

Connected Vehicle Impacts on Transportation Planning

Technical Memorandum #6: Skills and Expertise Required to Incorporate Connected Vehicles into Transportation Planning

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Final Report—February 8, 2016

FHWA-JPO-16-364



U.S. Department of Transportation

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Technical Report Documentation Page

1. Report No. FHWA-JPO-16-364		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Connected Vehicle Impacts on Transportation Planning <i>Technical Memorandum #6: Skills and Expertise Required to Incorporate Connected Vehicles into Transportation Planning</i>				5. Report Date February 8, 2016	
				6. Performing Organization Code	
7. Author(s) Mark Jensen, Aldo Tudela, Shelley Row, Dan Krechmer, Erin Flanigan				8. Performing Organization Report No.	
9. Performing Organization Name And Address Cambridge Systematics 4800 Hampden Lane, Suite 800 Bethesda, MD 20814				10. Work Unit No. (TRAIS)	
				11. Contract or Grant No. DTFH61-12-D-00042	
12. Sponsoring Agency Name and Address U.S. Department of Transportation ITS Joint Program Office-HOIT 1200 New Jersey Avenue, SE Washington, DC 20590				13. Type of Report and Period Covered May 2015 to January 2016	
				14. Sponsoring Agency Code HOP	
15. Supplementary Notes GTM: Max Azizi					
<p>Professional development and training are essential to the incorporation of connected/automated vehicles (C/AV) into the transportation planning process. In order to guarantee a successful deployment, transportation planning agencies and their stakeholders must understand these technologies well enough to support both planning and operations functions. The objective of this task is to assess and describe how professional development and training programs should be designed to impart the required knowledge and skills.</p> <p>This Technical Memorandum summarizes the results of the work conducted in Skills and Expertise Required to Incorporate Connected Vehicles into Transportation Planning, and documents the results of the following four activities:</p> <ol style="list-style-type: none"> Benchmark Existing Training Programs—C/AV training programs are defined and categorized including a comprehensive table that summarizes available C/AV training such as courses (in person and online), webinars, workshops, presentations, and special event training (e.g., “hackathons”). Public and private sector programs are identified along with academic/NGO programs. Conduct Interviews—Interviews conducted with representatives of the public and private sectors, as well as academic and NGO personnel are documented. Synthesize Interview Findings—Interview findings are synthesized and organized according to the four discussion topics. Provide Recommendations and Potential Strategy—Recommendations for C/AV training for the planning community are summarized, organized by training content, audiences, and delivery approaches, and describes a potential strategic approach to developing a training program, along with a range of expected costs, and recommended frequency for delivery. 					
17. Key Words Connected vehicles, automated vehicles, transportation planning, professional development, skills, training			18. Distribution Statement No restrictions		
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 31	22. Price N/A

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1.0 Introduction

Professional development and training are essential to the incorporation of connected/automated vehicles (C/AV) into the transportation planning process. In order to guarantee a successful deployment, transportation planning agencies and their stakeholders must understand these technologies well enough to support both planning and operations functions. The objective of this task is to assess and describe how professional development and training programs should be designed to impart the required knowledge and skills.

This Technical Memorandum summarizes the results of the work conducted in Skills and Expertise Required to Incorporate Connected Vehicles into Transportation Planning, and documents the results of the following four activities:

1. **Benchmark Existing Training Programs.**

- This section defines and characterizes existing C/AV training programs, including a comprehensive table that summarizes available C/AV training such as courses (in person and online), webinars, workshops, presentations, and special event training (e.g., “hackathons”), each one categorized by the following:
 - Public Sector;
 - Academic/Nongovernmental Organizations (NGO); and
 - Private Sector.
- Also included is a summary of the results of the training course benchmarking.

2. **Conduct Interviews.**

- This section includes documentation of the interview process, including the following:
 - Interview targets based on the three types of organizations defined in step 1 above (i.e., Public Sector, Academic/NGO, Private Sector) and list the organizations interviewed; and
 - Provide interview guidelines and sets of questions used to collect relevant information focused on four discussion topics.

3. **Synthesize Interview Findings.**

- This section provides a synthesis of the interview findings organized according to the four discussion topics.

4. **Provide Recommendations and Potential Strategy.**

- Based on the findings, this section provides recommendations for C/AV training for the planning community, organized by training content, audiences, and delivery approaches, and describes a potential strategic approach to developing a training program, along with a range of expected costs, and recommended frequency for delivery.

1.1 Benchmarking Existing C/AV Training Programs

As a first step towards assessing the role of institutional training and professional development, research was conducted online to determine the current status of training programs in the C/AV field. Table 1 provides an overview of available training programs, characterized by the type of entity providing such programs and stratified by Public, Private, and Academic/NGO Sectors.

More specifically, this table characterizes the focus of current training programs and outlines the types of organizations involved in providing such programs. (Given the growth of topics in this area, new training courses, seminars, and summits are developed on a regular basis.)

The characteristics of different programs can be identified by reference to table 1, based on the type of sponsor organization:

- In general, public agencies' training programs are provided online, with the U.S. DOT's CV 101 and 102 online programs providing a CV overview suited to a relatively wide audience. Furthermore, a following course, CV 201, is currently being developed. This instructor-led course will build off of the CV101 and 102 online courses and is expected to roll-out in 2016.
- Other programs include workshops that offer courses at conferences and seminars. The programs sponsored by academic and NGOs were either in-person programs—involving primarily academic institutions, like the Washtenaw Community College or Michigan Tech Transportation Institute—or short webinars and presentations, seeking to provide a general overview of CV technology.
- The private institutions' training programs were generally in the form of daylong seminars and focused more on operations- and technology-specific topics. In contrast to other programs, privately sponsored programs seem to target populations with greater knowledge of C/AV technology.

An important conclusion to be drawn from this benchmarking effort is that there is not one training program designed specifically for planners. Although the great majority of the programs found are open to the general public and could be of interest to planners, most of these program are either technology- or operations-centric or both. Clearly there remains a need for C/AV-oriented training programs that focus on planning activities.

This underscores the need to build off the more technically oriented training courses for ITS and CV operations—translating content relevant to the stakeholders (transportation planners). Due to the nature of the program, C/AV is necessarily telecommunication connectivity heavy and driven by standards and operations parameters and data. Translating these into transportation-planner recognized terms will be critical to success.

Table 1. Survey of Current Available C/AV Training

Entity Type	Program Type	Entity	Approx. Program Duration	Course or Program Name	Description	Focus
Public	Online courses (recorded for playback)	Intelligent Transportation Systems Joint Program Office—Professional Capacity Building Program (ITS-JPO-PCB)	N/A	ITS Courses and Training (http://www.pcb.its.dot.gov/courses.aspx)	The U.S. DOT, through the ITS Professional Capacity Building Program, provides links to a number of free online courses related to different ITS topics. This source is very useful for professionals with basic knowledge of these topics, as they provide a thorough introduction to different ITS topics.	Important repository of online courses related to different transportation topics, available for all type of audiences, and with different focuses.
Public	Webinar (recorded for playback)	ITS Professional Capacity Building Program (ITS-JPO-PCB)	N/A	ITS Standards Training Modules (http://www.pcb.its.dot.gov/stds_training.aspx)	The ITS PCB provides free ITS standards training. The 35-module series is designed for practitioners working at State and local highway agencies and transit agencies who seek the skills needed to procure, implement, and operate standards-based systems. Consultants, system designers, integrators, and testers will also find the training informative.	Important repository of online courses related to ITS topics, available for all type of audiences, and with different focuses.
Public	Webinar (recorded for playback)	Iteris	3 hours	ITS PCB Standard Training Modules (http://www.iteris.com/cvria/html/resources/cvriatraining.html)	This Web-based training course provides an introduction to the Connected Vehicle Reference Implementation Architecture (CVRIA). The purpose of this training is to acquaint public- and private-sector professionals with the background, structure, Web site, and use of the CVRIA.	Introduction to CVRIA tool, for the correct use of the tool to incorporate Connected Vehicle projects to ITS Architecture.

Entity Type	Program Type	Entity	Approx. Program Duration	Course or Program Name	Description	Focus
Public	Webinar (recorded for playback)	ITS-JPO-PCB	1.5 hours	Connected Vehicle Workforce (https://www.pcb.its.dot.gov/t3/s150910_connected_vehicles_workforce.asp)	This webinar will focus on the workforce skills that support the future CV environment. Attendees will learn about the ITS JPO PCB's CV Training and Education Plan. The Plan is proposed to connect people to training and educational opportunities that will lead certain students to developing CV knowledge, skills, and abilities required for the industry. The webinar will also introduce attendees to the Vehicle-to-Infrastructure (V2I) resources.	Introduction to Connected Vehicles projects, providing initial thoughts on how should attendees prepare for Connected Vehicles' projects
Public	Workshop (one-time event)	ITS-JPO-PCB, Iteris	3 days	Connected Vehicle Reference Implementation Architecture Workshop (http://www.itsa.org/cvriastandardsworkshop)	The ITS JPO/Iteris program addresses the implementation of the CVRIA through the Systems Engineering Tool for Intelligent Transportation (SET-IT) software. The three-day training and workshop sessions are designed to bring together State and local government stakeholders who are planning connected vehicle deployments, device manufacturers who need to know the overall scope of the architecture, researchers and academics, and standards developers.	Workshop focused in practitioners discussing and giving feedback on CVRIA efforts.
Public	Workshop (one-time event)	ITS-JPO-PCB	3 hours	Connected Vehicle 101 Workshop (http://www.its.dot.gov/press/2013/connected_vehicle_training.htm)	U.S. DOT offered a Connected Vehicle (CV) 101 workshop at ITS America. This workshop described the CV concept and the status of U.S. DOT's CV research program. During the workshop, participants had the opportunity to describe their needs concerning future connected vehicle deployment.	Introductory course on Connected Vehicles to assistants.

Entity Type	Program Type	Entity	Approx. Program Duration	Course or Program Name	Description	Focus
Public	Workshop (one-time event)	ITS-JPO-PCB	3 hours	Connected Vehicle 102 Workshop (http://itsannualmeeting.org/blog/the-u-s-department-of-transportation-to-unveil-new-connected-vehicle-102-course-at-itsam/)	U.S. DOT unveiled a new training workshop at the ITS America program in May 2015. This course, CV 102, is designed to prepare transportation managers, project engineers, and operations staff for participating in a CV pilot deployment. The program uses various delivery approaches, including e-learning, archived webinars, e-books, and in-person approaches.	Focus on deployment and implementation, for all type of public agents.
Public	Workshop (one-time event)	ITS Canada	1 day	Western Canada Connected Vehicle Workshop (http://www.its.ualberta.ca/)	This workshop provides an update on the state of the CV industry and Canada's first connected vehicle test bed network, ACTIVE-AURORA.	Introductory workshop.
Public	Workshop (one-time event)	Government of Japan	2 days	2 nd SIP-adus Workshop on Connected and Automated Driving Systems (http://www.sip-adus.jp/workshop/program/index.html)	Experts from Europe, the Americas, and the Asia-Pacific shared information regarding the progress of related projects and discuss technical and nontechnical challenges for deployment. The scope of the discussion included technologies, human factors, legal issues, and integrated applications of automated driving technologies, such as reduction of traffic injuries and next generation transportation services.	Introductory course, seeking to provide assistants broad insights on more specific topics such as human factors, legal issues, and integrated technologies.

Entity Type	Program Type	Entity	Approx. Program Duration	Course or Program Name	Description	Focus
Academic/ NGO	Course (one-time event)	Washtenaw Community College	1 week	The Future Starts Today (http://sites.wccnet.edu/atc/)	The Washtenaw Community College, in cooperation with the University of Michigan, offers a week-long course to explore the science of cell phones and wireless communication. Participants interact with simulated autonomous and connected vehicles equipped with circuits and sensors, created via 3D printers. The course is not currently being offered although more general courses in mobile applications are available.	Technical approach, seeking to provide students a broad understanding of connectivity issues.
Academic/ NGO	Online courses (recorded for playback), and instructor-facilitated courses	Consortium for ITS Training and Education (CITE)	4 hours	Connected Vehicles 101 (http://www.citeconsortium.org/)	This introductory course targets transportation planners, managers, and engineers at State and local agency levels, who are interested in learning more about the Connected Vehicle Program and its benefits and implications for public agencies. Participants will learn about the safety, mobility and environmental applications envisioned for the connected vehicle environment. They will gain an overview of the infrastructure requirements being developed, including communication standards, and operations and maintenance implications, and upcoming policy decisions. There are other ITS-related courses that CITE offers beyond CV; some are related to CV. The entire catalog of courses offered can be seen in CITE's webpage.	Introductory course for all audiences.

Entity Type	Program Type	Entity	Approx. Program Duration	Course or Program Name	Description	Focus
Academic/ NGO	Workshop (one-time event)	ITS World Congress 2015	6 hours	FOT-Net Data International Workshop—ITS and Connected Vehicle Data: from Field Operational Tests to Deployment (http://itsworldcongress.com/associated-events/)	The EU-U.S. Sustainability Working Group (SWG) conducted its second joint workshop on October 9, 2015 in Bordeaux, France. During the workshop, the international audience held discussions about how to prioritize research topics and the prospects for collaborative research. The workshop took place in the context of the EU's Horizon 2020 program and the United State's CV research program.	Research focus, seeking to uncover research gaps and needs to facilitate deployment.
Academic/ NGO	Workshop (one-time event)	Transportation Research Board (TRB)	2 days	Connected Vehicle Dynamic Mobility Applications and Multimodal Intelligent Traffic Signal Systems (http://www.trb.org/Calendar/Blurbs/172020.aspx)	TRB sponsored the Workshop on Connected Vehicle Dynamic Mobility Applications and Multimodal Intelligent Traffic Signal Systems on May 17-19, 2015 in Scottsdale, Arizona. The workshop explored the current state of the practice in multimodal traffic signal control in relation to connected and automated vehicles.	Technical focus, particularly on traffic signal control.
Academic/ NGO	Workshop (one-time event)	Michigan Tech Transportation Institute	3 hours	Developing Partnership and Advancing Driving Research (http://www.mtti.mtu.edu/news/workshop-developing-partnership-and-advancing-driving-research-hosted-michigan-tech-campus)	In May of 2015, Michigan Tech Transportation Institute (MTTI) hosted a workshop named "Developing Partnership and Advancing Driving Research" attended by researchers and practitioners interested in in-vehicle user interfaces and applications. This workshop's goal was to identify plausible research projects and collaborators for each identified project, introduce possible funding agencies and proposal submission logistics, and plan and schedule activities that will culminate in competitive proposal submission.	Research focus, seeking to uncover research gaps and needs to facilitate deployment.

Entity Type	Program Type	Entity	Approx. Program Duration	Course or Program Name	Description	Focus
Academic/ NGO	Webinar (recorded for playback)	University of Virginia	5 hours	CVI-UTC Connected Vehicle Short Course (http://www.cts.virginia.edu/cvi-utc-connected-vehicle-short-course-to-be-delivered-as-distance-learning-as-well-as-workshop/)	The goal of this short course is to provide participants with a basic understanding of CV technology.	Introductory course for all audiences.
Academic/ NGO	Webinar (recorded for playback)	Commercial Vehicle Training Association (CVTA)	1 hour	Advancing the connected vehicle (http://www.automotiveworld.com/events/webinar-advancing-the-connected-vehicle/)	In this 60-minute free webinar, Scott McCormick of CVTA addresses the challenges C/AV presents in the areas of privacy and data ownership, enabling capability in existing cars, and standards for training and certification.	Focus on security challenges and data ownership.
Academic/ NGO	Presentation (recorded for playback)	CITE	1 hour	Connected Vehicles and the Future of Transportation http://www.51ea.net/course.asp?CourseNo=362944	This one-hour presentation is part of the Regional Operations Forums (ROF) developed under the Strategic Highway Research Program (SHRP 2) Project L36: Regional Operations Forum for Advancing Systems Operations, Management, and Reliability. The presentation educates participants regarding the concept of C/AV and its applications by public agencies. There are other ITS-related courses that CITE offers beyond CV; some are related to CV. The entire catalog of courses offered can be seen in CITE's webpage.	Introductory course for all audiences.
Academic/ NGO	Presentation (one-time event)	American Planning Association (APA)	1 hour	Automated Vehicles and Transportation System Sustainability http://orfe.princeton.edu/~alaink/SmartDrivingCars/Presentations/APA_2014_Atlanta/APA_Merlin_042614.pdf	During the 2014 National Conference of the American Planning Organization, Dr. Louis A. Merlin gave a presentation on automated vehicles and the impacts of this technology on planning processes.	Focus on sustainability concerns.

Entity Type	Program Type	Entity	Approx. Program Duration	Course or Program Name	Description	Focus
Private	Courses (one-time event)	SAE International, CVTA, Mobile Comply	1 day	Wireless Communications in the Autonomous Connected Vehicle (http://training.sae.org/seminars/c1025/)	This course provides an engineering and technical overview divided into through three sections: a general overview of technology, issues with networking (Vehicular Area Network (VANET) and Mobile Ad Hoc Network (MANET)), and applications opportunities. The program provides a trademark certificate of Connected Vehicle Professional after participants' completion of the courses.	Technical focus, to understand in depth connectivity and technology issues.
Private	Courses (one-time event)	Secunet	1 day	Security for connected vehicle (http://www.secunet.com/en/topics-solutions/automotive-security/security-for-connected-vehicles/)	Secunet, a cybersecurity provider, offers courses about the security of CV as relates to its products.	Technical focus on security concerns.
Private	Courses (recorded for playback)	NXP	1 hour	Secure Connected Vehicle (http://www.nxp.com/applications/secure-connected-vehicle:SECURE-CONNECTED-VEHICLE)	NXP provides training modules about the services they provide, including services relating to sensors and network connectivity for vehicle-to-vehicle and vehicle-to-infrastructure (V2X) communications.	Technical focus on Connected Vehicle security.
Private	Presentation (presentations available as documents)	Cisco	1 hour	Connected Vehicles (http://www.cisco.com/web/about/ac79/ps/motm.htm#~cv)	This presentation describes CV technology and suggests research opportunities for researchers and academic institutions.	From general concerns in Connected Vehicle implementation, to introduction of more precise concerns, like insurance and service providers.

Entity Type	Program Type	Entity	Approx. Program Duration	Course or Program Name	Description	Focus
Private	Webinar (one-time event)	TU-Automotive	1 hour	In Car Data Enables New Frontier of Services (http://www.tu-auto.com/europe/webinar-in-car-data.php?utm_source=CVTA&utm_medium=External%2Bemail&utm_campaign=2711)	TU-Automotive is an international organization that seeks to serve as a hub for the automotive sector and manufacturers of different technologies, including electronics, mobile, and Internet of Things technologies. In this webinar, experts from private industry discuss the car as a payment platform and a mobility device, and the role of automakers in enabling these functions.	Technical focus on data and how connected vehicles can enhance the driving experience.
Private	Webinar (recorded for playback)	Automotive Grade Linux (AGL)	1 hour	Remote Vehicle Interaction: A Cooperative Effort For Next-Generation Connected Vehicles (https://www.automotivelinux.org/webinar-remote-vehicle-interaction)	In this webinar, AGL presents a plan to organize the implementation of a complete open source connected vehicle system that can be readily adopted by vendors and customers alike.	Technical focus on connectivity systems and architectures.
Private	Workshop (one-time event)	Transportation Intermediaries Association (TIA)	1 day	Exploring Connected and Autonomous Vehicle Technologies and Research Initiatives (http://www.tiaonline.org/connected_car_workshop_2015)	TIA's Workshop was held in conjunction with the unveiling of the GoMentum Station Connected Vehicle/Autonomous Vehicle Program, the largest autonomous vehicle testing site in the United States; it was hosted by the Contra Costa Transportation Authority (CCTA) on Tuesday, March 31.	Focus on research and challenges for implementation.
Private	Hackathon (one-time event)	Toyota, api.ai, Pebble, Sensory, SmartThings, Twilio	2 days	Connected Vehicle Hackathon (http://toyota-itc-hackathon.challengepost.com/)	Toyota, along with five other private cosponsors, hosted a hackathon to invite the community to develop applications for connected vehicles for: Driver Comfort and Convenience, Safety and Security, the Relationship between Cars and Community, and Energy Management and Sustainability.	Technical focus on mobile phone applications development.

Entity Type	Program Type	Entity	Approx. Program Duration	Course or Program Name	Description	Focus
Private	Hackathon (one-time event)	AT&T and NestGSV	2 days	The Connected Vehicle Hackathon (http://www.eventbrite.com/e/the-connected-vehicle-hackathon-tickets-10732263489)	AT&T and NestGSV hosted a hackathon to develop applications for connected vehicles.	Technical focus on mobile phone application development.
Private	Hackathon (one-time event)	Car Connectivity Consortium	3 days	Car Connectivity Hackathon (http://www.mirrorlink.com/news/articles/63)	At this event in Paris, developers worked to create new Android apps for connected cars using MirrorLink technology. This type of event encourages participants to learn from peers through application and design and thus is a resource for training development.	Technical focus on mobile phone application development.
Public/private	Varies	National Operations Center of Excellence (NOCoE)	Varies	Varies (http://www.transportationops.org)	There are other ITS-related courses that CITE offers beyond CV; some are related to CV. The entire catalog of courses offered can be seen in CITE's webpage. This source offers ongoing development of resources on CV, ITS, and other transportation-related programs.	Transportation Systems Management and operations

Source: Cambridge Systematics, Inc.

2.0 Conducting Interviews

2.1 Interviewing Targets

In order to better understand training programs and their relevance for different transportation stakeholders, the team designed an interview process intended to obtain firsthand information from different stakeholders and experts in the field.

The first activity in the interview design process was to define the target audience. Given that the objective was to identify gaps in and needs for C/AV training options for planners, a list of planning agencies was developed. Understanding that there are other stakeholders currently involved in C/AV training programs, however, the team included personnel from academia and the C/AV industry in the target audience. More robust insights can be developed by obtaining information from different stakeholders involved in the C/AV field, which in turn informs the design of broad concepts for creating new training programs.

In total, 30 different organizations were approached, including 17 planning organizations, 6 academic institutions, and 7 industry-related organizations. Members of these organizations were approached via email or telephone calls and asked to participate in the interview. In total, 18 organizations agreed to participate in this effort. In addition input was obtained from members of the AASHTO Standing Committee on Planning (SCOP) and the TRB Statewide Multimodal Planning Committee at a Peer Exchange held on July 7, 2015 in Salt Lake City. Skills and training were among the topics discussed at this meeting and the inputs are reflected in this report. Of particular concern to AASHTO and TRB Committee members was the need for a better understanding of long-range planning scenarios related to C/AV. Table 2 shows a list of all the other participating organizations.

Table 2. Organizations Interviewed

Organization Type	Organization
Academic	Georgia Tech
Academic	University of Arizona
Private/Nongovernmental Organization	Leidos
Private/Nongovernmental Organization	Transportation Research Board—Traffic Signal Committee
Public Organization	Association of Metropolitan Planning Organizations
Public Organization	Atlanta Regional Commission
Public Organization	Baltimore Metropolitan Council
Public Organization	Caltrans
Public Organization	Capital District Transportation Committee
Public Organization	Corvallis Area Metropolitan Planning Organizations

Organization Type	Organization
Public Organization	Genesee Transportation Council
Public Organization	LA Metro
Public Organization	MetroPlan Orlando
Public Organization	New York Metropolitan Transportation Council
Public Organization	Michigan DOT
Public Organization	North Jersey Transportation Planning Authority
Public Organization	Puget Sound Regional Council
Public Organization	Virginia DOT

Source: Cambridge Systematics, Inc.

Although 18 organizations participated, in some cases more than one representative of an organization was interviewed, so that a total of 27 individuals participated in the process—20 of these interviewees are with transportation planning entities, and seven are more involved in transportation operations, but have an understanding of transportation planning needs. The interviews were conducted using the method preferred by the responder and included in-person meetings, telephone conversations, and emails. The informal and open-ended nature of these interviews remained consistent; however, guaranteeing that individual responses would remain confidential.

2.2 Interview Questions

Looking at the types and structures of the organizations involved, the team created an initial set of questions to obtain input on the content, design, and delivery mechanisms of CV training programs for public and private stakeholders involved in transportation planning. The interviews were designed to be open-ended discussions in order to obtain as many insights from each respondent as possible. The design of the interview was organized around the following four discussion topics:

- The C/AV Field and Current Training Programs Available;
- Current Need for C/AV Training Programs;
- Defining specific technical focus and content of C/AV Training Programs; and
- Defining C/AV Training Options.

To guide the conversation with each respondent, the following discussion questions were defined, and finalized after review with U.S. DOT:

The C/AV Field and Current Training Programs Available

1. Are you aware of C/AV training programs available in the planning field? If so, can you give some examples?
2. Have you attempted to begin any training activities related to C/AV and planning (either taking the course or giving it)? If so, could you please describe the programs and activities—their purposes, goals, and effectiveness?

3. Who should provide planning training programs (academic institutions, private experts, public agencies, etc.)? Why?
4. Do you see value in obtaining a certificate from these types of programs? If so, why?

Current Needs of C/AV Training Programs

1. What do you see as important training needs for C/AV in planning in the next 10 years? Can you identify specific needs for transportation, land use, policy, and regulatory areas of planning?
2. Do you think planners will require different skills and backgrounds in the next 10 years? Does this apply to the different planning areas mentioned (transportation, land use, policy, and regulation)?
3. To what type of participants should these training programs be targeted (entry-level, manager, associate, etc.)? Why?

Defining the Technical Focus and Content of C/AV Training Programs

1. What should the primary objectives be for a C/AV training program for planners?
2. What areas of C/AV you think are of greater interest to planners (planning, design, implementation, management, repercussions in other planning areas, etc.)? Why?
3. What specific C/AV technical/engineering issues will planners be more interested in learning about? Why?
4. What specific tools/skills do you think planners are more interested in learning about in these training programs?

Defining C/AV Training Options

1. What type of training program platform (seminar, course, webinar, etc.) do you think would work best for C/AV training programs? Why?
2. How can stakeholders keep updated about emerging technology? How often should training sessions be provided for stakeholders?
3. Having discussed this topic, could you provide a broad description of your ideal C/AV training program (type of program, main topic, duration, cost)?

3.0 Synthesizing Interview Findings

The following sections provide a synthesis of the interview findings, organized to correspond with the four discussion topics.

3.1 The C/AV Field and Current Training Programs Available

The first section was focused on understanding the respondents' awareness of training programs that are currently available, particularly as they relate to planning needs. The majority of the respondents were not aware of any C/AV training programs available for planners; however, most of them were aware of general informational sessions available online. Most respondents were aware of the U.S. DOT CV 101 and 102 programs. An interesting finding from this activity was that several of the public agencies have taken steps to become more involved in this topic: some State and municipal planning agencies are reaching out to other stakeholders and organizing events to keep themselves updated. The vast majority of the respondents indicated that there is a need to increase training among planners in this area.

Opinions regarding who should lead training efforts on C/AV topics for planners were divided. The majority of the respondents agreed that any stakeholder group (public, private, or academic) would be fit to provide training on this topic, as long as the instructors are knowledgeable about the technology and the course is relevant to planning. Furthermore, the pervasive sentiment was that a combination of these stakeholders would be desirable. The stakeholder most mentioned to lead these efforts was the U.S. DOT, but others were noted, including organizations such as the American Association of State Highway and Transportation Officials (AASHTO) and the National Highway Institute (NHI). Respondents agreed that different stakeholders could provide greater insights, depending on the specific topic. In general, respondents agreed that the private sector would be better suited to delivering training programs with a technical focus, while public-sector stakeholders would be a better fit for training sessions focused on policies and regulations. Respondents generally stated that the role of academic institutions should be to validate such programs but not lead these efforts. Respondents considered C/AV training programs to be more valuable if they keep a practical focus, instead of a theoretical one.

Finally, respondents were asked about the value of obtaining a certification from these training programs. Although some mentioned that it would help incentivize management support for training, the majority of the respondents agreed that they do not see value in certification at this stage of C/AV technology development. In general, respondents indicated that certification would be more useful once the nature of the preferred technology is more settled and skills validated, giving course certificates a greater value for professional purposes.

3.2 Identifying Current Needs of C/AV Training Programs

The second general topic addressed the respondent's insights on important training needs for C/AV in planning. The insights obtained can be categorized by three needs:

1. **Understanding Upcoming Changes**—The most discussed need was to understand the effect of C/AV deployment on current planning products. Respondents mentioned that there is a need to tailor these programs so that planners understand what changes can be expected in regards to infrastructure, traffic signals, road side equipment, and capacity, among other topics. Respondents mentioned that there should be guidelines that show how these changes will be reflected in plans and regulations, like ITS Architecture, ITS/Operations implementation plans, and both short- and long-range planning documents.
2. **Technical Changes**—A second common topic identified was the need for changes in planning analysis and evaluation tools. Respondents mentioned that there is a need to understand changes in modeling processes, performance measures, data management, and scenario planning to accommodate this technology in planning endeavors. Respondents mentioned the need to move to more flexible models to better evaluate future transportation scenarios.
3. **Integration**—Finally, an important training need discussed was the need to integrate planning activities with other tasks that are related to C/AV technologies. Planners should have a general understanding of C/AV engineering and technical concepts, enabling communication between stakeholders. This will promote a discussion of common planning challenges to be addressed, such as environmental impacts and transit and equity issues, during various steps of technology development.

To address these needs, respondents mentioned that planners must learn new skills or polish existing skills. The skill most mentioned was the ability to develop scenario analysis, considering shorter time horizons and incorporating different risks associated with the volatile way in which this technology is being developed. According to the majority of respondents, scenario analysis will be a useful tool to evaluate the incorporation of this technology in future plans.

Respondents also highlighted the importance of considering technology market penetration rates and incorporating risk assessment in their evaluations. Another skill mentioned frequently was the ability to manage new data and abstract useful information that describes transportation system performance at shorter time horizons.

Finally, regarding the focus of training on planning, respondents generally agreed that all types of planners, from entry-level to top managers, require training in this field. Within this broad audience, respondents would like training programs to be tailored to specific subsets of the planning audience. There was an agreement that top managers need to be more familiar with this technology and understand its benefits across different planning fields. In addition, training should provide an understanding of the implications of C/AV on policies, regulations, and financial schemes. Staff planners and technicians require a more technical approach to training that will provide an understanding of the changes to evaluation tools that will be required. Training would also include C/AV impacts on planning analysis, including C/AV architecture, system requirements, and modeling capabilities.

3.3 Defining the Technical Focus and Content of C/AV Training Programs

In order to obtain more detailed information on desired training programs, respondents were asked to comment on specific technical objectives and goals for these training programs. When asked about what objectives training programs should have for planners, respondents answered according to their background and experience. The majority of operations-oriented planners stated that the chief aim should be to educate them about C/AV technologies, rather than technical specifications. They further indicated the program should focus on impacts of the technologies across different planning activities. On the other hand, more policy-oriented planners stated that these programs should have the objective of educating them about impacts and possible future scenarios.

Next, respondents were asked what areas of C/AV technology would be of greater interest for planners. Insights obtained can be categorized according to the nature of the respondent:

- **Policy-Oriented Planners**—Respondents who were more involved with policy analysis and regulations were interested in knowing the impact this technology would have on land use, transit systems, parking requirements, and sustainability. A number of respondents also mentioned the need to understand the impact of C/AV on current regulatory and legal frameworks. This orientation of planning encompasses the planning fields of both Project Development Planners (involved in scoping and NEPA at project level), and Program Management Planners (involved in fiscal aspects of the State DOT or MPO programs).
- **Operations-Oriented Planners**—Operations-oriented respondents showed a greater interest in understanding in detail the operational changes that would accompany C/AV implementation, focusing on areas such as ITS deployment and communications. These respondents were also interested in understanding the effect on roadway capacity, congestion, safety, traffic synchronization, and subsurface retrofitting, among other more specific components.

Finally, respondents were asked what specific technical/engineering issues planners would be more interested in learning about. The majority of the respondents mentioned a need to understand systems engineering and how to plan and deploy the public-sector elements of this technology. Moreover, planners need to understand how to integrate their work with the work of other parts of their agencies, like engineering and operations departments.

3.4 Defining C/AV Training Options

The last section of the interviews focused on the respondents' views on training program formats. The objective of this section was to understand what types of content would better fit a desirable C/AV training program. The vast majority of the respondents agreed that webinars are a useful format for reaching a wide range of audiences and should provide general overviews of the training topic. On the other hand, seminars were considered good for building curiosity, keeping up to date about technology development, and sharing experiences. For more in depth training, workshops and in-person sessions were considered the most effective methods.

The final topic was related to the respondents' description of their ideal C/AV training program for planners. Responses varied, but the following interesting findings were identified:

- **Consider the Target Audiences**—Given that different planners have different areas of expertise and emphasis and require different levels of detail in C/AV training, it is important to understand the needs of the target audience. Often, managers and high-level planners have less time availability, so a flexible platform would provide a better fit for this audience. Staff and technical planners could benefit more from in-person sessions and are in a better position to take advantage of them.
- **Shotgun Approach**—Regarding the structure of training programs, respondents agreed that a combination of strategies, tailored by audience and topic, would be more beneficial. A suite of training programs that seek to provide the information appropriate for each type of planner could result in better results.
- **Progressive**—Finally, most respondents mentioned that an ideal training course would provide insights at different levels. In general, respondents agreed that a good start is a general overview, like the one provided in CV 101. Subsequent courses could build on that foundation course and focus on different target audiences.

4.0 Recommendations and Potential Strategy

After further distilling the interview comments, themes emerged that speak to future training activities. These themes inform the trends, gaps, and needs—in the form of recommendations—for C/AV training and skills for the planning community. These recommendations are grouped by future training content, audiences, and delivery approaches, along with a range of expected costs, and recommended frequency for delivery. By building on these recommendations, this section offers a potential strategic approach for a proposed training program.

4.1 Future Training Content

- **Increase Awareness of Existing C/AV Programs for Planners**—When viewed by background (planner, operations, other), planning staff are less likely to be aware of or to have taken existing training programs regarding C/AV. Additional information may be provided specifically to the planning profession about the availability of current C/AV awareness programs such as the CV 101 and 102 training.
- **High-Level Training for Leaders**—Early training development should target agency leaders and senior planners. High-level training should examine broad impacts and policy ramifications. This training would discuss the technology in general terms with particular focus on timing of C/AV impacts. Information on the potential timing of C/AV deployment and the impacts of that deployment is essential.
- **Scenario Planning**—Given the level of uncertainty in timing and fleet penetration rates, training through scenario planning is highly beneficial, and is recommended as an early training effort. An example of a scenario would be a Year 2025 scenario, with assumed marketing penetration of 15 percent of the vehicles on the road being equipped with DSRC, and would also outline deployments of CV infrastructure that the relevant planning agency was responsible for maintaining. FHWA developed a Scenario Planning Handbook¹ that focuses on socioeconomic and land use scenarios; the general approach used in this handbook could potentially be used to develop guidance to develop scenarios that address the impacts of C/AV technology. Moreover, the ITS-JPO Professional Capacity Building program has developed two formal case studies for training—for Adaptive Signal Control and for the ITS National Architecture²—that provide instructors ITS Case Studies that provide for scenario-based learning tool that exposes students to real-world decisions that come with planning, deploying, and operating ITS technologies. These two case studies, and future case studies developed under this program, can also support the development

¹ See: https://www.fhwa.dot.gov/planning/scenario_and_visualization/scenario_planning/scenario_planning_guidebook/ch01.cfm.

² See: <https://www.pcb.its.dot.gov/casestudies/default.aspx>.

of the C/AV scenarios. Finally, it's important to realize that a lot of unknowns exist in how to develop C/AV scenario planning. In moving forward, it will be incumbent on the ITS-JPO to develop scenario planning tools and guidance which planners can use to develop scenarios that meet regional/local needs. Here, the role of the ITS-JPO can be to set the standards by which such scenario development should occur, thus ensuring the C/AV developments occur across the Nation based on well-understood and consistent scenario development.

- **Technical Training for Planning Staff—**
 - **General Planning Implications.** This training areas should include modeling, capacity impacts, infrastructure investment, design, and land use. This training effort should have a technical and practical focus and be specifically designed to address the needs of planning staff.
 - **Data Implications.** Encompasses disaggregating, understanding and using “big data” in the planning activities. This training area will comprehensively assess new and emerging data sources, public and private data sharing, and use of data and data outputs to improve planning.

4.2 Target Audience

- **Audience-Specific Training—**Training is needed at all levels of the planning profession. The planning community is not homogeneous; consequently, training must take into account the differing roles and responsibilities of planning professionals and the need to engage across disciplines. For example, managers and senior leaders may need early training because internal policies and processes are driven from the top. More technical training is needed for modelers and those engaged with the details of plan development and analysis.
- **Multagency and Multidiscipline—**C/AV technology impacts cross transportation disciplines and geographic boundaries. Training activities therefore should encourage participation across organizational lines in order to foster communication and understanding.

4.3 Delivery

- **Range of Delivery Types—**Due to travel restrictions and funding limitations, it is important to provide a range of delivery options matched to the content and audience. Options include webinars, in-person workshops (one to two days), in-person workshops at conferences (one-half to one full day), conference sessions, articles in journals, and Web portals.
 - Note here that the emerging “Flipped Classroom” delivery approach may be especially applicable here given the demands on time for the typical planner. Under this approach, video lectures are first viewed by students, which is the followed by online course sessions that are devoted to exercises, projects, and/or discussions. More details of this approach are provided in appendix A.

- **Sources of Training**—The transportation planning community in general is familiar with the organizations that traditionally provide transportation training such as U.S. DOT, NHI, and AASHTO, and they should continue to do so, as agencies will look there first. Larger agencies, however, may benefit from having their own training programs. In that case, materials developed for U.S. DOT, NHI, or AASHTO may be shared so that these agencies have consistent information delivered to them in a timely way. The developers of training can come from a range of providers as long as the training is practical and not theoretical. Use of the “train the trainers” technique is assumed for all training approaches.
- **Frequency**—Due to the fast-moving nature of developments in C/AV technology, planning professionals may be provided with frequent updates. Delivery options include webinar updates, articles, and information on Web portals.

4.4 Proposed Strategy

Building upon these recommendations, the proposed training program consists of five steps, focusing on different aspects of C/AV topics in planning and oriented towards specific audiences. Table 3 describes the proposed training programs considered; following table 3, a brief description of each training program is presented. In this table, “costs” represent the cost for development and delivery of the training; for the ranges of costs, “low” represents 20 hours or less of labor, “medium” represents 20 to 80 hours of labor, and “high” represents greater than 80 hours of labor.

Note that appendix B provides an example of the student materials developed for the ITS-JPO Professional Capacity Building program’s Case Study for Adaptive Signal Control. This is provided to illustrate to the reader what the format and level of content of training materials developed to support this strategy may take in the near future.

Table 3. Recommendations for Training Programs Summary

Target Audience	Content	Resulting Skills/Focus	Delivery	Frequency	Cost	Priority
All planning staff	Introduction to technology— applications and possible impacts	Focus on existing C/AV training, general awareness of C/AV technology and applications, awareness of potential impacts	Webinars, articles, conference sessions, Web portals	Scheduled periodically for live or on-demand (recorded) presentation, articles and conferences as available	Medium	High
Leadership, politicians, appointees	Overview of technology and impacts on planning	General awareness of magnitude and timing of C/AV impacts	Conference sessions, articles	Opportunistic	Low	High
Planning leaders	Overview of policy benefits and impacts— timing, financial implications	Awareness of magnitude and timing of C/AV impacts, ability to assess impacts on policy, land use, and major investments	Webinars, conference sessions	Scheduled periodically for live or on-demand (recorded) presentation	Medium	High
Planning managers	Planning for Operations and Scenario planning— how to incorporate scenarios in planning evaluation tools	Development of viable scenarios, conduct scenario analyses considering impact over time, assess C/AV impacts on land use, transit, and transportation investments, incorporate CV infrastructure in short-term plans	In-person programs	Conference workshop opportunities, scheduled sessions one to two per year	High	Medium
Planning technical staff	General planning implications— modeling, technology, capacity, infrastructure, data	Model C/AV impact, estimate capacity impact (HCM), incorporate infrastructure needs into short-term plans, incorporate CV in ITS Architecture	In-person workshops	Yearly workshop, for a one-half to two-day program	High	Low
Planning technical staff	Data Implications	Encompasses disaggregating, understanding and using “big data” in the planning activities	In-person workshops	Yearly workshop, for a one-half to two-day program	High	High

Source: Cambridge Systematics, Inc.

The following expands on the recommended training programs defined in the “Content” columns of table 3:

- **Introduction to Technology**—This program can adapt the current CV 101 and 102 programs to explain the basic concepts that all planners must understand to work with C/AV technology issues. The U.S. DOT should encourage planning agencies, working from the State to local levels, to take CV 101 and 102 online.
- **Overview of Technology and Impacts**—This program would focus on describing general impacts related to city planning and transportation. The main objective of this program should be to inform participants about what to expect once C/AV technology is deployed at different penetration rates and with varying efficacy rate and timeframes for implementation. This program can take place in conference sessions, where planning managers and decisionmakers can understand in some depth the general impacts of these technologies. It is recommended that U.S. DOT lead this effort by organizing an initial set of seminars, preferably taking advantage of an already organized seminar or conference such as the Transportation Research Board Annual Meeting, Association of Metropolitan Training Organizations, or the AASHTO Planning Subcommittee.
- **Overview of Benefits of Integrating CV in Short- and Long-Range Transportation Planning Processes**—This training would be aimed at local leadership, politicians, and rather than being technical in nature, it would instead provide a general understanding of the benefits of incorporating CV into Transportation Planning (long and short range).
- **Overview of Policy Impacts**—This program can be designed as an additional webinar offered by U.S. DOT but exclusively targeting planning audiences. This program should focus on identifying the impact this technology would have on current policies and addressing how planners should incorporate this effect in planning efforts. U.S. DOT should lead this program, by designing the webinar content and making it accessible to the general planning community.
- **Planning for Operations** —Planners should be aware of the operational impacts their policies and decisions have. In order to facilitate communication and understanding between planners and operations-oriented personnel, FHWA has established a program called “Planning for Operations.” This program centralizes a number of resources for planners to have at their fingertips as they identify investments that will improve existing and future system operation.
- **Scenario Planning**—This program should show participants how to implement scenario planning techniques that incorporate the effects of C/AV technology on transportation systems and socioeconomic and land use forecasts. Topics covered should include guidelines to define feasible and realistic horizons, as well as methods to embellish current risk analysis. U.S. DOT could participate in this effort by providing in-person workshops, preferably through established popular conferences and seminars.
- **Technical Implications**—This program should cover more technical issues of interest to planners. The content should address how to incorporate C/AV technologies into current ITS Architectures, transportation models, and data analysis, among other technical platforms. Given the nature of this program, it is proposed as a one-half to two-day in-person workshop, where modelers and analyst can gather and obtain the necessary information to update their skills. U.S. DOT could organize and host these events yearly, targeting exclusively technical staff.

APPENDIX A. Overview of How the Flipped Classroom Approach Could be Implemented to Enhance C/AV Training Programs for Planners

The “Flipped Classroom” is an emerging online training concept³ that turns the standard approach for online education on its head. In the Flipped Classroom, the typical lecture and homework elements of a course are reversed. Video lectures are first viewed by students, which is then followed by online course sessions that are devoted to exercises, projects, and/or discussions. As applied to training programs for C/AV planning, Flipped Training online programs could include the following three elements:

- C/AV course trainers develop a Class Guide, and develop/produce a series of Video Lectures. The Course Guide provides an implementation plan for how the course will be conducted, and also develops the course exercises, projects and discussion topics. The Video Lecture is the key ingredient in the flipped approach, and they are created by the instructor and posted online.
- C/AV course trainees view online video lectures at work or at home on their own pace. These ideally short-length videos (e.g., 30 minutes) provide for foundational learning on the key topics for the course trainees.
- Concept engagement would then take place via an online classroom, where the C/AV trainers cover the major lesson areas with the C/AV trainees. Exams or class assignments can be potentially added here to ensure that the course trainees have mastered the material.

The primary benefit that transportation planners can realize from implementation of flipped classroom training is that it allows for different types and speeds of learning. A secondary benefit is that it is flexible based on the student’s available time. A third benefit is that it lends itself to easy reference in the future—“develop once, use often.”⁴

The Flipped Classroom also allows for much of the material to be covered individually online, and then provides for online classrooms which can be conducted more efficiently, and which require less time given the video lectures have already been viewed by the students. Additionally, during the online classroom time, the trainer is now freed up (i.e., versus the traditional classroom model) to work one-on-one with students on the content they most need support with, which supported increased comprehension of the trainees.

³ These references (a video and an infographic) provide a tutorial on the Flipped Classroom concept: <https://www.youtube.com/watch?v=iQWvc6qhTds>
<https://www.knewton.com/infographics/flipped-classroom/>

⁴ For more details on the benefits of implementing Flipped Classroom training, see: <https://cft.vanderbilt.edu/guides-sub-pages/flipping-the-classroom/>.

APPENDIX B. Student Training Materials Example: ITS-JPO Professional Capacity Building Program's Case Study for Adaptive Signal Control

The following provides an illustrative example of ITS-JPO Professional Capacity Building program training materials developed for student use. This example focuses on training associated with a Case Study for Adaptive Signal Control. Three sets of student materials were developed, as outlined below. This example is intended to highlight to the reader an example of the form and level of content that some of the future C/AV training materials may take.

B.1 Introduction to Intelligent Transportation Systems and Adaptive Signal Control Technologies

Summary: The purpose of this case study is to allow you to experience what it would be like to work as a Transportation Engineer, working on an Adaptive Signal Control Technology project. There are three learning objectives for this specific introduction to the topic: 1) describe the importance of ITS to the future of transportation; 2) demonstrate awareness of Adaptive Signal Control Technology; and 3) differentiate between goals, objectives, strategies, and tactics in the context of a transportation problem.

Introductory materials available for download:

https://www.pcb.its.dot.gov/casestudies/documents/ASC_StudentGuide_Component1_Intro.pdf

B.2 Case Study Take Home Packet

Summary: This set of materials provides the student a take home packet that summarizes this case study, and provides review and critical thinking questions.

Case Study Take Home Packet materials available for download:

https://www.pcb.its.dot.gov/casestudies/documents/ASC_StudentGuide_Component2_TakeHome.pdf

B.3 In-Class Debrief

Summary: This set of materials provides an in-class debrief that covers a class discussion of the scenario, reviews the questions that the student answered, and covered the student experiences “on the job.”

In-Class Debrief materials available for download:

https://www.pcb.its.dot.gov/casestudies/documents/ASC_StudentGuide_Component3_Debrief.pdf

U.S. Department of Transportation
ITS Joint Program Office-HOIT
1200 New Jersey Avenue, SE
Washington, DC 20590

Toll-Free "Help Line" 866-367-7487
www.its.dot.gov

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