

DRIVERLESS CARS AND THE FUTURE OF AMERICAN INFRASTRUCTURE

Aaron M. Renn

Senior Fellow



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About the Author



Aaron M. Renn is a senior fellow at the Manhattan Institute, a contributing editor of *City Journal*, and an economic development columnist for *Governing* magazine. He focuses on ways to help America's cities thrive in an ever more complex, competitive, globalized, and diverse twenty-first century. During Renn's 15-year career in management and technology consulting, he was a partner at Accenture and held several technology strategy roles and directed multimillion-dollar global technology implementations. He has contributed to the *Guardian*, *Forbes.com*, and numerous other publications. His perspectives on urban issues are regularly cited in the *New York Times*, *Washington Post*, *Time*, *The Economist*, *Daily Telegraph*, and other international media.

Renn holds a B.S. from Indiana University, where he coauthored an early social-networking platform in 1991. He has created several widely used open-source software packages, including the only program for recovering data from corrupted gzip backups. In 1998, Renn launched one of the nation's first blogs, the *Weekly Breakdown*, to cover the Chicago Transit Authority.

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Executive Summary

Improving the country's infrastructure will likely be high on the agenda of the incoming administration and Congress. The threshold question is what priority should be given to building or widening new roads and highways and bridges, versus repairing and maintaining the ones that already exist.

This paper outlines the reasons federal spending should strongly favor repairing and maintaining the current infrastructure, not expanding it. As much as 20% of the nation's major roads are in poor condition, and tens of thousands of the country's bridges are structurally deficient. Fixing them is an expensive proposition.

To overhaul a single deteriorated segment of the Brooklyn-Queens Expressway in New York, for example, will cost an estimated \$1.7 billion.¹ But highway spending fueled by federal dollars is often directed to expansion rather than repair—and doing so could be an enormously costly mistake.

- Spending on new or expanded highways is already showing lower economic returns than maintenance. In the past, traffic engineers could use projections of population and job growth to extrapolate the need for new or expanded highways. But two developments may render such projections increasingly unreliable.
- The first development is self-driving cars. Companies like Google and Uber are already testing autonomous vehicles on public streets in cities such as Pittsburgh. The timing and spread of this technology is uncertain, but many researchers and experts expect the shift to autonomous vehicles to have dramatic and unpredictable effects on, for example, traffic congestion.
- The second development is the possibility that the U.S. may reach what some analysts refer to as “peak car.” The long-term trend in traffic growth, on both a total and per-capita level, underwent an unprecedented reversal in 2007, with several years of actual decline. This included nine straight years of declining per-capita travel. Vehicle miles traveled (VMT), total and per capita, has begun to grow again, but some researchers believe that the U.S. may be at or near the end of the era of per-capita traffic growth.

Both these developments make it increasingly uncertain as to how much new road and highway capacity the U.S. will need in the future—or even what kind of roads the country will need. Policymakers need to keep this uncertainty front and center.

AVOIDING POTHOLES ON THE ROAD TO BETTER INFRASTRUCTURE

I. Introduction

Infrastructure spending in the U.S. is heavily influenced by political, not economic, criteria—and cutting a ribbon to open a new or widened highway makes for great optics. Whether the project can be justified by a cost-benefit calculation is not always the main consideration. As the Congressional Budget Office (CBO) noted last year, “Spending on highways does not correspond very well with how the roads are used and valued.”²

Quite apart from decisions to build new roads that are skewed by political considerations, it’s also the case that return on investment from new roads has simply been declining over time. In part, this is because the U.S. already has an extensive transportation network of railroads, highways, and air routes.

Building the initial networks provided large amounts of value by significantly reducing transportation costs. Subsequent additions to the highway network post-1980 have generated significantly less value. The CBO has noted as much: “Research suggests that the increases in economic activity from spending for new highways in the United States have generally declined over time.”³ Harvard economist and Manhattan Institute senior fellow Edward Glaeser confirmed these findings: “There have been diminishing returns to building new roads, particularly since we completed the National Highway System.”⁴

Glaeser’s conclusion is no outlier. A 2013 meta-analysis by Pedro Bom and Jenny Ligthart of 68 studies conducted between 1983 and 2008 showed declining returns on highway investment.⁵ One of the studies that they looked at suggested that the return on new highways in the 1980s and 1990s had already dropped below 5%. Conversely, maintenance yields returns of 30%–40%.⁶

Nevertheless, about 35% of federal highway funding continues to go to new or expanded highways instead of the backlog of repairs on the existing system.⁷ A few examples: the state of Ohio recently spent \$160 million to build a bypass around the town of Nelsonville, population 5,400.⁸ The state of Iowa is widening US 20. Maryland is widening MD 404.

The point is not to critique this or any other specific project but to show that American states are extensively building new highways as well as widening existing highways. The relative lack of expansion in key northeastern metro areas such as New York or Boston can give a misleading

impression to policymakers, who often bemoan—inaccurately—the lack of highway expansion.

For a measure of the poor return on investment (ROI) on expansion projects, consider the failure or underperformance of various privately financed toll-road projects. Even in rapidly growing Texas, the concessionaire operating the SH 130 toll road near Austin, which opened in 2012, went bankrupt in 2016.⁹ The company operating the Foley Beach Express toll bridge in Alabama opened in 2000 and went bankrupt in 2013.¹⁰ The operator of the South Bay Expressway in San Diego went bankrupt in 2011, after opening in 2007.¹¹

In these cases, traffic and revenues fell far short of projections. As it turned out, drivers' willingness to pay tolls—that is, to pay the cost of constructing and operating the highways in question—was less than anticipated. In other words, the value of the road to motorists had a negative ROI. While toll financing, which charges the users of highways for their cost, is preferable to paying for new roads with tax dollars, these bankruptcies also suggest that President Trump's proposed \$1 trillion infrastructure plan, which relies heavily on private investment and tolls, may not generate the anticipated results.

Alongside the poor returns for many expansion projects, America has a significant backlog of critical maintenance needs. Many estimates, such as the well-known Infrastructure Report Card,¹² published by the American Society of Civil Engineers, are produced by organizations with a stake in increased infrastructure spending. But even if the exact needs are difficult to quantify, the legitimate repair needs appear to be considerable.

According to a recent report from the transportation research organization TRIP, 20% of the nation's major roads are in poor condition. In urban areas, that number rises to 32%.¹³ The Reason Foundation's Annual Highway Report lists a fairly small number of interstate highway miles in poor condition, only 5.4% in urban areas, but this value is trending upward.¹⁴ The Federal Highway Administration reports that 9.6% of America's bridges are structurally deficient, but this still means that 59,000 bridges need to be fixed.¹⁵ (Reason's report says that 20% of bridges are deficient.)

Estimates of the maintenance needs of America's highway systems vary widely; but in all cases, a signif-

icant number of roads and bridges require repair—and the money currently being spent on speculative system expansion could be profitably redirected.

II. Infrastructure and Driverless Cars

Google is currently testing autonomous vehicles on the streets of Austin and elsewhere; Uber's driverless cars are cruising in Pittsburgh and San Francisco. A driverless tractor-trailer using Uber's technology recently made a 120-mile beer delivery run for Coors.¹⁶ Apple is working on driverless cars. And the traditional auto companies are gearing up to compete against these technology companies by developing autonomous vehicles—cars as well as trucks.

Numerous technical, legal, and other challenges must be addressed before autonomous vehicles are ready for deployment to ordinary customers. But the fact that actual test vehicles are already on the road suggests that this moment might not be that far off.

There has been tremendous speculation about what autonomous vehicles will mean for American society. Articles on their potential impact have appeared in a large number of publications, including *New York* magazine,¹⁷ the *New York Review of Books*,¹⁸ and the *Harvard Business Review*.¹⁹ Most agree that their impact could be vast, including:²⁰

- Significant economic displacement. About 4 million people work as truck drivers, for example; their jobs are at risk.
- Radically changing the ownership model of vehicles. Some suggest that people in the future will access a shared fleet of driverless cars rather than own an individual one.
- Eliminating the traffic-enforcement function of policing, which would deprive local government of moving-violations revenue.
- Pervasive change or the elimination of entire industries such as car dealers and insurance agents, with follow-on effects in state and local politics, where these constituencies are currently very powerful.

- Expansion of the surveillance state as autonomous vehicles connected to the cloud upload sensory data in real time.
- An increased shortage of organs for transplantation, as fewer organ donors die in accidents.

While it's impossible to predict whether any of these changes will actually come to pass, it seems likely that autonomous vehicles could represent a major economic and even social inflection point. That is, they will be more like an entirely new mode of transport than merely another feature extension of the automobile as we know it.

This innovation introduces significant uncertainty into our requirements for transportation infrastructure over the medium and long term. Consider the effect of autonomous vehicles on congestion alone. One study projects that “the adoption of AVs will likely result in higher per-capita VMT due to latent demand.”²¹ Another predicts: “When fleet penetration reaches 95% and when non-drivers are permitted to travel in robotic cars, VMT increases may reach as high as 35% on portions of the transportation network.”²²

How might driverless cars lead to more congestion? First, they could be used widely by those currently too old or too young to drive. Second, people could easily become more tolerant of longer commutes if their travel time is productive. And third, so-called dead-heading, in which empty vehicles, such as those exiting a city center to park at a remote site or to return to the owner's home for another family member to use, could lead to a serious increase of vehicles on the road.

On the other hand, autonomous vehicles hold the promise of making highways much safer and more efficient. “The reduction of traffic crashes and consequent secondary incidents alone,” one study suggested, “will lead to significant efficiencies in traffic operations by reducing non-recurrent congestion, because 25 percent of traffic congestion can be attributed to traffic incidents such as crashes and vehicle breakdowns. At high market penetration, AV technology potentially can make it possible to move toward an advanced form of vehicle platooning in which convoys of vehicles move at high speeds and small spacing in between. This approach is being tested in the trucking industry, in which a number of driverless trucks are coupled and led by a human-driven truck.”²³ Another study sug-

gests that “when regulations, liability concerns and driver comfort allow much more aggressive car-following algorithms, vehicle delays may be reduced by 45% or more.”²⁴

Which of these effects will predominate? How much traffic will there actually be in the future? How much highway capacity will be required? Will driverless cars require different types of roadways to be built?

These questions are very much up in the air. But what we can say with certainty is that the advent of autonomous vehicles materially increases uncertainty about both the type of infrastructure that we will need and the highway capacity required, making speculative investment today unwarranted.

III. “Peak Car” and the Future Demand for Travel

Starting in 1950, total VMT had been increasing at a rate faster than population and jobs (see **Figure 1**). This was true for per-capita VMT as well. There were a very small number of short-term interruptions, such as the time period around the 1973 Arab oil embargo; but overwhelmingly, the trend was up.

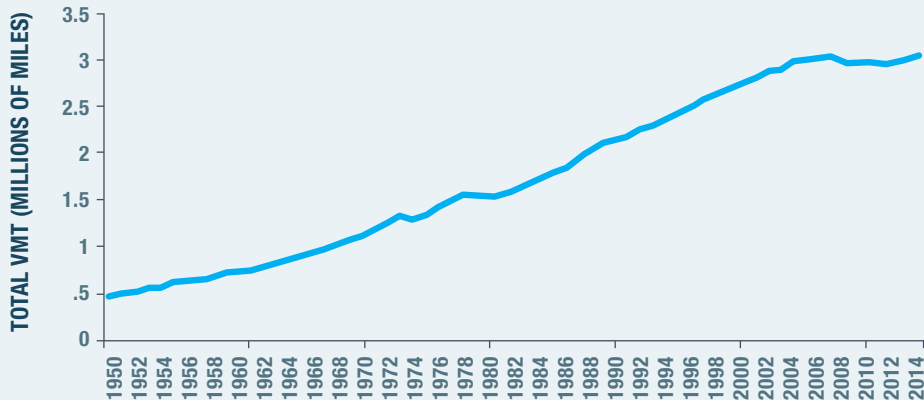
This changed starting in the 2000s. Total VMT fell, starting in 2007, and continued until 2011. Per-capita VMT (see **Figure 2**) started falling in 2005 and continued through at least 2013. (Per-capita and total VMT can move in different directions because the total U.S. population is growing.)

One obvious factor behind this decline was the onset of the Great Recession; it's unsurprising to see that total VMT began falling in 2007 as Americans lost their jobs and incomes. But there may be other forces at work.

Many argue that driving demand is unlimited. This is embodied in the idea of so-called induced demand, which holds that when a new highway is constructed, that new road (increased supply) will tend to increase the quantity of driving consumed because it lowers the price of driving (in the form of reduced congestion, more direct routings, and so on).

FIGURE 1.

Total Vehicle Miles Traveled (in Millions of Miles)



Source: Federal Highway Administration

This is true so far as it goes. But the logic of induced demand also insists that any attempt to address traffic congestion by building more roads or widening more roads is futile because those roads will simply fill up with new cars until they are equally congested.

But there may be a countervailing force, “saturation”: at some point, there is simply little to no further demand for driving to satisfy. Traffic engineers as far back as the 1950s anticipated that per-capita VMT would level off at a future date. In fact, a 1974 British study predicted that that country would reach a saturation point in 2010, close to the time in which British VMT did, in fact, peak and start to decline.²⁵

David Metz, a researcher at University College London and formerly chief scientist of the U.K. Department for Transport, states: “Saturation of daily travel demand is to be expected and is a likely explanation for the observed cessation of per capita growth of personal travel.”²⁶

He bases his claim on the diminishing marginal utility of additional car travel.

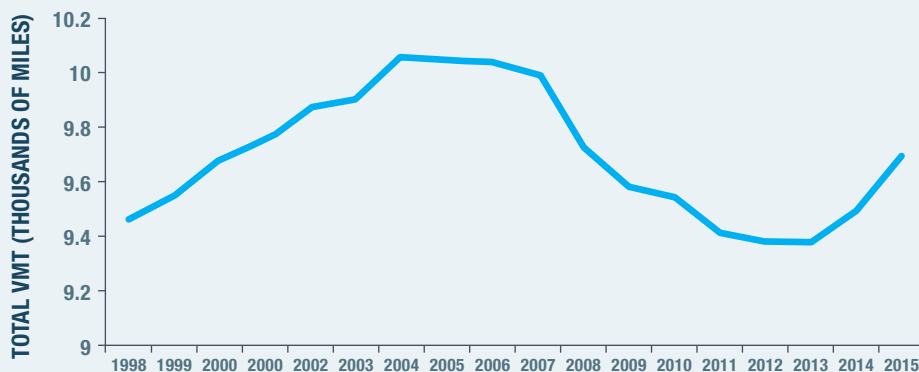
Metz points out that 80% of Britons already have three supermarkets within a 15-minute drive. In many categories, ample choices are already available within easy driving distance and within each person’s daily travel budget, which he estimates as a historical constant of about one hour. There’s limited need to drive more and farther to access more opportunities, except in a limited number of places with unique amenities or employment characteristics.

This saturation effect exists independently of any other effects that might limit or even reduce travel demand, such as claims that the current generation of young people prefers walking, bicycling, and public transit to a greater extent than previous generations did.

Both total and per-capita VMT resumed their upward climb, beginning in 2012 and 2014, respectively. Total

FIGURE 2.

VMT per Capita, 1998–2015



Source: Federal Highway Administration, “Moving 12-Month Total Vehicle Miles Traveled,” retrieved from FRED (Federal Reserve Economic Data), Federal Reserve Bank of St. Louis

VMT has reclaimed its peak, though per-capita VMT remains well below peak. It's possible that the declines were purely recession-induced and the previous trend will resume indefinitely. But given the fact that this decline wasn't anticipated by contemporary traffic engineers, that per-capita VMT declined for nine straight years (as opposed to only two during the Arab oil embargo of the 1970s), and that there are theoretical reasons to believe in a demand saturation point, we should not behave with as much certainty about future traffic increases as we did previously.

In short, even apart from autonomous vehicles, there has been a material increase in our level of uncertainty about future demand for highway infrastructure.

IV. Conclusions

While there may be select regions—for example, Houston—where rapid growth makes highway expansion necessary, the national story is one of uncertainty, thanks to autonomous vehicles and travel-demand saturation. On the national level, the danger is to commit to building highways that can't be economically justified while existing roadways crumble. To avoid this danger, federal policy should be changed in the following ways:

1. *Limit or eliminate federal grants for highway expansion.* One way would be to restrict federal grants to maintenance only, or to cap the share of expansion projects at a low percentage, such as 5%. Economists Matthew Kahn of UCLA and David Levinson of the University of Minnesota made an interesting proposal for this in 2011 that might serve as a model.²⁷ Their proposal would: a) restrict federal grants to maintenance only; b) create a highway-specific federal infrastructure bank to finance highway expansion projects that meet a clear economic return threshold; and c) provide lower interest rates on loans for projects that meet various performance standards. Something of this nature could serve as a template for reform.

2. *Permit existing highways to be tolled to manage congestion and finance expansion.* Rather than expanding highways that are currently congested, one alternative solution is to use pricing to manage congestion instead. This so-called congestion pricing approach has long been used in Singapore and has been deployed in many

other cities around the world. It is also already in use in the U.S., such on the SR 91 express toll lanes in the Los Angeles area. This can be implemented with modern electronic toll-collection methods that don't require congestion-creating toll booths.

The bankruptcy of various U.S. toll-road projects noted above shows that drivers are sensitive to pricing. Requiring states to use either 100% state funds or toll revenues to build expansion projects would enforce greater market and political discipline on expansion projects.

3. *Limit or eliminate federal funds for rail-transit expansion.* About 20% of federal surface transportation spending is directed to transit. Some of this goes to buses, but a significant amount has been badly misdirected to build new rail projects in cities with limited histories of rail transit and infrastructure designed overwhelmingly around the automobile. These projects, like Dallas's light rail system, are even more speculative than highways.

Meanwhile, the existing rail system in Washington, D.C., has experienced severe problems due to a lack of maintenance. The same is true in Boston. New York City's subway signals are many decades old and obsolete, among myriad other maintenance needs. Given the extensive maintenance needs on existing high-volume rail systems, limited federal dollars should not be directed to such speculative enhancement projects.

With the future of transport so uncertain, the government would do well to stay away from the new and stick to investing limited federal resources on what we know will deliver: the maintenance of our existing roads, bridges, and transit lines.

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Abstract

Improving the country's infrastructure will likely be high on the agenda of the incoming administration and Congress. To accomplish this goal, federal spending should strongly favor repairing and maintaining existing roads, highways and bridges, not building new ones. That's because as much as 20% of the nation's major roads are in poor condition, and tens of thousands of the country's bridges are structurally deficient. Fixing them will yield the best return for the taxpayer dollar.

Key Findings

1. Spending on new or expanded highways is already showing lower economic returns than maintenance. In the past, traffic engineers could use projections of population and job growth to extrapolate the need for new or expanded highways. But two developments may render such projections increasingly unreliable.
2. The first development is self-driving cars. Companies like Google and Uber are already testing autonomous vehicles on public streets in cities such as Pittsburgh. The timing and spread of this technology is uncertain, but many researchers and experts expect the shift to autonomous vehicles to have dramatic and unpredictable effects on, for example, traffic congestion.
3. The second development is the possibility that the U.S. may reach what some analysts refer to as "peak car." The long-term trend in traffic growth, on both a total and per-capita level, underwent an unprecedented reversal in 2007, with several years of actual decline. This included nine straight years of declining per-capita travel. Vehicle miles traveled (VMT), total and per capita, has begun to grow again, but some researchers believe that the U.S. may be at or near the end of the era of per-capita traffic growth.

Both these developments make it increasingly uncertain as to how much new road and highway capacity the U.S. will need in the future—or even what kind of roads the country will need. Policymakers need to keep this uncertainty front and center.