The Role of Human Factors in the Development of Automated Vehicles

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Human factors analysis in the automated vehicle industry has evolved as quickly as the industry itself. Five years ago, much of the human factors focus was on the impact that advanced driver-assistance systems (ADAS) (e.g., adaptive cruise control, collision warning and mitigation systems, lane keeping, etc.) would have on drivers. Our own studies showed that driver behavior changed in the presence of these technologies (Moorman et al. 2017), with drivers spending more time looking inside the vehicle when certain ADAS technologies were active (Crump et al. 2017). As vehicle automation has progressed past ADAS technologies, and as fully automated vehicles are entering the roadways, the focus of human factors efforts has similarly expanded to include design and safety considerations at these higher levels of automation and the broader interactions of the technology with drivers and the transportation infrastructure. Human factors scientists are poised to support automated vehicle manufacturers as they make decisions about driver performance and training, vehicle interaction with infrastructure and pedestrians, and how safe is "safe enough."

One of the primary areas where human factors can best be leveraged is in assessing the changing role of the driver, who will have very different responsibilities in an SAE Level 2 vehicle than in a Level 4 or 5 (Click here for SAE Automation Level Definitions). In a highly, but not fully, automated vehicle, what should/could the operator in the driver's seat be doing? What are the capabilities and limitations of human performance that will affect that person's ability to interact with or take over from the automation as needed? A human factors understanding is critical to answering both of these questions, and the March 2018 fatality involving a self-driving ride-share vehicle illustrates the importance of answering them correctly.

Optimizing a strategy to appropriately inform the public of automated vehicle capabilities as well as to educate users on how to interact with the automation is another area where human factors has an important role. Many investigations of incidents involving highly automated and SAE Level 2 vehicles have shown confusion between the expectations of the driver and the actual capabilities of the technology. It is certainly dangerous when people indicate "I thought the car was going to do X, and it did Y instead." Confusion with new vehicle technologies is not a new problem, and recent data support the idea that the public does not have a clear picture of what automated vehicle technologies can and cannot do (Hoyos et al. 2018). Education also plays a role in the interaction of pedestrians and vehicles. Pedestrians often rely on eye contact with drivers of conventional vehicles to ensure they are safe to cross the street. How might a pedestrian receive this acknowledgment from an automated vehicle? Human factors evaluation can help manufacturers understand how best to take advantage of learned behavior and implant some of the necessary human tendencies for safe driving into highly automated vehicles.

Finally, human factors assessments and analysis can help automated vehicle manufacturers answer the critical question of "How safe is safe enough?" This question, roughly translated to "what level of risk or safety factor is acceptable to the public" or "what is the public's risk tolerance", is not a new one. In fact, it is a question that goes right to the roots of this company: one of our founders, Alan Tetelman, co-authored a white paper in 1977 titled "How Safe is Safe Enough?" discussing exactly these issues in the context of automobiles and general industrial products. In the automated vehicle space, manufacturers have regularly touted headlines about the number of miles driven or the rate of accidents per million miles driven and have held that out as a measure of safety. While miles driven and accident rates are important data points, from a human factors perspective, we can also consider public perception and the risk tolerance of the population that will interact in any way with vehicle automation. This is in line with one of Dr. Tetelman's main points: the context of use of a product is not as straightforward as looking at one metric. To that effect, experts are increasingly asking whether a more sufficient denominator for vehicle safety should be incidents per mile driven, incidents per difficult scenario encountered, or some more complex melding of various metrics to paint a comprehensive picture of safety. Automated vehicle manufacturers can leverage human factors insight to evaluate how issues that are traditionally problematic for human drivers might translate to an automated vehicle. Engineers can then pair boundary case scenarios along with closed-course track testing, simulator data, computer modeling, and Monte Carlo simulations to determine how a vehicle will respond in each situation and whether it is ultimately safe enough for market deployment.

Over the next several years, despite continued advances in, and pushes towards, higher levels of vehicle automation, as long as there are still people interacting with a complicated system, the ability of human factors scientists to inform design and safety decisions will only grow as manufacturers' ability to collect, store, and use relevant data sets continues to improve. For example, today's manufacturers can leverage mobile eye tracking and perceptual data to evaluate alternative cabin configurations and help minimize the risk of vestibular disturbance for riders. Manufacturers can also leverage over-the-air updates and data tracking to investigate the cause of adverse incidents involving automated vehicles and help understand the behavior of the driver. Moving forward, the industry will see continued advancements in the ease of obtaining this type of actionable data from both people and vehicles. Manufacturers can expect to use these data to inform important research and design decisions that optimize the comfort, safety, and overall consumer acceptance of automated vehicles. Furthermore, if vehicles of the future are going to be less focused on driving performance and more on the ride experience, then leveraging human factors and user experience expertise to assess the quality, comfort, enjoyment, and overall usability of the vehicle will be an essential part of the product lifecycle.

While automated vehicle manufacturers often employ in-house human factors teams, many also turn to independent third parties for enhanced human factors support. What sets Exponent apart is our ability to offer a multidisciplinary team of Ph.D.-level engineers, scientists, and human factors experts along with our newly minted Phoenix User Research Center (PURC), attached to our automotive testing facilities at the Test and Engineering Center to quickly and seamlessly integrate with in-house teams to address a client's human factors needs across the entire automated vehicle lifecycle.

References

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