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A Path Towards More Sustainable Personal Mobility

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In the United States, light duty vehicles travel about three trillion passenger miles every year. That means that annually we collectively travel a distance more than thirty thousand times the distance from the Earth to the Sun! While we appreciate the convenience of personal automobile travel, we also know that our behavior has negative impacts, especially on the environment.

Every year, we burn 140 billion gallons of gasoline in our automobiles, contributing to climate change and causing a measurable decrease in air quality. In many metropolitan areas the pollution from traffic creates visible smog, which is especially a problem in developing countries. Finally, oil resources are slowly being depleted and the control of remaining, valuable oil supplies has been a persistent source of international conflict.

If the effects of driving personal vehicles are so bad, why do we continue using them? The problem is that the ability to move around freely and independently in a personal vehicle is a fundamental value of our society. So what can we do? There are three possible solutions that could mitigate the problems described above before the negative impacts lead to irreversible damage to our ecosystem, and ultimately to the exhaustion of our natural resources. These solutions, which likely will be implemented over the next few decades, are electrification, automation, and transportation sharing.

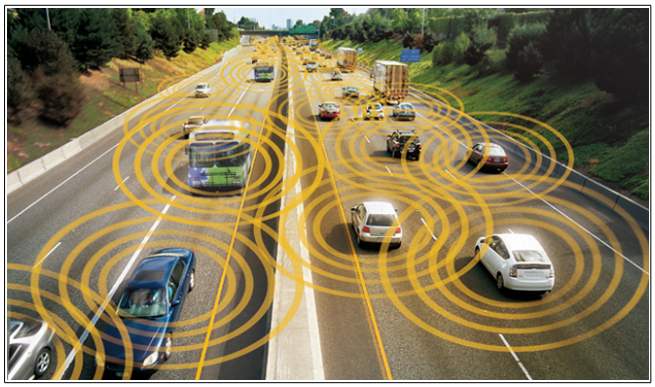
Electrification means that conventional powertrain components are supported or completely replaced by electric motors and batteries. Different levels of electrification are possible, such as hybrid electric, plug-in hybrid, battery electric, or fuel cell vehicles. These are promising solutions to the climate, pollution, and resource problems that I have described above. For example, an electrified powertrain can be powered by many different sources of electricity. This would allow cars to be powered mainly by renewable energy rather than only by fossil fuels, as is the case with the combustion engines that power most of our cars today. In addition, an electric powertrain is much more efficient than a traditional combustion engine in everyday stop-and-go traffic, so electrification of cars brings both lowered emissions and increased energy efficiency.

However, electric vehicles are not a perfect solution. Electricity can come from many sources and some of them, like coal, are no better for the environment than burning gasoline. Also, while it is possible to cover everyday driving with an electric motor, long-distance driving might still require combustion engines for a number of reasons. One of the main reasons is the limited range of electric vehicles. In contrast, the range of a gasoline powered vehicle is virtually unlimited because even if the tank is empty, one can refuel within minutes basically anywhere. Additionally, the combustion engine – if reasonably sized –is actually not a bad solution for long-distance travel at relatively constant speeds. Therefore, plug-in hybrids and range extended electric vehicles should and will probably be a preferred solution for personal automobiles for the next 10-20 years, until hydrogen fuel cell vehicles and the infrastructure required for their widespread adoption are figured out. Once the infrastructure is in place fuel cell vehicles will require no supplementary combustion engine to extend their range and will not degrade over many charge-discharge cycles like a battery does. They probably will, when mass-produced, require less weight and space for energy storage than an electric vehicle. All of these advantages will hopefully allow fuel cell vehicles to have an even lower impact on climate, air quality, and resources than battery powered vehicles.

The next solution to our personal transportation issue is automation wherein a computer system takes over driving, at least in part, from the human. The main motivation for this is improved safety because in 95% of all accidents human error is at least a contributing factor. However, centralized and anticipatory vehicle control can also help lower the fuel consumption of the vehicle for several reasons. First of all, computer controlled vehicles could be spaced closer together and therefore take advantage of decreased air resistance, increasing fuel economy. This would also increase the efficiency of traffic overall, meaning that all cars would spend less time on the road. Today each of us is stuck in traffic for about 36 hrs. every year and this time could be significantly reduced through automation of personal vehicles. Secondly, humans often have slightly erratic driving patterns instead of precisely adapting their speed to match the overall traffic flow. This means that a vehicle consumes less gas when driven on cruise control than when the driver tries to maintain a constant speed manually. A central traffic coordination center would take this to another level by arranging for a smooth and energy optimal traffic flow which would greatly reduce fuel consumption, consequently cutting energy use and reducing emission of pollutants.

For complete automation a communication link to connect as many vehicles as possible to a centralized control would be necessary, and fortunately this seems feasible within the next 10-15 years. In the meantime, sensors on the vehicle, such as radars, lasers, and cameras, will allow individual vehicles to be automated. These sensors will help control the vehicle smoothly and efficiently based on

the traffic pattern of the surrounding vehicles and improve efficiency on an individual basis.



Networked Cars, Photo: US Department of Transportation

A third way to make personal mobility more sustainable is transportation sharing, which will help to save energy and reduce emissions as well. Transportation sharing was possible but inconvenient before the widespread use of mobile, internet-connected technologies, but now there are several ways it can be used conveniently. One way is car sharing, which saves about 40% of energy and emissions compared to an individually owned vehicle. This is because a driver becomes more aware of every trip if he has to make special arrangements before getting in the car. This suggests that driving is just too convenient. We need to consider whether making it less convenient is a direction that society as a whole is willing to accept.

However, other options for sharing transportation, such as carpooling, can also help. With a broad variety of devices, apps, and cloud services, the personal automobile will become much more integrated into our digital lifestyle and will therefore be easier to use more efficiently. For example, if a driver knew that someone in the same group of friends wanted to go to the same place at the same time, why would they not carpool? Hopefully carpooling will significantly increase vehicle occupancy from 1.4 people per vehicle today and thereby save energy and reduce emissions.

A final option for transportation sharing is making public transit easier to use. Integration of the automobile into a public transportation system would allow more efficient sharing of transportation resources and could be implemented via the mobile internet, which would allow transit information to be made available online in real-time. If travelers know they can get to their destination 20 minutes earlier by taking public transit and avoiding traffic rather than driving, and if public transit were easily accessible at park and ride stations, why would one not do it? Integrating the personal automobile into the mass transit system has the potential to greatly increase the efficiency of transportation overall.

We see that there are many solutions on hand to address the climate, air quality, and resource challenges that the use of personal vehicles creates. It is up to us how, as consumers, we use them, and probably even more how, as scientists and businesspeople, we implement them to create a much more efficient, sustainable, and also more enjoyable personal mobility system. I am very hopeful that we can do that.

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