

HUMAN FACTORS CHALLENGES OF SEMI-AUTOMATED DRIVING

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Advanced Driver Assistance Systems (ADAS)



- * **ABS**
- * **Electronic Stability Control**
- * **Navigation**
- * **Lane control systems**
- * **Adaptive cruise control with assisted braking**
- * **Forward collision warning with assisted braking**
- * **AEB**

Advanced Driver Assistance Systems (ADAS) (cont)



- * **Curve speed warning**
- * **Blind spot monitoring**
- * **Back up warning**
- * **Cross-traffic detection**
- * **Fatigue warning**
- * **Lane change control**
- * **Road sign recognition**
- * **Intelligent headlight control**
- * **Automated parking**

What are the human factors challenges?

Human Factors Challenges

- * **Transfer of control and loss of situational awareness**
- * **Behavioural adaptation**
- * **Transfer of control and distraction**
- * **Accuracy of mental model**
- * **Allowance for driver variability**

Challenge 1: Transfer of Control

- * **Sharing of control between the system and the driver**
 - Expectation of drivers to continue monitoring semi-autonomous system
 - Sudden re-introduction of out-of-loop driver into control loop



Challenge 1 : Transfer of Control

- * **Simulator study of driver response to critical events**
 - * Faster response to critical events (0.4 s vs 1.9 s)
 - * Longer minimum headways
 - * Longer time to contact
 - * In manual vs. semi-automated mode
- * Drivers may have reduced situational awareness and/or over-trust automated system
- * Need to keep drivers engaged and in the loop

(Merat & Jamson, 2008)

Challenge 2 :

Behavioural adaptation

Simulator study found:

- * Increased driver engagement in secondary tasks (entertainment, eating, grooming) with increased automation (3 levels)
- * Most sustained attention to DVD and listening to radio
- * 33% fewer glances to centre for autonomous vs. manual

(Carsten et al. 2012)

Challenge 3 : Distraction

Simulator study of manual vs. semi-automated, with and without distraction (Twenty Questions), found:

- * If no distraction, response to critical incidents is similar in manual and highly automated conditions
- * Worst performance occurred when drivers in automated mode were called upon to handle a critical incident while distracted



(Merat et al., 2012)

Eyes on the Road

- * **Looking away from forward view for more than 2 sec in a 5 sec period doubles risk of a crash**

(Klauer et al., 2006)



Challenge 4 : Accuracy of Mental Model

- * **Driver mental model of system operation**
 - Knowing role (e.g., daytime headlights)
 - Knowing system mode
 - Using unfamiliar (e.g., rental) vehicles
 - Understanding system limitations
 - e.g., ACC and detection of debris/rocks/queued vehicles



2018 Toyota Manual ACC

DO NOT USE ACC WHERE:

- * There are pedestrians, cyclists, etc.**
- * On slippery roads**
- * Where there is rain, snow, etc. on front of sensor**
- * Where there are sharp changes between up and down gradients**
- * On winding roads**

Challenge 5: Allowance for Driver Variability

- * How much leeway to allow drivers in setting desired speed, headway?
- * What are appropriate warning intervals?



Crashes Involving Semi-Automated Vehicles

Crash Case 1

- * Driver using Tesla Autopilot
- * Requires touching wheel at regular intervals to indicate paying attention
- * Driver crashed into white trailer crossing in front while watching movie, daytime
- * NHTSA investigation
 - * Driver had 7 seconds to respond
 - * System functioned as designed
 - * Concern re misleading use of term “autopilot”
 - * Crash rate down by 40% since introduction of Autopilot



Crash Case 2

- * **Uber semi-automated vehicle struck woman crossing two lanes per direction roadway at night**
- * **Woman pushing a bicycle**
- * **Mid-block crossing in open lane**
- * **When ACC/LC on, AEB does not work**
- * **Pedestrian detected at 6 sec to collision**
- * **AEB responded at 1.3 sec to collision**

Crash Case 2



Closing Thoughts

- * **Transition period will be lengthy**
- * **Transfer of control problematic due to distraction temptation and loss of situational awareness**
- * **Exceptions to coverage so drivers must continue to attend**
- * **But unrealistic to expect drivers to monitor the same way with automatic vs. manual**
- * **Over-trust may be a problem**
- * **Potential for large reduction in crashes but also for new crash types**

Thank You for Your Attention