How Autonomous Vehicles Will Change the Future of Road Design and Construction

By Jay Bowman

As automakers scramble to make cars that need little or no human intervention, it's time to consider four key implications of this trend for the engineering and construction industry

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Auto manufacturers have been spending more time in the lab lately, experimenting with new technologies and concepts with one common goal: to be first to market with a fully autonomous vehicle. According to various media reports, Ford recently threw down the gauntlet when CEO Mark Fields announced that the company is working toward launching a fleet of commercial, level 4 (one level below a completely autonomous system, in which drivers don't have to be engaged) vehicles in a ride-hail service by 2021. To get there, Ford is investing in Velodyne, a self-driving tech company and working with three other startups.

There's no question that the transition to autonomous vehicles is already underway. Features such as adaptive cruise control, lane keeping and collision avoidance systems exist in many vehicles being sold today. Although vehicles with these features do not operate independently of humans, the transition to fully autonomous vehicles could occur within as little as 15 to 20 years. The disruption this will have on highway and street infrastructure is almost unimaginable. While neither good nor bad, this development represents the many facets of change that can benefit and some (if not most) that may suffer.

The purpose of this article is not to make definitive statements about the future but rather to hypothesize reasonable outcomes, outline four key areas of impact and show the implications of these trends on the design and construction industry of the future.

Breaking Down the Barriers

Self-driving cars are expected to ease our commutes, make driving as a whole much safer and make life more efficient. Seniors who are unable to drive safely in traditional vehicles, for example, will be more mobile thanks to their autonomous vehicles. In

terms of infrastructure, everything from streets to curbs to sidewalks will need to change when the autonomous car makes its official debut. And while an exact date may not be in clear view yet, the day is definitely coming.

For the construction industry, the transition to fully autonomous vehicles represents the single greatest disruption to current highway and street design and construction for the next 25 to 30 years. Although difficult to imagine for many and rejected in full by others, the pursuit of fully autonomous vehicles is evident by the large-scale investment made to date. This includes billions of dollars spent by automobile manufacturers such as GM, Mercedes and Nissan as well as firms perhaps until recently not associated with autonomous vehicles or transportation in general, such as Google.

There are many misguided allegations surrounding fully autonomous vehicle transportation and whether the world will reach this point by midcentury. Most of these allegations are false. Consider, for example, that the millennial generation (those people currently between the ages of 19 and 35) does not view vehicles in the same manner as older generations nor does it place extraordinary value in them. A recent Zipcar survey, for example, indicated that "millennials would rather give up driving than give up their smartphones or laptops."

But driving preferences alone may not matter in the transition to fully autonomous vehicles. At a recent GPU Technology Conference, Tesla co-founder and CEO Elon Musk hypothesized that human-driven cars may be illegal in the future. Speaking with NVIDIA CEO Jen-Hsun Huang, Musk said, "People may outlaw driving cars because it's too dangerous."[1] Musk was not endorsing such prohibition but rather conjecturing a reasonable expectation of results that many anticipate with the advent of fully autonomous vehicles.

Following are four more implications that the engineering and construction industry must be aware of:

1. **Funding shifts.** As we move toward a world where cars operate independently of humans, construction funding becomes another key consideration for the companies adapting our highways, roads and streets for the change. Funding for highway and street infrastructure investments is expected to shift from motor fuel taxes to a toll-type basis and perhaps result in a major increase in available monies. A U.S. Department of Treasury Department report estimated 1.9 billion gallons of gasoline are wasted per year due to traffic congestion.[2] Assuming an average $0.485 per gallon tax for gasoline, this represents $921.5 million in federal, state and local revenue.

   Various industry stakeholders suggest not only that autonomous vehicles could eliminate most if not all traffic congestion, but also that anticipated efficiency gains could further reduce motor fuel consumption by 20% (a conservative estimate among the ranges that currently exist). Applying this estimate to the U.S. Energy Information Agency's reported 137 billion gallons of gasoline consumed in 2014 results in 27.2 billion fewer gallons consumed and slightly more than $13 billion in motor fuel taxes lost.

[1] Musk, E. (2015, March 17). GPU Technology Conference 2015. (J.-H. Huang, Interviewer)
[2] (2012). A New Economic Analysis of Infrastructure Investment. Washington, D.C.: Department of Treasury.

One can assume that voters will reject the required increase in federal, state and local motor fuel taxes to merely replace this potential loss in revenue (and such tax increases would likely be unpalatable to the politicians who would have to legislate them). With the introduction of electronic toll collection (ETC) technologies and the inherent "connectedness" of autonomous vehicles, the ability to toll becomes applicable to essentially any highway and street in the nation. The deployment of new "remote" ETC could be as simple as activating a software program, as little hardware (e.g., automated gate, vehicle detector) is required.

Regardless of how fuel-efficient future vehicles become—by design or operation— tax revenues for highway infrastructure investment will be unaffected. Combined with low operational cost, the ease by which remote ETC may be deployed will also facilitate much greater opportunities for public private partnerships (P3), perhaps unleashing another major injection of funding for highway and street infrastructure investment on the level (or even greater than) witnessed with TEA-21.

2. **Enhanced efficiency and accuracy.** The enhanced accuracy and efficiency of autonomous vehicles will have a profound effect on highway and street design and construction as well as any ancillary and related infrastructure. The American Association of State Highway and Transportation Officials (AASHTO) and the Federal Highway Administration (FHWA) have established lane widths for various types of roadways. For example, these range from 12 feet for freeways to 9 feet for two-lane rural highways. Lane widths are designed according to speed and roadway capacity, which in turn assumes human operation of vehicles and reaction times (e.g., acceleration, deceleration).

   Typical roadway capacity is currently about 2,200 vehicles per hour per lane. The Center for Urban Transportation Research (CUTR) states that "this reflects only 5 percent utilization of roadway space."[3] The transition to autonomous vehicles assumes a concurrent reduction in lane width (a 25% reduction in freeway lane width if assuming 12 feet to 9 feet) and an increase in roadway capacity (more than 50% by several industry estimates). This significantly limits the volume of additional highway infrastructure required, including widening and new alignment.

   As a result, consumption of construction materials (e.g., asphalt, concrete) could decline by a third or more. Moreover, ancillary highway infrastructure such as lighting, railing, signage, striping and so forth could be largely eliminated. The same is true for other types of related infrastructure. For example, are parking lots and garages necessary in a fully autonomous vehicle society if people no longer own personal vehicles?

3. **The potential for disruptive impacts.** Autonomous vehicles will have many other disruptive effects on transportation, both evident and unforeseen. And while all of the disruptive effects may be unknown at this time and even unimaginable, certain issues are sure to arise. For example, public rail transit systems (e.g., light rail) will no longer be viable in second-tier metropolitan markets. It is reported that only 5% of employees in the U.S. currently utilize public transit to commute to work (2012 estimate).

[3] Pinjari, Ph.D., A. R., Augustin, B., & Menon, N. (2013). Highway Capacity Impacts of Autonomous Vehicles: An Assessment. Center for Urban Transportation Research, University of South Florida.

Moreover, this is down from the almost 9% of employees who did the same in 1970. Although it is believed that established public rail transit systems, such as the subway system in New York City, will not be impacted by autonomous vehicles to any great extent, those in second-tier cities (existing or planned) will be abandoned. In contrast, high-speed rail will become viable as autonomous vehicles solve the "last mile" problem.

Improving the existing highway and street infrastructure, as well as upgrading it to include intelligent transportation features, will shape and influence design and construction activity for decades. It is important to note that the reduction in some types of highway and street construction does not necessarily translate to an overall reduction in the level of highway and street infrastructure investment.

Instead, limited funds may be directed toward much needed improvement of existing assets. This may be welcomed by state and local administrators and agencies, as indicated by a recent survey commissioned by the American Society of Civil Engineers (ASCE) with the Governing Institute. The survey reports that the needs of these administrators and agencies are primarily focused on "significant upgrades/replacements" and "general maintenance," as only 8% of respondents identified new infrastructure as their most pressing issue.[4]

Furthermore, the embedding of technologies into the highway and street infrastructure could usher in a period of rapid "upgrades." As previously noted, the volume of available monies for highway and street construction could also accelerate quickly with the transformation to autonomous vehicles due to new funding models (e.g., remote ETC) and sources (e.g., P3).

4. **Greater need for third-party planners.** State and local highway and street administrators and agencies will require greater third-party involvement with development activities as a result of the evolution to autonomous vehicles. Few state and local highway and street administrators and agencies have actively studied the impact of autonomous vehicles in their planning practices to date.

   This is not an indictment of these organizations but rather recognition of the conflicting conditions within which they are operating. Consider that state transportation employment has decreased by more than 10% over the past decade while highway and street construction projects have simultaneously increased in value and compressed in schedule.

   The rate of technological innovation, which itself is accelerating, further complicates issues for these state and local highway and street administrators and agencies. Therefore, it is believed that third-party providers of planning, technology consulting, design-build and other nontraditional services will be of greatest importance to owners of transportation infrastructure. The inability to provide these services (or some combination thereof) will then present competitive disadvantages to many design and construction services firms operating from a historical perspective.

[4] Vock, D. C. (2014, October 1). The Long-term Cost of Building Transportation Projects on the Cheap. Governing.

It's Time to Make a Move

The bottom line is that just 15 to 20 years from now, highway and street design and construction will look very different than they do today. The changes will include not only new designs and construction but also the manner in which funding is secured for transportation, the level of services expected from third-party providers, and exactly how those services will be delivered. The changes will create new opportunities and eliminate others. Now is the time to consider the range of possibilities such a future presents to you and your organization, develop possible responses and enjoy the ride.

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