Surface Transportation 3.0

Sebastian Thrun
Stanford University

Henry Kelly
Federation of American Scientists

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The challenge

The nation's system of highway transportation – Surface Transportation 2.0 – has provided the flexibility, speed, reliability, and efficiency needed to support a US economy constantly changing and constantly on the move. But innovations are badly needed if the system is to continue to provide such services in the future. Consider:

- **Energy and the Environment:** Highway transportation uses approximately 22 percent of all US energy[2] and is responsible for roughly the same proportion of CO2 emissions. (For comparison, US petroleum imports are about 28 percent of US energy use.[3])

- **Efficiency and Productivity:** Congestion in the US is responsible for 3.6 billion vehicle hours of delay annually. The European Union, which faces similar problems, estimates that the cost of congestion is about 0.5% of GDP.[4] In the US, the average daily commute time exceeds one hour.

- **Safety:** Over 41,000 people are killed[5] and 2.5 million injured[6] in highway accidents each year in the US – most from vehicles leaving the road or traveling unsafely through intersections. Over 95% of all automobile accidents are caused by driver neglect.

- **Equity:** Urban development patterns have forced many low income families to move to suburban or exurban neighborhoods to find affordable housing. This requires long commutes, with few mass transit opportunities, and the threat of rapidly rising costs. The number of people over the age of 65 will increase 80 percent by 2025; more than half of the people in this age group stay at home on any given day because they lack transportation.[7] Driving is not an ideal solution, though; people in their 70s have nearly 4 times the accident rates of people aged 25-65.

- **Homeland Security:** While the US has been spared terrorist incidents on trains and subways, the threat remains very real. New methods must be put in place to detect danger and manage reaction to natural and man-made disasters. This includes tracking freight through multi-modal journeys.

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[1] For the most current version of this essay, as well as related essays, visit http://www.cra.org/ccc/initiatives
[2] http://cta.ornl.gov/data/tedb27/Edition27_Chapter02.pdf
[3] http://eia.doe.gov/mer/overview.html
[4] http://www.ertico.com/
[5] http://www-nrd.nhtsa.dot.gov/Pubs/811016.PDF
[6] http://www-nrd.nhtsa.dot.gov/Pubs/811017.PDF
[7] http://www.apta.com/research/info/online/documents/aging_stranded.pdf

Innovation in surface transportation is hampered by complex patterns of ownership and incentives. While the vehicles and guideways of rail transit are under a single management, this is the exception. In spite of the best efforts of the Bush administration, most highways are still built and maintained by federal or state governments. Vehicles are primarily owned and maintained by individuals. Traffic information (weather, road conditions) is a mixture of public and private services (National Weather Service, radio stations, Google, etc.). The complex financing of transport often creates bizarre incentives. When high gasoline prices increased incentives for using public transportation, state revenues from gasoline taxes went down and some states responded by cutting back on funding for public transportation.

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Radical reductions in the cost of sensors, communication, and information processing have the potential to be game changers but have not been effectively exploited. **Federal leadership is essential** to break the logjam and encourage new approaches. The key is designing programs that drive change but leave plenty of room for ideas from unexpected sources. The key elements in Surface Transportation 3.0 include:

- **Improved urban design**: A number of urban and suburban regions have developed creative plans for converting traffic clogged sprawl into areas which mix residential and commercial development. Most trips can be made by walking, biking, or in short-range electric vehicles for people with limited mobility. High density housing and commercial development is encouraged around transit hubs. The shift to more efficient urban designs may require many years but can only occur if the community develops clear goals and uses these goals to guide decisions about new construction and infrastructure investments. This has worked particularly well in housing developments built around new transit projects.

- **Expanded transit networks:** Mass transit's share of person-miles traveled has probably declined[8] in recent years in spite of huge investments. One problem is the difficulty of keeping load factors high in large vehicles because of the need to avoid "split shifts" for drivers and ensure service in off peak periods. In some cases mass transit's passenger miles per gallon may be below today's high-efficiency cars since heavy buses run nearly empty on many runs and often return to terminal areas empty. New infrastructure should include both traditional rail and bus lines, smaller vehicles (vans and jitneys) that fill the gap between taxis and large buses, and possibly driverless units on dedicated guideways (like those used in many airports). Real-time sensor information tracking the position and speed of each vehicle can increase efficiency and safety by automatically detecting potential congestion and collision conditions. These systems are vastly more efficient when facilitated by good urban design.

- **Personalized, real-time information for choosing travel options:** New information tools should make it possible for individuals to use hand-held and other devices to get a variety of options for travel.[9] By entering a destination a traveler could be given a price and

[8] http://www.bts.gov/publications/journal_of_transportation_and_statistics/volume_08_number_03/html/paper_03/
[9] http://www.google.com/intl/en/landing/transit/#mdy

estimated time of arrival for options including walking (including directions), mass transit (where to go, what bus/train to enter, next available arrival), and jitney, taxi, and "zip car"/bike locations. Selecting a jitney or taxi would instantly send an order and update routing. Some bus companies already let people find the next bus at a stop using conventional cell phone text messages, or form "just in time" car pools using services from companies like Ride Now[10]. The Irish firm Avego[11] is experimenting with methods that use the iPhone to let people offer rides to people headed in the same direction and receive appropriate payments. "Zip cars" are a particularly attractive option in urban areas; Americans appreciate the convenience of personal vehicles, but the average personal vehicle is utilized less than 5% of the time over its lifetime, meaning that the economic and environmental costs of manufacturing it are not well-amortized (and also that it is occupying an expensive parking space more than 95% of the time).

- **Improved highway vehicle management:** New technologies[12] also permit real-time, individualized information and advice for drivers and highway managers, including such services as: real time reports on road conditions; incident detection and management; surveillance and detection of hazardous material; open road tolling; electronic border crossing and credentialing; electronic parking payments and guidance to free spaces; commercial vehicle inspection verification; variable message signs; on-ramp metering; improved incident management; and driving fees based on when and where a vehicle is driven (e.g., the fees charged for driving in downtown London during business hours). These and other steps can improve safety and reduce congestion using technology available today.[13] The key technologies are low-cost sensors embedded in highways, wireless communication systems (including analysis of cell-phone signals), and low-cost sensors in vehicles (radar, GPS, and accelerometers). Dedicated Short Range Communications devices (a variant of Radio-Frequency Identification) play a critical role since they allow vehicles to communicate with each other and with the highway. Additionally, sensors embedded in bridges and other parts of the highway system allow early detection of flaws.

- **Real-time driver assistance:** Information available from the network of sensors described above also provide resources to help drivers navigate dangerous conditions through such things as adaptive cruise control and collision and rollover warning/avoidance, and warning of approaching emergency vehicles. This is particularly important for individuals with disabilities and for a population of older drivers. Over time these "cruise control" technologies can evolve to take on an increasingly complex set of tasks and safety maneuvers. Given successful research outcomes, it may be possible to develop a new generation of "cruise control" that would make it possible to put more vehicles in the same highway space allowing an increase in highway capacity without decreasing safety. Research could also lead to an infrastructure for conveys of computer-controlled trucks traveling on dedicated guideways.

- **New vehicles and fuels:** A major research program is needed to explore new electric,

[10] http://www.ridenow.org/
[11] http://www.avego.com/ui/index.action
[12] http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_te/14412.HTM
[13] http://www.itsdocs.fhwa.dot.gov/JPODOCS/REPTS_te/14412.HTM

hybrid, and advanced engine cycles as well as new transportation fuels. These should be considered in a separate initiative.

Actions

- Undertake a major upgrade of the Department of Transportation's research program, making it responsible for managing an ambitious program of technical research as well as economic and policy analysis – possibly by greatly expanding the Research and Innovative Technology Administration[14] in the Department of Transportation now funded at only $10 million/year. DoT presently spends about $570 million on surface transportation[15] in several different Administrations (Highway, Transit, Railroad, and Motor Carrier Safety). An additional $335 million is spent by the FAA (which also needs help, but that's another white paper). Close collaboration with NIST and the Department of Energy is essential. A fixed fraction of these funds should be dedicated to high-risk research on potentially disruptive technologies.

- Create a number surface transportation research centers at universities based on a competitive solicitation (each would be funded for at least five years).

- Work with NIST to develop interoperability standards for intelligent transportation systems and safety (there is already incompatibility between US and European implementation of Dedicated Short Range Communications devices).

- In collaboration with HUD, create a competitive solicitation for urban areas to propose innovative intelligent transportation schemes.

- The NSTC should be tasked with building a tightly integrated program involving DoT, NIST, DoE and HUD to carry out these missions.

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[14] http://www.rita.dot.gov/ordt/
[15] http://www.aaas.org/spp/rd/dot09s.htm#tb