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TRANSPORTATION RESEARCH BOARD

# NCHRP Project 20-102
# Impacts of Connected Vehicles and Automated Vehicles on State and Local Transportation Agencies

Announcement of New Tasks, October 2018

The **National Cooperative Highway Research Program** (NCHRP) is supported on a continuing basis by funds from participating member departments of the American Association of State Highway and Transportation Officials (AASHTO), with the cooperation and support of the Federal Highway Administration, U.S. Department of Transportation. The NCHRP is administered by the Transportation Research Board (TRB) of the National Academies of Sciences, Engineering, and Medicine. The NCHRP is an applied contract research program that provides timely solutions to problems facing highway and transportation practitioners and administrators.

The objectives of **NCHRP Project 20-102** are to (1) identify critical issues associated with connected vehicles and automated vehicles that state and local transportation agencies and AASHTO will face, (2) conduct research to address those issues, and (3) conduct related technology transfer and information exchange activities. This announcement contains preliminary descriptions of those tasks that will be undertaken next by NCHRP Project 20-102.

Nominations for panel members to oversee each of these tasks are currently being sought. A nomination form and résumé should be sent to Mr. Ray Derr (rderr@nas.edu) **by November 20, 2018.** You may nominate yourself or others. Panel members will be responsible for (1) developing the final scope of work, (2) selecting the best contractor, (3) overseeing the contractor's work, and (4) reviewing and recommending publication of interim and final deliverables.

The tasks included in the NCHRP 20-102 portfolio have been largely drawn from a research roadmap developed through **NCHRP Project 20-24(98)** and updated through **NCHRP Project 20-102(19).** That roadmap is available on the project webpage and describes policy, planning, and implementation issues that will face state and local transportation agencies. The research described exceeds the resources that are expected to be available through the NCHRP and it is hoped that other organizations will choose to undertake some of the described efforts.

A competitive process was used to identify four task-order contractors for NCHRP Project 20-102. For each task, it is expected that proposals will be requested from the selected task-order contractors and unsolicited proposals from other organizations will not be considered. The oversight panel for a particular task may choose to use an open solicitation of proposals. In that case, a typical NCHRP request for proposals will be released.

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**IMPORTANT NOTICE**

**The research tasks described are tentative.** The final program will depend on the level of funding available from the Federal-aid apportionments for FY 2019. To accelerate the research program, the NCHRP is proceeding with the customary process through the selection of research agencies.

**NCHRP 20-102(20) Workforce Capability Strategies for State and Local Agencies**

**Funds**: $300,000
**Staff Responsibility:** Andrew Lemer
**Fiscal Year:** 2018

**BACKGROUND**

The transportation industry is rapidly expanding, and new technologies are creating connective networks that are merging the physical and digital worlds of transportation. The pace at which these technologies are evolving is creating workforce challenges for the transportation industry as new skills are quickly becoming essential to deploy, operate, and maintain these technologies. The transportation industry requires new and modified training opportunities to effectively acquire these advanced skillsets.

**OBJECTIVES**

New technologies, such as connected vehicles, connected infrastructure, smart cities, and automated vehicles, are changing the landscape of the physical and digital worlds of transportation and redefining necessary skillsets to achieve successful deployment. These changing workforce needs for state and local agencies must be researched. Key research objectives include:

- Understanding the array of training opportunities/resources currently available to state and local agencies,
- Understanding the areas of incoming technologies that state and local agency personnel feel most comfortable/uncomfortable with,
- Determining the new/anticipated skillsets that will be required of state and local agency personnel and which will require the most training,
- Determining gaps between currently available training resources and necessary new skillsets,
- Understanding the most impactful method of delivery/resource format for the needed new training materials, and
- Understanding how to best evaluate the effectiveness, employee satisfaction, and return on investment of suggested workforce development strategies.

**INTENDED OUTCOMES**

Outputs of this research will inform state and local agencies on how to best prepare their personnel for successful connected and automated vehicle (CAV) deployments. Research results will determine the current training landscape, anticipated skillsets/training needs, training gaps, and strategies for successful training delivery/evaluation. Enhancing the focus on newfound/anticipated training needs and achievement strategies will promote a universal understanding of CAV concepts throughout state and local agencies while effectively guiding personnel to successful CAV deployments.

**NOTES**

The study should build upon National Operations Center of Excellence work, TCRP J-05/Task 18-03, NCHRP 20-07/408, TCRP J-11/Task 34, and other efforts, including the U.S. Department of Transportation's new project titled "Impact of Automated Vehicle Technologies on Workforce." New disciplines and skills should be identified and consideration should be given to the likely V2I communications technologies.

**NCHRP 20-102(21) Infrastructure Modifications to Improve the Operational Domain of Automated Vehicles**

**Funds:** $400,000
**Staff Responsibility:** Ray Derr
**Fiscal Year:** 2018 ($380,000) & 2019 ($20,000)

**BACKGROUND**

AV deployments will be limited to operational domains (OD) where vehicles can readily demonstrate safe operation. Limitations in ODs may stem from factors that challenge an automated vehicle's ability to accurately perceive the surrounding environment and effectively make decisions, such as adverse weather and degraded lane markings. City and state agencies may wish to extend the ODs to improve benefits, such as to improve economic opportunities and accessibility, connect strategic locations, and simply be an attractive place for AV testing and deployment. While agencies may not be able to control some of these OD limitations, they can take steps to modify infrastructure to improve the OD.

Infrastructure modifications may include infrastructure-to-vehicle (I2V) communication systems, signage, and civil infrastructure such as curbs and barriers to provide different levels of segregation between the CAVs and other road users. Uniform and well-maintained traffic control devices, such as lane markings and traffic signs, may improve the extent of AV OD. AV functionality depends on perception algorithms to accurately detect

and respond to infrastructure based on sensor information. Just as humans learn to drive through experience, many perception algorithms use machine learning that is trained to detect and classify objects and events based on past experience. Atypical conditions are more challenging for perception systems. Segregation can create a less complex environment by eliminating mixed road users that can be unpredictable, or can even take advantage of an AV's conservative behavior. Infrastructure owners and operators want to understand how the OD of near term deployments may benefit from infrastructure modifications.

**OBJECTIVE**

This research will review and identify potential infrastructure modifications that could improve the OD of AVs. The analysis will:

- Investigate aspects of technology and operation that influence OD, such as vehicle connectivity, dedicated lanes, AV sensors, perception algorithms, operating speeds, and pickup/drop-off locations;
- Review lessons learned from AV testing and deployment activities;
- Identify and characterize aspects of physical and digital infrastructure elements that may limit OD, such as V2I, curbs, barriers, reflectivity, geometry, and quality of data; and
- Develop implementation guidance for infrastructure modifications, including potential improvements to OD, costs, and impacts to other road users.

**INTENDED OUTCOMES**

This research will provide state and local transportation agencies with guidance on how to modify infrastructure to improve the OD of AVs. The assessment will provide insights based on AV technology and operations. It will provide a catalogue of potential infrastructure modifications, and describe how these modifications will impact ODs. Key considerations for prioritizing potential modifications will be provided to infrastructure owners and operators to enable decision making and investments.

**NOTES**

In addition to highly automated vehicles, the study should include automated driving system (ADS) technologies that are available now. The scope should include the digital infrastructure, data management, and work zones. The scope of this task should be coordinated with that of NCHRP 20-102(24) to minimize overlap.

**NCHRP 20-102(22) State and Local Impacts of Automated Freight Transportation Systems**

**Funds**: $350,000
**Staff Responsibility:** William Rogers
**Fiscal Year:** 2019

**BACKGROUND**

The automation of freight transportation systems is proceeding along multiple fronts and at a pace faster than this sector's historical pace of change. Private capital is flowing into technologies and companies in this space at levels that are also unusual in the sector.

Freight system automation occurs in several environments and throughout the SAE spectrum of automation levels. Truck platooning concepts are focused on corridors that emphasize interstates, but that also have application on major urban freeways. The relative ease of automating limited-access highways relative to urban areas is enticing new operating concepts to be thought about in which distribution centers and similar transfer points are increasingly located adjacent to highway access points, anticipating a future environment in which manned trucks are driven to the access point, followed by a highly automated line haul run across the highway network. Within urban cores, the sector is enjoying a period of robust experimentation in last-mile automated freight delivery options, with localities struggling to keep up with legal, regulatory, land use and other issues within their jurisdictions. Marine and rail port environments present a different operating environment for the introduction of the same basic family of automation technologies.

In 2016, NCHRP Project 20-102(03) identified a set of research initiatives needed to advance automated (and connected) freight systems. The recommendations may be a starting point for updated research; they include the areas of planning, regulation, policy, application-level research, technical standards development, and stakeholder engagement. Topics such as physical and cyber security and privacy are included and important to consider.

**OBJECTIVE**

This research will identify the range of automated freight transportation systems that are under development or consideration, and assess likelihoods, timing, and expected penetrations of deployment. Within this range, the research should offer governments at the state and local level with an enumeration of the issues that impact them and insight on how to address. The research should also guide state

and local governments to act in a way complementary to and in anticipation of the applicable federal guidance in effect at the time of this study (such as defined in the U.S. DOT's Federal Automated Vehicle Policy).

**INTENDED OUTCOMES**

Outcomes of this research should—at a minimum—provide guidance and suggested best practices with regards to state and local decision making to provide a proper environment to evaluate and introduce automated freight transportation systems, covering all relevant functional areas of a state or local government's jurisdiction.

The project should also identify research gaps that organizations such as the U.S. DOT, AASHTO, and TRB should consider to further define the need and help the local governments to succeed.

**PANEL NOTES**

The study should consider the U.S. DOT pilot efforts and the FHWA's National Dialogue on Highway Automation.

**NCHRP 20-102(23) Potential Impacts of Highly Automated Vehicles and Shared Mobility on Traveler Behavior**

**Funds**: $450,000
**Staff Responsibility:** Stephan Parker
**Fiscal Year:** 2019

**BACKGROUND**

In recent years, economic, environmental, and social forces have quickly given rise to shared and on-demand mobility, a collective of entrepreneurs and consumers leveraging technology to share transportation resources, save money, and generate capital. Ridesourcing/ transportation network company (TNC) services, such as Lyft and Uber, and peer-to-peer carsharing services, such as Getaround and Turo, have become part of a sociodemographic trend that has pushed shared on-demand mobility from the fringe into the mainstream. A number of social, environmental, and behavioral impacts have been attributed to shared mobility, and an increasing body of empirical evidence supports many of these relationships. The various effects can be grouped into four categories: (1) travel behavior, (2) environmental, (3) land use, and (4) social. These impacts can include sold vehicles or delayed or foregone vehicle purchases; increased use of some alternative transportation modes (e.g., walking, biking); changes in vehicle miles/kilometers traveled (VMT/VKT); increased access and mobility; reduced fuel consumption and greenhouse gas emissions (particularly when fleets are electrified); and greater environmental awareness. However, the impacts of automated vehicles (AVs) and shared AVs (SAVs) are uncertain. One possible outcome is that existing roadway capacity may increase due to more efficient operations associated with automation (e.g., closer vehicle spacing, etc.). Conversely, there is a possibility for widespread AV and SAV adoption that could induce VMT by making automobile trips more convenient and affordable with fewer hassles than personal driving, such as parking. This could potentially negatively impact the nation's roadway infrastructure through increased VMT and vehicle use. As such, more research is needed to understand the impacts of highly AVs (HAVs) and SAVs on travel behavior.

**OBJECTIVE**

The objective of this research is to explore the potential impacts of HAVs and shared mobility on VMT and system capacity, as well as the behavior of other road users, particularly in light of the potential for zero occupancy vehicles.

Key objectives of this research include:

- Understanding the impact of HAVs and SAVs on private vehicle ownership and use in an automated future;
- Understanding the relationship and interaction of HAVs and SAVs on public transportation;
- Understanding the impacts of HAVs and SAVs on individual modal choice and willingness to use active transportation, public transportation, and other modes; and
- Understanding the VMT, congestion, air emissions (greenhouse gas (GHG) emissions and criteria pollutants) of SAVs and HAVs under a variety potential deployment scenarios, such as:
    - The travel behavior and environmental impacts of HAVs and SAVs on jobs and housing location decisions (i.e., will HAVs/SAVs encourage denser urban cores, suburban/exurban growth, or a combination of both, and under what circumstances?);
    - The travel behavior and environmental impacts of HAVs and SAVs based on business model deployment (i.e., business-to-consumer, peer-to-peer, or mixed fleets); and
    - The travel behavior and environmental impacts of HAVs and SAVs based on a variety of pricing and pooling scenarios (i.e., will zero occupant vehicles be permissible and, if so, under what circumstances?).

**INTENDED OUTCOMES**

Outputs from this research will inform policymakers at all level of government on the potential travel behavior impacts of HAVs and SAVs. The results will help to inform proactive policy development to encourage positive HAV/SAV adoption outcomes, such as reduced congestion and air emissions (GHGs and criteria pollutants). Additionally, the results of this research will enhance understanding of the potential societal adoption and barriers associated with SAV use and the willingness to sell or forego the purchase of a personal AV. Finally, this research will help the public sector understand the potential impacts of HAVs and SAVs on mode choice and the willingness of users to use active and public transportation in an automated future.

**NOTES**

The study should build upon NCHRP 20-102(09) and synthesis efforts on international pilot deployments. It should also include other disruptive modal choices like e-scooters. This is a priority issue for the TRB Forum on Automated Vehicles and Shared Mobility. This project will be combined with TCRP Project B-47, Mobility Inclusion for Un(der)served Population with the Emerging Technologies ($250,000).

**NCHRP 20-102(24) Infrastructure Enablers for Connected and Automated Vehicles and Shared Mobility—Near-Term and Mid-Term**

**Funds**: $600,000
**Staff Responsibility:** Ray Derr
**Fiscal Year:** 2019

**BACKGROUND**

Connected and automated vehicle (CAV) technologies are quickly advancing, and, as a result, there is a growing need for roadways and infrastructure, designed for human drivers, to consider the impacts of CAVs. To achieve a smoother transition to CAV transportation, state and local agencies must understand how and when traditional highway and street infrastructure may be affected and the impacts this could have on design, operations, maintenance, and policy.

**OBJECTIVE**

Existing NCHRP research is already exploring early impacts of potential design changes for roadways, intersections, streets, etc., including dedicated lanes. While an update of that research will undoubtedly be necessary (given how quickly technology is evolving), additional consideration should also be provided to impacts on public agency procurement policies, legislative/regulatory actions, and workforce needs and changes. In dense urban areas, consideration might also be given to curb space and parking management.

Key topics for exploration include:

- Design Standards and Guidelines—given the nature of lateral and longitudinal control of CAVs, what impact will this have on design standards that relied on human variability?
- Digital Infrastructure/Connectivity—CAVs will interact with physical and digital infrastructure in ways that impact their standards and practices. How will that create different network architectures and the need for new business models?
- Variable Roadway Features—features such as reversible lanes, dynamic speed limits, work zones, and dynamic shoulder use are designed for human perception. What types of changes might be needed, and are there alternative methods/technologies that need to be considered?
- Urban Design—in dense urban areas, what changes in curb space might be necessary to accommodate alternative pick-up/drop-off scenarios. What impacts (if any) to parking or vehicle storage might be anticipated?
- Roadway Markings – as more vehicles are equipped with next generation automated driving system (ADS) technology, what impact will this have on maintaining roadway markings and signage in a visible/retroreflective way, and supplementing these by newer technologies?
- Procurement and Regulation – CAV and transportation technology might require a policy-framework that is nimble enough to adapt to fast-changing needs, functional requirements, and product availability.

**INTENDED OUTCOMES**

Outputs of this research will update and expand the guidance for state and local transportation agencies in evaluating and—if necessary—adapting their standards, practices, and institutional frameworks for roadway and infrastructure, urban design, and related maintenance and operations—to reflect the deployment of connected and automated vehicle technologies.

**NOTES**

The study should include work zones and dockless shared personal mobility devices. The task scope will be coordinated with NCHRP 20-102(21) to minimize overlap.