The Human Side of Vehicle Technology

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1. **Driving safety is an important health problem.** Approximately 34,000 Americans died in motor vehicle crashes last year. These crashes are the most likely cause of death for those between 4 and 34 years of age, and account for 30% of teen deaths. The coming years will bring increasingly complex distractions and increasingly complex vehicles to drivers who may be unprepared for either. This technology can dramatically improve or degrade driving safety.

2. **Your car is a computer.** A typical luxury car requires over 100 million lines of computer code. Software and electronics account for 40% of the car's cost and 50% of warranty claims. We think of cars as mechanical systems, but they are actually rolling computers.

These computers are changing what it means to drive. They already enable cars to take over many important driving operations, with features such as adaptive cruise control, automatic parking, and autonomous braking. Entertainment systems now enable drivers to connect to social networks, hear text messages, and choose from thousands of songs.

From these changes a critical safety threat may emerge: with technology automating driving much of the time, drivers have the freedom to focus on the entertainment system, but the vehicle can then unexpectedly hand control back to the distracted driver. Drivers are particularly error prone in such situations. Changing vehicle technology may make such unexpected handoffs more likely.

Moore's law suggests the capacity of automation and entertainment systems will change rapidly, doubling every 18 months. This exponential increase means that in fifteen years we are likely to be discussing whether people should be *allowed* to drive—because autonomous vehicles may be much less error prone than people. Until cars assume complete responsibility for driving, the critical challenge is to design vehicles so that drivers clearly understand how the car works and what it can and can't do. This is particularly challenging because even small design changes can violate drivers' expectations and confuse them.

3. **Automated cars are like paper towel dispensers.** Using a manual paper towel dispenser isn't confusing: you grab and pull. Automatic and semi-automatic dispensers can be confusing. Some are motion sensitive and automatically roll out a towel when you

wave a hand in front; others require that you press a button to trigger the motor. Fruitlessly waving at a dispenser before you realize you need to press the button can be embarrassing. Such confusion in a car can be deadly.

Like paper towel dispensers, push button ignition systems can be confusing. When the car is stopped you only need to push the button to turn off the engine, but when in motion, you must press and hold the button. The need to press and hold can confuse drivers, which can have tragic consequences when a driver tries to stop an unintentionally accelerating vehicle. Such mode confusion represents an important challenge for increasingly automated vehicles.

4. Technology may be particularly problematic for teen drivers. Vehicle technology may confront teen drivers with a "perfect storm" of challenges. New entertainment systems encourage multitasking. Teens are notorious multitaskers, which would *seem* to make them more able to handle distractions. But that's only what they think. The opposite is actually true: heavy multitaskers are more distractible. Teens are also less able to anticipate roadway hazards, and so are unlikely to anticipate limits of vehicle automation. The combination of increasingly distracted and distractible drivers managing imperfect vehicle automation may severely undermine driving safety.

5. Technology may counterbalance the threat of distractions. Distraction represents a long-standing safety problem that the explosion of entertainment systems threatens to exacerbate. Fortunately, other emerging technologies can detect distraction and direct drivers' attention to hazards. Soon cars will know when you look away from the road, when the car ahead brakes, and when to call your attention back to the road.

6. The road ahead. As an engineer, I am very optimistic about future vehicle technology. As a researcher focused on the psychology of human-technology interaction, I see substantial challenges.

I hesitate to offer recommendations, and so I draw upon the wisdom of the Committee on Electronic Vehicle Controls and Unintended Acceleration. I paraphrase several of their recommendations:

1. Assess whether electronic interfaces, such as push-button ignition systems, delay responses in emergency situations.
2. Promote government and industry collaboration to create designs that communicate vehicle capability and status to drivers.
3. Identify when drivers' expectations of vehicle automation diverge from designers' intents.
4. Establish electronic data recorders and associated information infrastructure to catch design errors that will escape even the most thorough design process.