The Role ITE Can Play in Connected / Autonomous Vehicle Technology

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ABSTRACT

This paper provides guidance of ways in which the Institute of Transportation Engineers (ITE) may align itself with the emerging connected / autonomous vehicle technology. It begins with the question of “What is ITE’s role as it relates to the implementation of the emerging technology of connected / autonomous vehicles”. To respond to this, research concerning the state of the current practice, technology, and known information was initially completed by the team. By incorporating the aforementioned with the ITE’s mission statement and goals, the team assessed and determined where needs exist that the ITE could contribute to as an organization. The team’s assessment is that ITE can play a role in five key areas: collaborator, a leader in Vehicle to Infrastructure (V2I) infrastructure, a facilitator, a resource to the transportation professional, and assist with achieving an appropriate scales of economy.

1.0 Introduction

Interest in the topic of connected / autonomous vehicles has been rapidly evolving over the past several years. With the capability to drastically change the way transportation engineers plan, design, operate, and maintain this infrastructure, it is important to understand the possibilities associated with this technology and determine how best to prepare for it.

This paper seeks to answer, “What is the Institute of Transportation’s (ITE) role as it relates to the implementation of the emerging technology of connected / autonomous vehicles”. The following sections of this paper provide context for what the technology is,
when it may become publicly available, the state of the practice currently, and ways that ITE can assist with this change in the way we travel.

2.0 Background

This section provides background about the definition of connected / autonomous vehicles along with information concerning the other associated terminology. There is further discussion regarding the state of the current practice while providing a background assessment for when the public may expect to see the evolvement of this emerging automotive technology. A legislative component is presented as another item to better assess and understand the state of the present practice.

2.1 Definitions

Connected / autonomous vehicles refers to varying levels of technology being developed to make vehicles operate more efficiently and safely. Connected references a vehicle that uses a number of different communication technologies to communicate with the driver, other automobiles on the road (vehicle to vehicle or V2V), or roadside infrastructure (vehicle to infrastructure or V2I). Autonomous vehicles are vehicles that are capable of sensing their environment and navigating without human input.

The National Highway Traffic Safety Administration (NHTSA 2013) provides a specific definition of the various levels of autonomous vehicles:

- Level 1 – Function-specific Automation: Automation of specific control functions, such as cruise control, lane guidance and automated parallel parking. Drivers are
fully engaged and responsible for overall vehicle control (hands on the steering wheel and foot on the pedal at all times).

- **Level 2 – Combined Function Automation:** Automation of multiple and integrated control functions, such as adaptive cruise control with lane centering. Drivers are responsible for monitoring the roadway and are expected to be available for control at all times, but under certain conditions can disengaged from vehicle operation (hands off the steering wheel and foot off pedal, simultaneously).

- **Level 3 – Limited Self-Driving Automation:** Drivers can cede all safety-critical functions under certain conditions and rely on the vehicle to monitor changes in those conditions that will require transition back to driver control. Drivers are not expected to constantly monitor the roadway.

- **Level 4 – Full Self-Driving Automation:** Vehicles can perform all driving functions and monitor roadway conditions for an entire trip, and may operate with occupants who cannot drive and without human occupants.

### 2.2 Deployment

Most of the major car manufactures are pushing to have a form of semi-autonomous vehicle on the roads by 2020. By 2025, all automobile manufactures suggests having semi-autonomous vehicles deployed. By the year 2030, all manufactures expect to have fully autonomous vehicles in circulation. Jaguar, Google and Tesla plan to have the technology totally deployed in less than ten (10) years. While the technology may be available within the aforementioned time frames, the public has to accept and embrace it for it to be successful.

Accordingly, the industry’s major concern is that the technology will arrive before
society is ready. With that, public education becomes essential. Public education is needed so that people feel safe riding in driverless cars considering that they have become totally accustomed to having full control while driving. The public will have to become familiar with trusting human technology while humans are still perfecting the mechanisms that operate such machinery. The public's acceptance plays a major role in the deployment of such vehicles.

2.2.1 Freight and Connected Vehicles

Freight is following a similar path as passenger vehicles in that the same V2V and V2I connectivity is being developed. However, freight traffic is deployed on the road to make money by shipping goods. In the US, freight is a $650 billion industry; wherein, trucks return a profit when they are actually on the road shipping goods. Accordingly, trucks as the principal mode of freight movement, requires that the trucking industry increase or maximize efficiency. Currently, the trucking companies and independent drivers profit approximately a 3% return on investment by successfully shipping goods to their respective destination in a timely manner.

The trucking industry desires vehicle connectivity because it will increase their profit margin to approximately 4%. Accordingly, the trucking industry has employed much of these ITS solutions in an effort to keep its trucks on the road for profit making purposes. These efficiency solutions include but are not limited to the electronic monitoring of parts; wherein, technology tracks which parts are about to fail and notifies the nearest mechanic shop so that parts are waiting on the vehicle prior to the vehicle's arrival. This reduces the vehicle's down time and keeps the vehicle on the road.
Another factor that the freight trucking industry appreciates concerning connected vehicles is saving the money from lost revenues expended on truck accidents. Truck accidents incur approximately $50 billion annually when including insurance and other associated fees and industries. Freight vehicles benefit greatly from blind spot technology and coupling to safe on fuel cost. The truck companies are looking forward to connected infrastructure; wherein, the vehicle itself is "speaking" to objects such as but not limited to bridges, tunnels and overpasses. These objects typically have clearance heights which may restrict a truck's ability to appropriately negotiate the height limitation. Through connectivity, the truck driver is warned of the low clearance and may navigate accordingly prior to such an accident occurring.

With these assets that may be derived from connected truck vehicles, the industry still acknowledges that the human driver is still going to be an important element of their vehicles. There have been some deployments of fully autonomous trucks such as in Miami-Dade County, however, the trucking industry has a number of restrictions which limit the full autonomy of such vehicles. For example, trucks that load/unload in very urban environments which may not use a loading bay nor have the room for automated turning and/or docking. Circumstances such as this require "real time" assessments of current situations to appropriately navigate.

2.2.2 Connected Rail Vehicles

Connected rail vehicles whether passenger or freight would benefit greatly from connected vehicles particularly at "at-grade" crossings. Many accidents occur at "at-grade" crossings which in some places has required the separation of pedestrian and passenger cars from rail crossings either through elevation or below grade conduit. With connected rail
vehicles, the number of accidents becomes reduced as the trains are "talking" to other vehicles expressing that the train has the "right of way". This would save rail transit and freight rail operators and local, state and federal governments from spending money on elevated or below grade infrastructure for safety purposes solely. It prevents this infrastructure from being constructed for non-topographic and engineering purposes and keeps these operators from having to maintain such infrastructure which during the course of the 20th Century has proven to be problematic.

2.2.3 Connected Maritime and Aircraft Vehicles

Similar to the trucking industry, any vehicle in these industries which is not in service or deployed is not returning a profit. Therefore, it behooves these industries to use the connected technology to link vehicles to mechanic shops. This way if a vehicle is in need of service the vehicles detectors sense it and advise the mechanic shop of the serviceable part. The mechanic shop can have the part ready for the vehicle when it arrives. This reduces the wait time for parts and service. Accordingly, the vehicle can be serviced more quickly and efficiently and placed back in service quicker.

2.2.4 Limitations of the Study

This report provides information based on subjects, topics, research materials and items in which the group was able to find. However, the research was limited to access, data and the lack of prior research. Limited access to the car manufacture data and technology impairs the research in terms of assessing the number of crashes, safety and cyber threats. With restricted access to governmental decision makers regarding the topic, it is difficult to ascertain the types
of policies that may be implemented and when. The dissemination of prior research is controlled because the industry leaders are seeking to be the first to patent the technology. Therefore, obtaining these "industry secrets" becomes very challenging. Recognizing that the technology is in its infancy, means that there is very little data to compare. As the technology grows, it will become easier to explore and examine trends over time in which conclusions can be drawn and imperfections can be corrected. Accordingly, there are items that require further research or that future data will have to be collected prior to any assessments being made. These items include but are not limited to cyber security, privacy issues, paying for the infrastructure upgrades, the appropriate amount of State and Federal regulations, technology's ability to respond to atypical events by "analyzing" in an appropriate manner, minimum age to use such transportation, its impact on mass transit systems particularly in rural and small town settings and the way this newer technology will be integrated into the existing infrastructure.

2.3 Legislation

As this technology becomes more commonplace and replaces the existing way vehicles travel, state and municipal governments may be forced to address the potential impact of these vehicles on the road. The initial wave of legislative activity focuses on defining what "autonomous vehicle” and “autonomous technology is, along with authorization for the operation, safe development, and testing / operation of motor vehicles with autonomous technology on public roads. On a national level, in January 2016, a new policy was unveiled that updates the National Highway Traffic Safety Administration’s (NHTSA) 2013 preliminary policy statement on autonomous vehicles. Within it is a commitment of nearly $4 billion over the next 10 years to accelerate the development and adoption of safe vehicle automation.
3.0 **Infrastructure Needs**

Connected Vehicle (CV) technologies will require infrastructure improvements and investment for successful deployments. United States Department of Transportation (USDOT) suggests that intelligent transportation systems (ITS) equipment or traffic controllers purchased by agencies from this point forward should be connected vehicle ready. The CV equipment should be installed in secure cabinets. Current roadside cabinet space should be evaluated to ensure the equipment will fit an external processor. Agencies must ensure a reliable power supply to the cabinet and the equipment. Secure communications from the roadside units back to a traffic management center (TMC) is key for system security and privacy. The USDOT suggest two secure backhaul communication links from a traffic management center (TMC) to each roadside unit. Traffic controllers and other existing ITS equipment shall comply with current National Transportation Communications for ITS Protocol (NTCIP) standards and should be ready to program/install a connected vehicle equipment. Agencies should also begin conducting mapping activities of roadway geometry. Finally, agencies should consider surveying and planning for future mounting locations for the DSCR units, ensuring adequate line of sight for antenna’s, and for the vehicle to infrastructure communications. [7]

4.0 **Currently Available Funding Sources**

Updating agency infrastructure and maintaining the technology installed can be very costly. The equipment, installation, maintenance, and operational costs are all eligible for federal-aid funding under ITS investment avenues that have been previously established by the
federal government. V2I applications are eligible for Highway Safety Improvement Program (HSIP) funds if they address the state in which the agency resides Strategic Highway Safety Plan [7]. Currently, there is language in the California Strategic Highway Safety Plan (SHSP) which notes that connected and automated vehicles can enhance SHSP efforts which is promising for agencies in California agencies looking to implement V2I technologies in the future [8]. Mobility applications are eligible for Federal Highway Administrations National Highway Performance Program (NHPP) and Surface Transportation Program (STP) funds [7]. Air quality and congestion mitigation application projects that tackle environmental applications are eligible for Congestion Mitigation and Air Quality Improvement Program (CMAQ) funds [7]. The Federal Highway Administration (FHWA) and USDOT also encourage Private Public Partnerships to ensure adequate funding for projects but warn that those parts of the project would not be eligible for federal subside. All connected vehicle technology purchased with federal funds must conform to the federal standards for interoperability and standard connected vehicle architecture. The best way to reduce costs is to survey existing intelligent transportation system assets and identify those which can receive upgrades or modifications. As this technology becomes more readily accepted by the transportation engineering and planning community and the Federal Government, we could see other funding avenues available for agencies to implement connected vehicle technology.

5.0 Planning and Agency Programming

The transportation element of an agencies general plan, master plan and/or comprehensive plan is a planning/ policy document produced by agencies to assess existing transportation trends and look ahead to program large scale transportation improvements to
their region based on the areas growth projections and regional expansion. Connected vehicles have the potential to drastically change an agencies transportation element of their general plan. Connected vehicle technology can greatly impact Vehicle Miles Traveled (VMT) projections, congestion, air quality, and greatly reduce collisions and increase safety. The upgrades will be costly and without prior planning and programming, those investments cannot be realized. The USDOT estimates that connected vehicles will reduce travel time by 33%, reduce collisions at intersections by 41% to 55%, reduce left turn collisions at intersections by 36% to 62%, significantly reduce transportation’s portion of national greenhouse gas emissions [3]. This means that connected vehicle implementation will be central to agencies meeting and exceeding targets set forth in the general plan. USDOT suggest that connected vehicles rhetoric and planning be included in agencies long range transportation plans, corridor plans, and develop intelligent transportation systems strategic plans for deployments. [9]

Performance measures must be selected by the agency to assess the performance of connected vehicle deployments. CV technology gives network managers the potential for a wealth of data collected on system performance so the right performance measures is key. USDOT suggests that agencies following the guidelines spelled out in the Performance-based Planning and Programming Guidebook to figure out which performance measures are best to use [9].

Agencies also need to take a strategic approach to creating a successful connected vehicle program. This includes taking an active role in encouraging government regulation of connected vehicle standards and mandates. Developing themes and bold goals in planning documents asserts that connect vehicles will assist regions meet and exceed transportation
goals. It is also important to generate agency expertise by educating existing staff and hiring new staff well trained in big data management and data science, effective project management, transportation and electrical engineering. Public/private partnerships will be key in developing a strong team to be competitive in the bidding process for deployments. [9]

With this in mind, the following recommendations will ready an agency for the “connected and autonomous vehicle wave”. The following outlines steps a local municipal transportation agency should take to ready themselves for connected vehicle technology mandates from the Federal government.

1. Long Range Planning and Budget Issues

Governments whether local, county, regional and/or state will need to work with its local Metropolitan Planning Organization (MPO) to include connected vehicle language in the next update of Long Range Planning Document and negotiate to include a larger percentage of available funds in the next three years for ITS improvements. It will be imperative that the MPO open funding avenues for partial reimbursement of connected vehicle deployments. These agencies should also encourage MPO’s to play an active role in encouraging States to apply for more funding which will implement ITS improvements.

If agencies are not already within a self-help region, then working with local legislators to initiate a ballot measure for some kind of “self-help” tax to help fund ITS infrastructure improvements would help greatly. Agency transportation staff should negotiate with agency management to use some of those funds for upgrading the agencies’ ITS infrastructure during the next budget cycle.
2. Updating the General Plan Document

The agency should re-evaluate their general planning document to include more concrete language about the positive effects of connected vehicle technology on safety, mobility, and the environment which will, in turn, help the agency reach its qualitative objectives. Connected vehicles should become a priority for the agency because it is an avenue to reach all its other objectives. Performance measures should be chosen and written in the general plan with specific “if/when” statements to hold agency staff accountable.

3. Staffing Needs and Training

Trained staff knowledgeable about connected vehicle systems and how it operates will be imperative for a successful deployment. Engineer and planning staff should educate themselves on requirements for Federal grants and funding and attend webinars or in person trainings about the technology and the national standards, how to effectively deploy it and how to run and maintain the system. Staff should review the list of available applications and choose which ones will help address the goals and objectives of the circulation element. The agency should think about hiring at least one data scientist/data analysist to create a program to manage the large amounts of data gleaned from the vehicles and the infrastructure and turn it into tangible metrics for engineers to assess the systems performance. The agencies technicians and signal maintenance crews would also need training with the new roadside units, traffic controllers, and other equipment to be able to maintain and repair broken elements quickly.
4. Inventory and Update Existing ITS Infrastructure

Agency engineers and/or consultants will need to survey and evaluate current ITS infrastructure and propose improvements. If needed, traffic controllers will need upgrades to be able to handle CV/AV technology. Engineers will need to inventory the existing signal and roadside cabinets for empty space. If there is not enough space for the new equipment, then replacements should be purchased. If a cabinet with public art needs replacement, agency engineers should work with community development to arrange new public art on the new cabinets and creatively repurpose the old cabinets. A robust and reliable power supply will be needed for the cabinets and other roadside units. The current power supply will need to be surveyed and possibly updated.

An evaluation of the agencies signal interconnect architecture will be needed to ensure enough capacity, required redundancy, and security for large continual data transfers. I recommend also installing a fiber interconnect system that will also connect the DSRC roadside units back to City Hall. The City has the required existing pull boxes and conduits to run the fiber cable backbone. This will provide a secure backhaul communication links to the controllers and the DSRC units. Engineers should also survey and note possible locations on agency owned poles for the DSRC roadside units that provide adequate line of sight from the vehicles to the roadside unit. If there are not any agency owned poles within the required distance, then the agency should establish a relationship with the Power Company and apply for easements.

Finally, if the agency does not already have one, the agency should also build a physical traffic management center (TMC) in a central agency owned building so
engineers could assess, in real time, the performance of the system and make adjustments as needed. A TMC is vital to maintaining the system once vehicles are connected to the system and should include a communications server robust enough to handle the data lode on the system.

5. Community Outreach

Central to any large scale project, community outreach and education will be essential for citizens to understand how the agency is working towards its goals in the general plan. The agency should hold public meetings with communities to explain how the new system operates and to reassure the public that their privacy is protected. It will be vital for the agency to help citizens understand that these systems are not just for automobiles. The increase the safety of all users including at-risk pedestrians (the older and disabled population), bicyclists safety, transit reliability, and help facilitate ridesharing. As an option, the agency could also provide a subsidy program for citizens to retrofit their vehicles with the DSRC unit.

6.0 ITE’s Role

ITE plays an important and vital role in transportation infrastructure. To that end, ITE’s organizational planning efforts have identified their mission as the following:

MISSION

To be the principal source of professional expertise, knowledge and ideas promoting transportation science, principles and advocacy internationally.
Furthermore, ITE’s strategic planning document identifies a vivid description of the organization:

**VIVID DESCRIPTION**

Members, policy makers, and other transportation and engineering professional view ITE as a highly valued and respected source for global transportation information, insight and solutions tailored to their needs.

Society sees ITE as an innovator and leader in providing transportation solutions to today’s environmental and social challenges.

Transportation professional, policymakers and the public view ITE as the primary transportation professional association.

Transportation professionals and employers view ITE as the resource for identifying and providing for professional development needs.

Transportation professional benefit from ITE technical excellence, which provides enhanced visibility and respect for the profession.

As the transportation profession begins to face a paradigm shift in the way the public will fulfill its transportation needs, it is important that ITE plays an active role in leading that shift. With the advancement of computing and sensing technology, we stand on the cusp of an age when drivers will no longer need to provide input to a vehicle, other than their respective destination. Such a drastic change in the way transportation is consumed will require strong leadership, and visionaries to anticipate the needs of the coming technology. Transportation
professionals will be instrumental in guiding the coming technology, and its acceptance within our societies. ITE’s role then becomes paramount in the coming years, guiding transportation professionals into the future and beyond.

Five key areas have been identified in which an ITE role is defined in order to lead the transportation profession into the reality of connected and autonomous vehicles. These areas/roles are more fully described in the following sections.

6.1 Collaborator

Collaboration is key in advancing a knowledge base and providing a broader spectrum of views. Collaboration also provides for constructive dialogue amongst various professionals. Furthermore, collaborative efforts tend to provide a greater impact due to the broader scope and spectrum of a mutual endeavor. With the diverse transportation community, collaboration is key when undertaking the challenges of coming technologies such as autonomous and connected vehicles. In some respect ITE has already recognized the benefit of collaboration. ITE has worked to develop relationships with some entities, and can benefit from collaboration with others. The following organizations have been identified as key collaborators within the industry that will help ITE leverage their knowledge base for the mutual benefit of both parties’ membership and the spread of industry standards.

SAE International

The Society of Automotive Engineers (SAE) International is a global body of scientists, engineers, and practitioners that advances self-propelled vehicle and system knowledge in a neutral forum for the benefit of society.
Why Collaborate with ITE?

With its finger on the pulse of manufacturing within the automotive industry, and its hands firmly on the wheel of the development of autonomous and connected vehicles, SAE International is a natural partner in which to collaborate when it comes to the forefront of automotive technology and its implementation.

**Connected Vehicle Trade Association (CVTA)**

*The Connected Vehicle Trade Association (CVTA) is a non-profit business league established to facilitate the interaction, and advance the interests, of the entities involved in the vehicle communication environment. The Connected Vehicle Trade Association enables the collaboration of companies, organizations, and governmental bodies engaged in developing bidirectional vehicle communications. Membership is open to any corporation, public entities, standards and specification organizations and educational institutions.*

Why Collaborate with ITE?

ITE practitioners will be instrumental in the development of infrastructure communication and therefore collaboration with CVTA will help to diversify the spectrum.

**Mobile Comply**

*Mobile Comply is the leading provider of education and certification programs for connected transportation systems, autonomous vehicles and automotive cyber*
security. We serve automotive manufacturers and their suppliers, software developers and communications providers, national and local government, and transportation infrastructure developers. Our belief goes beyond simply educating people to create smarter, consummately prepared companies and consumers who will successfully advance and define the future.

Mobile Comply engages with the top thought leaders in the industry, creating course structures that reflect the forefront of data, information, technology, security, standards and practices. Our unique forward-looking approach enables professionals to quickly gain the knowledge, skills and insight necessary to make fully informed decisions that deliver better outcomes for their organizations.

Why Collaborate with ITE?

Mobile comply markets specific training for partners that currently provide education to practitioners in the autonomous / connected vehicle arena. Therefore, ITE technical committees can deliver a professional development program to the membership quicker and more efficiently.

ITS America

The Intelligent Transportation Society of America (ITS America) is the nation’s largest organization dedicated to advancing the research, development and deployment of Intelligent Transportation Systems (ITS) to improve the nation’s surface transportation
system. Founded in 1991, ITS America’s membership includes more than 450 public agencies, private sector companies, academic and research institutions.

Why Collaborate with ITE?

The application and the deployment of additional sensors and communication devices. Therefore, ITS America is a natural partner in that their membership will desire similar information and training for the technology changes.

ASCE

The American Society of Civil Engineers (ASCE) represents more than 150,000 members of the civil engineering profession in 177 countries. Founded in 1852, ASCE is the nation’s oldest engineering society.

ASCE stands at the forefront of a profession that plans, designs, constructs, and operates society’s economic and social engine – the built environment – while protecting and restoring the natural environment.

Why Collaborate with ITE?

ASCE broad reaching audience across the Civil Engineering field make it a good partner when it comes to working with policy makers.

AASHTO

American Association of State Highway and Transportation Officials (AASHTO) is a nonprofit, nonpartisan association representing highway and transportation
departments in the 50 states, the District of Columbia, and Puerto Rico. It represents all five transportation modes: air, highways, public transportation, rail, and water. Its primary goal is to foster the development, operation, and maintenance of an integrated national transportation system.

AASHTO works to educate the public and key decision makers about the critical role that transportation plays in securing a good quality of life and sound economy for our nation. AASHTO serves as a liaison between state departments of transportation and the Federal government. AASHTO is an international leader in setting technical standards for all phases of highway system development. Standards are issued for design, construction of highways and bridges, materials, and many other technical areas.

Why Collaborate with ITE?

It is widely believed that once we do not need to design roads for a human driver, design parameters for those roads will change significantly. AASHTO publishes one of the leading design manuals for roadways within the United States; therefore, a partnership addresses these needs would be beneficial. ITE staff is already collaborating with AASHTO, helping to lead the development of policies going into the American Association of State Highway and Transportation Officials (AASHTO) Connected/Automated Vehicle Research Roadmap, which will address the policy, planning, and implementation issues that will face state and local transportation agencies.
NACTO

The National Association of City Transportation Officials (NACTO) is a 501(c)(3) non-profit association that represents large cities on transportation issues of local, regional and national significance. NACTO views the transportation departments of major cities as effective and necessary partners in regional and national transportation efforts, promoting their interests in federal decision-making. We facilitate the exchange of transportation ideas, insights and best practices among large cities, while fostering a cooperative approach to key issues facing cities and metropolitan areas. As a coalition of city transportation departments, NACTO is committed to raising the state of the practice for street design and transportation by building a common vision, sharing data, peer-to-peer exchange in workshops and conferences, and regular communication among member cities. We believe that by working together, cities can save time and money, while more effectively achieving their policy goals and objectives.

Why Collaborate with ITE?

NACTO provides guidance to the urban designer. Urban designers focus on all modes of transportation. Similar to AASHTO, NACTO’s guidance would need to change when infrastructure is being designed for a driverless vehicle.

ITE could also benefit greatly from engaging the freight transportation engineers. This group of professionals is a segment of the transportation marketplace that ITE could explore to increase membership. Professionals in this field range from professional truck operators to mass transit (ferry, rail, taxi and bus), marine, rail and/or air freight transportation engineers.
These other groups of transportation engineers have very specific and unique qualifications as they interpret, analysis and grapple with finding efficiency through the movement of goods. ITE should stay abreast of the way connected and autonomous vehicles will impact these specific transportation engineering segments.

In many ways ITE is already working with a diverse spectrum of partners through the ITE Connected Vehicle Task Force. The ITE task force provides direct feedback to the U.S. Department of Transportation (U.S. DOT) Research and Innovative Technology Administration (RITA) ITS Joint Program Office (JPO) on its connected vehicle and autonomous vehicle program. In addition to staff support and volunteer councils, ITE is working with sister associations and U.S. DOT to help address design and operation challenges, while providing input to the policies needed to guide the transition.

ITE is represented by staff on the Transportation Research Board (TRB) subcommittee on autonomous vehicle. While also being tasked to investigate funding strategies for automated vehicle technologies, the TRB should continue to work with the National Conference of State Legislatures. Through this involvement in these many efforts, ITE is taking a leadership role as connected vehicles and autonomous vehicles come closer to implementation.

It is important to note that the depth of the collaboration between ITE and each respective organization may vary widely based upon the benefit that each organization could potentially receive.

Recommendation
Build upon the key relationships already established, and seek out additional partners that complement ITE’s mission and values to help ITE’s members learn and advocate for connected and autonomous vehicles.

### 6.2 V2I

With the coming technology, one important area identified is the Vehicle to Infrastructure (V2I) component. With ITE professionals being experts on the I (Infrastructure), it provides a great opportunity for ITE to take a leading role in helping develop policy and industry standards within this realm. ITE’s members and leaders should make recommendations about infrastructure needs and assist with the development of policy. Many of ITE’s practitioners will need guidance as documented in Section 3.0 as to the exact infrastructure changes that will be needed; how best to enact those changes, and how to finance projects. Members will also need support to assist and educate elected officials and policy makers to allocate funding for the required infrastructure improvements.

In addition, encouraging agencies to anticipate the additional funding needs and potential funding sources will be just as important. It is important for practitioners to understand which parts of projects can be funded by the federal and state governments based on grant requirements.

**Recommendation**

ITE should continue to work with the policy makers to develop comprehensive policy on the infrastructure needs in any capacity possible.
6.3 Facilitator

Much like the ITE’s position as a collaborator, ITE can also play an important role as a facilitator. Being the requisite knowledge base of the professional industry, ITE can help lead current practitioners in the coming changes. To do that, three (3) areas have been identified where ITE can facilitate the coming technology by guiding the practitioners it serves.

Create a vision of Transportation Infrastructure – Creating a vision for the future infrastructure needed to implement fully autonomous will educate practitioners as to the anticipated in the needs. The vision illustrates the items identified earlier in this document in Section 3.0. This will be a key component in maintaining value to the membership in the coming years.

Guide practitioners of the coming needs – Guiding transportation practitioners is a fundamental element of ITE. As the transportation industry enters a time of transition, it will be important to identify the changing elements within the industry such as trip generation, parking demand, roadway usage, traffic control changes, and other key elements and communicate the changes in those elements to industry practitioners. Thus creating a unified response in changes to the transportation network that reinforces the public’s trust in the profession.

Redefine how we evaluate transportation infrastructure – With the paradigm shift that is anticipated due to the usage of autonomous vehicles, the way we evaluate infrastructure will need to be redefined as well. Trip generation data will need to be evaluated for relevance, particularly on a regional basis. Parking generation will also
need to be evaluated, and could easily shift with in regions based upon the prevalence and acceptance of a shared economy. Safety measure and the need for them will need to be reevaluated and consideration will need to their cost effectiveness as some point. Capacity parameters for evaluating roadways and intersection will need to be further investigated. The MUTCD and its application will need to be reevaluated, including how to implement temporary traffic control measures. Essentially transportation practitioners will need to reestablish the standards they use to evaluate the infrastructure and the services they provide from top to bottom.

Recommendation

1. Create a vision of Transportation Infrastructure.
2. Guide Practitioners of the coming needs.
3. Redefine how we evaluate transportation infrastructure.

6.4 Transportation Professional

As with any shift in technology that systematically changes an industry, it will be important to identify the changes that will need to be made within the transportation profession to address the coming technological needs. Identifying new skill sets and thus making changes in workforce development will be important in helping to deliver technological changes and maintaining relevance within the industry. Developing a vision of the transportation professional of the future also could be key in recruiting perspective industry professional as well. Developing these skill sets will help members of the institution identify
the opportunities within the new technology and thus allow maximization of the technology within the industry

Recommendation

Identify key skill sets for and industry professional to possess on a 10 and 20 year horizon that will help to guide education and outreach into the future.

6.5 Shared Economy

With the advancement of autonomous vehicles, there continues to be the idea that our transportation system will move from a private vehicular ownership model, to a shared ownership model. In the shared model a corporation would own the vehicles, and users would pay a fee to have access to those vehicles. The users would schedule a time for usage of a vehicle.

A shared economy allows for improved resource allocation, provided for a more equitable use of resource across the social spectrum, and has the potential to reduce overall cost. Within the transportation realm, a shared economy could allow for greater mobility by allowing access to more users, reduce the environmental impact of vehicle usage, and provide for safer vehicle fleets. Much like the autonomous vehicle transition, there will also be a transition to a shared vehicular economy. Risk allocation will need to be addressed, and policy and regulations will need to be reviewed and updated to meet the demand for a shared economy.
The anticipated impact of a shared economy on transportation network varies widely. It will be important to explore the impact that a shared economy will have and its implications on the planning design and construction of transportation infrastructure.

**Recommendation**

*As how society views and uses transportation morphs to more of a shared economy, ITE should continue to help facilitate reevaluation of industry standards and continue to lead our industry in planning, design, and construction guides.*

**7.0 Societal Acceptance**

As with the introduction of any new technology that tends to challenge some of the societal norms that exist, it takes some time for acceptance of the technology. The emergence of Autonomous / Connected Vehicles will see similar challenges to the acceptance of the technology. In that context what is the transportation engineering industries role? What should we prepare for as an Industry?

Some preliminary polling has be conducted to see how society views the idea of autonomous vehicles, one may note the different generation responses shown in **Figure 1**.

**Figure 1: Preliminary Pole on How Society Views Autonomous Vehicles**
The trend to show that younger drivers have developed more trust in technology and therefore believe that well developed autonomous technology will keep them safe. The poll also illustrates a great generational divide on the acceptance of the technology. Perhaps even more interesting is the “undecided” portion of those polled. That figure was 25% or 1 in 4 people overall stated they did not know, or did not care one way or the other. The trend of younger people being more accepting of the technology bodes well for the anticipated timeline of the deployment of autonomous technology.

At this time, it is anticipated that within the next 5 years, most manufactures, if not all will have some Level 4 autonomous vehicles available to the marketplace. Then as manufactures meet the consumer demand for more Level 4 autonomous vehicles, the
complexion of automotive demographics will change. It is anticipated over the next 20 to 40 years beyond the initial roll out of Level 4 autonomous vehicles, a great transition will ensue. Autonomous vehicles numbers will grow, and they will begin to dominate the roadway. It is expected that third party manufactures will develop technology for non-autonomous vehicles to communicate with autonomous vehicles to further increase safety measure. Eventually, a majority of the vehicular travel market will give way to the autonomous vehicle, and that is when fundamental changes to the infrastructure utilized by the traveling public can be made.