonomous Transport Strategy aiming for 25% AV trips by 2030

Asia
- Significant CV deployments in Japan using DSRC
- Goals of EV-only sales in India (2025) and China (2030)
- Singapore leading AV testing with mobility-on-demand trials

developers and states and local governments across the nation and around the world that are also getting ready for the potential age of AVs.

While the U.S. Department of Transportation (USDOT) supports connected vehicle pilot programs, many states, including Minnesota, are moving ahead with their own programs rather than wait for federal dollars. "But the pilots are still challenged and encumbered by a debate about which path technology will go down, as well as the lack of a mandate from NHTSA," Shogan said.

The National Highway Traffic Safety Administration (NHTSA) released new federal guidance—Automated Driving Systems (ADS): A Vision for Safety 2.0—in September 2017. Shogan predicted more federal guidance on AV transportation and mobility issues will be coming.

AV developers continue to move forward with development, regardless of the plans in place at any level of government, he noted.

The USDOT designated 10 AV proving grounds in 2017 to provide federally funded places where the technology can be safely tested. The proving grounds will also offer insights into how big data can best be used in AV tests. Overall, the safety test results and the big-data information returned by the proving grounds

will be the foundation on which AV research is built, Shogan said.

The USDOT-funded AV research goes well beyond studying autonomous buses and other shared-mobility vehicles. AVs are critical to freight movement, but their deployment still isn't talked about enough in regulatory and public circles, Shogan added.

In closing, Shogan said to expect AVs to change the economy of shared-mobility systems around the world. Rather than taking away multiple-passenger options, AV will provide still more shared-transportation systems and could boost the economic model to make shared-mobility work, Shogan said.

State and Local Leaders: Experiences to Date

Moderator:
Nick Thompson, Director of Metropolitan Transportation Services, Metropolitan Council

Panelists:
Roger Millar, Secretary of Transportation, Washington State Department of Transportation
Alexander Pazuchanics, Assistant Director, Pittsburgh Department of Mobility and Infrastructure
Kristina Holcomb, Vice President of Strategic Planning & Development, Denton County Transportation Authority, Texas

In this session, attendees heard from a panel of experts who are actively engaged with AV deployments in their jurisdictions.

What have you learned from AV deployments in your areas?

"Our biggest takeaway so far is to focus on collaboration," Kristina Holcomb began. "Everyone has unique needs and resources. On the public side, we have funding opportunities those on the private side don't have. But the private side can bring a level of expertise we don't have."

"It's important to think about what the lived life with AVs will look like," Alexander Pazuchanics said. "The technology is incredibly disruptive in terms of societal norms and the ways cities and regions will operate. [We need to] acknowledge these transitions."

"AV is not a silver bullet. We have to be careful to not become so enamored with the technology we forget the public policy perspective," Roger Millar said. "People will think they can continue suburban development two hours from downtown because the commute will no longer be a problem. But what really is the technology doing for us? AVs have to blend with walking, biking, and mixed-use transportation."

What has been the local response to AVs?

"The federal government named Pittsburgh one of 10 AV proving grounds," Pazuchanics said. "When bicycle advocacy groups polled the general public, a majority was excited by the technology, as long as AVs obey speed limits and stop signs. I think [following the fatal Uber crash in] Arizona, that might be a different conversation."

"There's a fear of the unknown, so we're focused on community education," Holcomb said, referring to her agency's pilot program with Drive.ai that is testing driverless vehicles in Frisco, Texas. "We'll have chaperons sitting in the passenger seat. They'll help people on board and answer their questions."

"[We're setting] up what I call petting zoos, places where people can see this stuff in action," Millar said. "We propose local governments team with agencies and AV developers who could bring their technology into a low-speed urban environment where people could kick the tires."

What advice would you give for how Minnesota should move forward?

"It will be critical to build a sustainable funding strategy to replace revenue losses from things like parking and the gas tax and changes in property tax evaluations," Pazuchanics said. "If not addressed up front, those revenues will be harder to extract further down the line."

"Start small and focus on one market," Holcomb suggested. "Look at case studies [from] other cities. Look at lessons learned and apply them as you're developing policies. Some cities had AV programs first and then the policies came in, and they didn't allow for much out-of-the-box thinking. Make sure to form partnerships and have all the right players at the table."

"You have to get the public health, social equity, environmental, and economic people involved," Millar emphasized. "AV is a means to an end, and the end is the economic prosperity and quality of life you want to have as a community."

Future of Streets: Implications of Shared, Electric, and Automated Vehicles on Urban Infrastructure and Equitable Accessibility

Speaker: **Andres Sevstuk**, Assistant Professor, Department of Urban Planning and Design, Harvard University

AVs have the potential to make cities much more livable—or to greatly increase residents' dependence on single-occupancy vehicles. Policymakers must set a vision for AVs and lay the groundwork to attain it or risk cities overrun with the vehicles. That was the message from Andres Sevstuk during the second day's keynote presentation, in which he talked about how AVs may influence the look of cities in the future.

It's been a common assumption that wide deployment of AVs will result in walkable neighborhoods with easy-to-cross streets, local shops, and less noise and pollution—and generally more livable cities. But that vision could take a completely different turn, Sevstuk said

A project being carried out by Sevstuk and his colleagues, in collaboration with the cities of Boston and Los Angeles, is looking in an applied way at how the "triple revolution" of shared, electric, and automated vehicles will transform a particular infrastructure—especially streetscapes—for better or for worse.

The researchers conducted an exercise at a particular location around the Vermont/Sunset metro station in Los Angeles. Today, the streets surrounding the station contain the expected features of a parking lot, a gas station, retail stores, and a strip mall.

But Sevstuk wondered what the area would

Autonomous Vehicles

Hell   Heaven
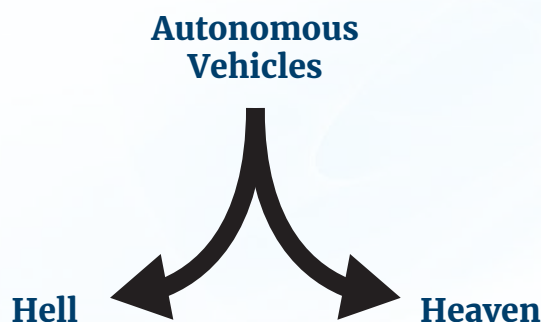
Courtesy Andres Sevstuk

look like 30 years from now, after AVs have become commonplace. So the study produced two quite different scenarios, dubbed "hell" and "heaven." The "hell" scenario depicts an elevated highway—for AV-use only—running along the top of the abandoned metro station. Broken-down single-occupancy AVs are abandoned in the street like litter. Individuals who must walk along the streets (for there are no sidewalks) can't cross them, as traffic lanes are separated by Jersey barriers and railings.

But that image of the landscape around the Vermont/Sunset station—and in other areas across the nation—needn't come to pass, Sevstuk said. In the "heaven" scenario, the width of the road is decreased and well-orchestrated AV pick-up and drop-off zones, taxi stands, and mini-bus stands are implemented. "We have new buildings, and the subway still works. People walk on the streets, and we've reduced the number of vehicles on the street," he said.

But that preferable scenario of life with AVs—of easier commutes, quieter and safer streets, and transportation access for all, including the disabled—won't come to pass if federal, state, and local governments fail to properly guide AV development and implementation, Sevstuk said.

Whether policymakers are aware of it or not, they're currently in a competition over who gets to define what streets will look like in 30 years. "We know the auto industry has been powerful in setting the tone of what our roadways look like today," Sevstuk added. "So how do we collectively define a vision that represents the public interest rather than the interests of AV OEMs [original equipment manufacturers], who generate revenue from their products and services?"

To successfully roll out their pilots, developers will have to align with goals for sustainability, multi-modal transportation, economic development, and spatial equity. "The AV developers that keep those goals in mind will be the most successful," he said.

Although AVs' capability to navigate complex urban environments is still years away, now is the time to determine how that eventual capability will affect streets, Sevstuk said. To do this, land-use and transportation officials must determine an ideal environment that includes AVs and then work backward, putting steps in place that will allow them to achieve that vision in increments.

Above all, policymakers should realize the importance of setting policies and guidance for AVs now, before the vehicles become commonplace, he said. "Otherwise, the transportation system will dictate where we go next. That's been the case for most of the 20th century."

Policy Leaders Panel: What's Ahead?

Moderator:
Sue Mulvihill, Deputy Commissioner, MnDOT

Panelists:
Connie Bernardy, Minnesota House of Representatives
Scott Dibble, Minnesota Senate
Katie Rodriguez, Metropolitan Council
Paul Torkelson, Minnesota House of Representatives

How do we communicate to make sure people understand what we're talking about, participate in implementation, and trust what we're doing?

Torkelson: I think it's about fast, cheap, easy, and convenient. With Uber or Lyft, you pick up your cell phone and it's right there. As a farmer, I use GPS technology every day.

Dibble: I think we need a lot of intentional community engagement and pilots. We're ahead of the technology and ahead of the public on this conversation...If you get too far ahead, the legislature is going to resist. We've seen that in bills introduced after the fatal accident in Arizona that would slow down the technology or even stop it.

But we also need to make sure we address the diversity of our state. There are rural and small-town AV applications, city and suburban, communities of color, the senior community, and the disability community. When we're talking about these communities, we're not talking about one-size-fits-all...We need to make sure we're putting people in a place to make decisions about the direction these solutions will take their lives.

Rodriguez: I don't want to be on the bleeding edge of this. What we do well in Minnesota is collaborate and form partnerships, and we need to do more of that

to put the building blocks in place to make sure we're ready for this technology. The government, academia, the community, and nonprofits can collaborate here.

One of the outcomes we can all agree on is that AVs can provide better mobility for all. But are we using those assets as efficiently as we can? That's part of the total cost accounting of this type of transportation.

From where you sit, how can you help us align Minnesota to a better future?

Torkelson: It's really important for our legislators to provide an environment that allows Minnesota to build a solid foundation for this technology. We need to have laws in place that allow AVs to be tested and vetted here in Minnesota. We have different challenges here than in California and Arizona, and AVs need to operate in a variety of conditions, including flooding.

Bernardy: This hasn't become a partisan issue. I can see where it could become a partisan issue but I really don't want it to. All of you play a role in that as well. Trying to be part of a collaborative environment that can help move this forward would be helpful. As a legislator, I can convene meetings and facilitate meetings.

I think we need to have an inspiring vision come out

of this. Minnesota has been known as [an] innovator and I expect no less now by harnessing the collective wisdom of everyone here in Minnesota.

Rodriguez: I think we need to be open to doing things differently, open to partnerships in ways we haven't before, including within the private sector. I also think we need to recognize that some of our transit services provide accessibility and equity, which is hard to do fast, cheap, and easy. I think we need to tell our story better about that so the public recognizes that providing accessibility and equity is hard.

And I think you have to look at funding. Funding for transportation doesn't work now and we will really have to change that drastically. If you can develop a funding system focused on the outcome of better mobility for all and more efficient use of our assets, I think that we'll do just fine.

A lot of people think AVs will be adopted first in cities and suburbs, so how do we enable Greater Minnesota to benefit from this technology?

Torkelson: I try to deemphasize that rural and urban borderline we've created in so many aspects of government. The density certainly is different, but many of the issues are the same. We have poor people and rich people in Greater Minnesota and in the metropolitan area.

One of the questions we'll be wrestling with is how do we structure the regulatory environment? Do we do things on the state level so we have a common regulatory environment throughout the entire state or do we encourage individualization of the regulatory environment depending on the situation? For Greater Minnesota I think a common, broader regulation makes sense because no company is going to go out and negotiate a contract for every small town, just like no company would negotiate a contract for every single suburb in Minnesota.

Dibble: The Minnesota Council on Transportation Access is a cross-jurisdictional group, so maybe we can task it with doing a deep dive into this: how to innovate access and mobility for those who lack access to private autos, for those who are disabled, for those with lower incomes, and for seniors—particularly those in Greater Minnesota who need access to opportunities.

Bernardy: We really need the top leaders of our parties to agree not to divide this as a rural versus metro issue. We've been talking about strategies, and I think that demonstrations and pilots need to happen throughout the state so people can see how automation can help their communities.

The adoption of AVs and shared electric vehicles will put pressure on the gas tax and sales tax, our normal levers for funding transportation. It will also impact industries that employ people and sell goods related to internal combustion engines. How are you thinking about this?

Dibble: The conversation about replacing revenue sources is an active conversation. But it's also kind of a case study in that the legislature rarely gets out ahead in these things. And it rarely enacts proactive regulation. But we're talking about it…We've had quasi-pilots and turned in policy reports so we have source material to go to and can move quickly in that direction and engage the public.

Torkelson: The workforce issues aren't just related to AV. Automation in general is causing quite a bit of upheaval. Three generations ago, 80 percent of us lived on farms. Now it's somewhere around 1.5 percent. Our society has gone through major transitions before, but what lies ahead for the workforce is hard to know.

Bernardy: It's important for people to participate in these types of AV conversations and events. Especially in transportation, it's better to have voices heard up front than at the end because that can impede implementation. We can all be communicators and ambassadors to get everyone involved in stakeholder groups that support the governor's advisory council.

The Strategic Direction

As the outputs of the workshop were analyzed, seven key themes, or takeaways, emerged. These themes emerged from a review of the workshop keynote presentations, panel discussions, a summary of the conversation circle discussion, and the products of the small-group sessions. The key themes from the workshop are described briefly below and include a reference to the strategic action plan(s) associated with each. Note that one plan may be tied to more than one theme. Complete versions of each of the strategic action plans are included on pages 18–20 of this summary document.

1. Define the problems we are trying to solve and the challenges we want to avoid with AVs

Agencies and organizations should determine if, and how, AV deployment can help support goals and plans they already have in place to address challenges and opportunities that have been previously identified. How can the deployment of AVs contribute to the realization of these goals?

Associated Strategic Action Plans
- Strategy 1.1: Define what problem(s) AV could solve
- Strategy 3.1: Position Minnesota as a leader in CAV certification in adverse weather conditions
- Strategy 4.1: Realize electrification, environmental, and health benefits
- Strategy 4.2: Update zoning and local regulations
- Strategy 4.4: Integrate the full cost of transportation into land use, environmental, and other decision making
- Strategy 4.5: Develop road pricing models that discourage the circulation of empty AVs and address curbside use in urban job centers

2. Focus on people-centric planning

Participants expressed optimism that AVs have the potential to help create a future where all people have equal access to mobility and opportunities regardless of geography, income, or ability. To realize that future, we should first think about the communities that we want and then develop the mobility systems that will help us get there.

Associated Strategic Action Plans
- Strategy 1.2: Review and strengthen policy centered on equitable transportation
- Strategy 1.3: Design the system for the most vulnerable users (pedestrians, bicyclists, and transit users)
- Strategy 3.5: Increase public awareness of technology functions and limitations
- Strategy 4.1: Realize electrification, environmental, and health benefits

3. Create a comprehensive framework for AV demonstration and deployment

There was consensus around the idea of identifying AV demonstration projects for implementation in a wide variety of use cases. These projects should be geographically dispersed (rural, urban, suburban); be at different levels of scale (from corridor to college campus to neighborhood); support multiple mode types, including shared; and account for alternate fuel types, in particular electrification. A policy and regulatory environment for AV deployment that supports innovation and acknowledges the role of government in protecting the public's interest should also be established.

Additional Considerations for Success

The following are general recommendations developed by the AV workshop steering committee.

Encourage alignment of the workshop's outcomes with the recommendations of the Governor's Advisory Council and with the current plans and goals of agencies and organizations that will be involved in the deployment of AVs in Minnesota.

Identify mechanisms for moving the strategic action plans forward and for communicating progress on their implementation.

Associated Strategic Action Plans
- Strategy 1.5: Conduct demonstrations of AVs to meet policy objectives
- Strategy 2.1: Support enabling legislation for freight AV testing
- Strategy 2.2: Develop AV freight pilot projects (e.g., platooning, night hauling)
- Strategy 3.3: Develop CAV compatibility policy
- Strategy 3.4: Migrate roadway infrastructure toward new designs for AV
- Strategy 4.2: Update zoning and local regulations

4. Foster collaborations and partnerships, including at the regional and national levels

Partnerships between government, industry, and academia are essential for success. A lack of cross-sector communication could limit engagement, so developing a shared vocabulary around AVs as well as defining the problems they could help solve would be a helpful starting point. In addition, Minnesota needs to collaborate with other states because AVs will not just travel within its borders.

Associated Strategic Action Plans
- Strategy 2.3: Convene consortium of freight players on AV freight planning and deployment
- Strategy 3.2: Build strong public-private partnerships to test/deploy AV for multimodal operations
- Strategy 4.2: Update zoning and local regulations

5. Account for AV impacts on transportation funding and full costs of transportation

Speakers and participants expressed the importance of developing a better understanding of the potential impacts that AV deployment could have both on revenue sources for transportation as well as the full cost of providing transportation to support both people and goods movement. It was suggested that first a baseline be developed of the full cost for the current transportation system and then measure against that baseline when evaluating AV implementation options.

Associated Strategic Action Plans
- Strategy 1.4: Develop a trip planning application for users to plan and pay for intermodal trips/services
- Strategy 4.3: Replace/supplement current state and local revenues
- Strategy 4.4: Integrate the full cost of transportation into land use, environmental, and other decision making
- Strategy 4.5: Develop road pricing models that discourage the circulation of empty AVs and address curbside use in urban job centers

6. Increase public education and engagement

The public sector and the private sector share the same customers, so they have the opportunity to jointly communicate the benefits of AVs, such as the potential safety improvements that could reduce fatalities and serious injuries. In addition, governments will need to communicate how AV deployment will help address the challenges faced by their constituents.

Associated Strategic Action Plan
- Strategy 3.5: Increase public awareness of technology functions and limitations

7. Develop the workforce of the future in MN

In addition to the new public sector job types highlighted by Papandreou—data scientists, behavioral scientists, and storytellers—new skill sets will also be needed in engineering to deal with AVs complex systems. Minnesota has the breadth of educational institutions needed to develop these core capabilities internally and to attract talent from elsewhere to study and work here.

Create a plan for ongoing engagement and convening of stakeholders around AV deployment.

Engage Minnesota's educational institutions to create new knowledge and develop the workforce needed for AV deployment.

Promote education and understanding among the general public about AV technologies and what opportunities they provide to solve problems.

Action Plans

In addition to the vision elements described previously, the workshop's small groups drafted a series of 18 strategic action plans in the topic areas of people mobility; freight mobility; traffic operations and safety; and planning, economic development, and the environment. Each strategic action plan includes a set of steps, potential champions, other key actors, and a recommended timeframe for implementation.

PEOPLE MOBILITY

Strategy 1.1: Define what problem(s) AV could solve
Action steps:
- Set aside the technology, then survey current mobility challenges (income, disabilities, children, cultures, age)
- Identify connections between AVs and existing challenges

Suggested champions or lead actors: UMN researchers; other third-party researchers
Who else needs to be involved: DEED, MnDOT, MCOTA, Metropolitan Council, private industry (to evaluate specific technologies with regard to challenges)
Suggested timeframe: 1–3 years

Strategy 1.2: Review and strengthen policy centered on equitable transportation
Action steps:
- Identify principles that define equity to be applied to the policy
- Identify AV problem sets for broad ridership community (e.g., urban, rural, wealthy, poor, etc.) and apply principles
- Have technology options that support broad ridership base (e.g., phone card) and incorporate in pilot

Suggested champions or lead actors: Center for Economic Inclusion
Who else needs to be involved: Transit for Livable Communities (now Move Minnesota), League of MN Cities, Metropolitan Council, MnDOT, UMN researchers, private sector (vehicle, connected)
Suggested timeframe: 1–3 years

Strategy 1.3: Design the system for the most vulnerable users (pedestrians, bicyclists, and transit users)
Action steps:
- Governmental units pass and implement a policy to support the goal
- Develop an implementation plan with stakeholders and implement
- Develop performance measures consistent with the goal and policy

Suggested champions or lead actors: Agency staff, elected officials
Who else needs to be involved: Stakeholders including UMN researchers, private sector, general public, other community groups
Suggested timeframe: 1–3 years to develop and implement policy; longer to monitor performance and update as needed

Strategy 1.4: Develop a trip-planning application for users to plan and pay for intermodal trips/services
Action steps:
- Examine similar apps in other markets (e.g., London, Helsinki)
- Engage programmers (open-source?)/broker to collect direct payment through app
- Promote end-user adoption and use
- Develop policy that ties permit to operate with requirement to participate and share data
- Support ongoing maintenance updates
- Explore revenue models (commissions, ads, subscription model)

Suggested champions or lead actors: Municipalities, tourism, private-sector mobility operators, commercial vehicle regulators, transit operators
Who else needs to be involved: Community groups—to mitigate digital, financial, and physical barriers to use
Suggested timeframe: 1–3 years

Strategy 1.5: Conduct demonstrations of AVs to meet policy objectives
Action steps:
- Determine/define problems to address
- Craft various AV demos in different geographic areas to address first action bullet
- Raise public awareness and opportunity for AV technology to support/complement transit
- Capture good data to help inform future policy decisions (be intentional)

Suggested champions or lead actors: Depends on demo type and location: transit agencies, MnDOT, counties
Who else needs to be involved: AV providers, public stakeholders
Suggested timeframe: 1–3 years

FREIGHT MOBILITY

Strategy 2.1: Support enabling legislation for freight AV testing
Action steps:
- Identify gaps and obstacles in legislation
- Understand hesitancy of legislators
- Develop "the story" for why we need to conduct AV freight testing

- Review other states and/or model legislation
- Review opportunities in short term (i.e., limited legislation)
- Document various prioritized AV use cases
- Define parameters for consideration for statements of work

Suggested champions or lead actors: Governor's Advisory Council, Minnesota Freight Advisory Committee (MFAC)
Who else needs to be involved: Legislators, administration, ATRI, private industry
Suggested timeframe: 1–3 years

Strategy 2.2: Develop AV freight pilot projects (e.g., platooning, night hauling)
Action steps:
- Define areas/corridors in MN for freight pilot projects
- Identify and evaluate corridors for freight platooning testing
- Identify testing standards
- Match corridors with technologies

Suggested champions or lead actors: MnDOT
Who else needs to be involved: State Patrol/DPS, MFAC, private industry
Suggested timeframe: 1–3 years

Strategy 2.3: Convene consortium of freight players on AV freight planning and deployment
Action steps:
- Connect with MFAC
- Ensure "right" stakeholders are engaged
- Work with MFAC to accept including AV as a priority item

Suggested champions or lead actors: MFAC
Who else needs to be involved: State Patrol/DPS, MnDOT, private industry
Suggested timeframe: 1–3 years

TRAFFIC OPERATIONS AND SAFETY
Strategy 3.1: Position Minnesota as a leader in CAV certification in adverse weather conditions
Action steps:
- Establish certification process with different gate approval levels
- Create or designate pilot facilities for testing
- Promote to the AV industry, agencies, and other partners
- Designate public or private roads for live testing including in inclement weather

Suggested champions or lead actors: MnDOT, DPS, private industry, legislature
Who else needs to be involved: University of MN, public, trucking/automotive industry, Dept. of Commerce, local agencies

Suggested timeframe: Start in 1–3 years; complete in 4–6 years

Strategy 3.2: Build strong public-private partnerships to test/deploy AV for multimodal operations
Action steps:
- Identify public-private partners and determine SWOT, gaps, barriers, etc. (1–2 years)
- Pilot quick PPP projects (3–6 years)
- Pilot longer-term PPP projects (7–10 years); refine as needed along the way

Suggested champions or lead actors: To be defined as part of first action bullet
Who else needs to be involved: Local and regional agencies, legislators, University of Minnesota
Suggested timeframe: See action timeframes

Strategy 3.3: Develop CAV compatibility policy
Action steps:
- Scan and review statutes, ordinances, and policies for CAV compatibility for the purpose of maximizing public health, safety, and welfare
- MnDOT, DPS, Dept. of Health, DEED, etc., League of MN Cities, Assoc. of Counties to participate in review process, and provide expert witness input to statutes
- Task force/blue ribbon panel to provide expert input; include transportation working groups (trucking association, disability population, travel and tourism, etc.)
- Report recommendations for policy framework to governor

Suggested champions or lead actors: State and local elected leadership plus "Itasca-style" group
Suggested timeframe: 1–3 years

Strategy 3.4: Migrate roadway infrastructure toward new designs for AV
Action steps:
- Need to define learning objectives that agencies want to achieve
- Designate CAV corridors in urban and rural environments owned by state, county, and city jurisdictions
- Agencies need to invest in corridors
- Industry partners need to provide input on corridor ideas (what to achieve) and agencies need to be receptive to input and open to new ideas
- Work with other states on developing national standards

Suggested champions or lead actors: MnDOT champion with cities and counties as lead actors
Who else needs to be involved: Industry partners
Suggested timeframe: 7–10 years to complete

Strategy 3.5: Increase public awareness of technology functions and limitations
Action steps:
- Train technical personnel for individualized training and inspections of on-board technology presence (not calibration)
- Gather existing training materials and create more as needs develop (mode: online, formal licensing, clinics, etc.)

Suggested champions or lead actors: National Safety Council and Minnesota Safety Council
Who else needs to be involved: Driver Vehicles Services (DPS), University of Minnesota
Suggested timeframe: 1–3 years

PLANNING, ENVIRONMENT, AND ECONOMIC DEVELOPMENT

Strategy 4.1: Realize electrification, environmental, and health benefits
Action steps:
- Adapt electricity rates to incentivize EVs and to help the grid operate more efficiently/optimize grid operation
- Start planning for EV charging infrastructure for a variety of use cases with equity incorporated
- Continue the progress toward a decarbonized electric grid
- Deploy electric transport plus clean energy strategically to maximize health benefits

Suggested champions or lead actors: Electric utilities, independent power producers, public health professionals, DOTs
Who else needs to be involved: Utility regulators, MPCA, EQB, Dept. of Commerce, AV providers, labor unions, third-party providers
Suggested timeframe: Planning is happening now, but ongoing as use cases change

Strategy 4.2: Update zoning and local regulations
Action steps:
- Define principles: greater collaboration between public and private spheres, flexibility, and performance zoning to promote "day-to-day" hubs
- Create pilot districts: walkable and livable hubs/destinations in relation to flexible zoning, electrification, and autonomous vehicle technology
- Define privately provided public benefits: enhancing public realm and benefiting private property
- Create white paper with public and private partners at the table

Suggested champions or lead actors: Planners, local governments
Who else needs to be involved: Private partners, technology experts, UMN researchers
Suggested timeframe: 1–3 years

Strategy 4.3: Replace/supplement current state and local revenues
Action steps:
- Define current revenues
- Define how fast electrification is coming
- Develop model to assess impacts
- Develop a blue-ribbon task force to identify potential sources and methods

Suggested champions or lead actors: MnDOT, Department of Revenue, local governments, providers
Who else needs to be involved: UMN researchers, those who receive current funding
Suggested timeframe: Define revenue 1–3 years; electrification 4–6 years

Strategy 4.4: Integrate the full cost of transportation into land use, environmental, and other decision making
Action steps:
- Define full cost (capital, operating, externalities, etc.)
- Determine deployment of resources
- Identify land-use alternatives
- Conduct environmental review

Suggested champions or lead actors: MnDOT, Department of Revenue, local governments, providers, UMN researchers
Who else needs to be involved: Regulators (DNR, MPCA, etc.), employers, policymakers
Suggested timeframe: Research and data collection (1–3 years), scoring and best practices (4–6 years), evaluation of impacts (7–10 years)

Strategy 4.5: Develop road pricing models that discourage the circulation of empty AVs and address curbside use in urban job centers
Action steps:
- Set pricing for SE (shared electric) world that connects to a SEA (shared electric autonomous) world
- Identify questions—make choices
  - Per car v. per mile?
  - How much access to public for providing info?
  - How much access to public for service?
- Develop a curbside app that charges a docking fee

Suggested champions or lead actors: MnDOT, legislators, Department of Revenue, local governments, UMN researchers
Who else needs to be involved: Fleet operators
Suggested timeframe: 7–10 years

Workshop Participants

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