1. General importance of HF

Parasuraman, R. and Riley, V.A. (1997). Humans and automation: Use, misuse, disuse, abuse. Human Factors, 39: 230–253.

> *"Automation abuse is the automation of functions by designers and implementation by managers without due regard for the consequences for human (and hence system) performance and the operator's authority over the system. The design and application or automation, whether in aviation or in other domains, has typically been technology centered. Automation is applied where it provides an economic benefit by performing a task more accurately or more reliably than the human operator or by replacing the operator at a lower cost. As mentioned previously, technical and economic factors are valid reasons for automation, but only if human performance in the resulting system is not adversely affected*."

2. Mode confusion in aviation and other domains

Parasuraman, R., Sheridan. T.B. and Wickens. C.D (2000). A model for types and levels of human interaction with automation. IEEE Transactions on Systems, Man, and Cybernetics—Part A: Systems and Humans, 30(3): 286-297.

> *"Humans tend to be less aware of changes in environmental or system states when those changes are under the control of another agent (whether that agent is automation or another human) than when they make the changes themselves."*

Sarter, N.B. and Woods, D.D. (1995). How in the world did we ever get into that mode? Mode error and awareness in supervisory control. Human Factors, 37, 5-19.

> *"Inadvertent mode settings and selections may not produce visible consequences for a long time, thereby complicating the process of error or failure detection. This creates the possibility of errors of omission (i.e., failure to intervene) in addition to errors of commission as a consequence of a lack of mode awareness."*

Sarter, N.B. and Woods, D.D. (1994). Pilot interaction with cockpit automation II: an experimental study of pilots' mode and awareness of the flight management system. The International Journal of Aviation Psychology, 4(1): 1-28. https://doi.org/10.1207/s15327108ijap0401_1

> *"It confirms that most of the difficulties in pilot-automation interaction are related to a lack of mode awareness and to gaps in pilots' mental models of the functional structure of the automation."*

Sarter, N.B., Woods, D.D., Billings, C. (1997). Automation surprises. In: Salvendy, G. (Ed.), Handbook of Human Factors and Ergonomics. Wiley, New York ,pp. 1926-1943.

"With more advanced systems, each mode itself is an automated function that, once activated, is capable of carrying out long sequences of tasks autonomously in the absence of additional commands from human supervisors. This increased autonomy produces situations in which mode changes can occur based on situational and system factors. This capability for "indirect" mode changes, independent of direct and immediate instructions from the human supervisor, drives the demand for mode awareness."

Sarter, N.B. (1994). Strong, silent, and 'out-of-the-loop': properties of advanced (cockpit) automation and their impact on human-automation interaction. PhD thesis, Ohio State University.

"Mode errors on advanced technology aircraft are more often associated with title pilot's failure to detect and intervene with undesired system behavior that was not explicitly commanded by him — an error of omission."

3. Mode confusion in driving

Wilson, K.M., Yang, S., Roady, T., Kuo, J. and Lenne, M.G. (2020). Driver trust & mode confusion in an on-road study of level-2 automated vehicle technology. Safety Science,130 (104845). https://doi.org/10.1016/j.ssci.2020.104845.

Several incidences of mode confusion occurred, where participants believed the vehicle was in AutoPilot (level-2 automation), but was in fact either in adaptive cruise control (without lateral control; level 1) or manual driving (level 0).

Endsley, M.R. (2017). Autonomous driving systems: a preliminary naturalistic study of the Tesla Model S. Journal of Cognitive Engineering and Decision Making , 11(3): 225–238. https://doi.org/10.1177/1555343417695197

"Mode confusion was the most frequent problem I encountered. In the majority of cases (n = 11), this confusion stemmed from the fact that the lever controlling the ACC and autosteer functions was located directly below the turn-signal lever on the left-hand side of the steering column.

In two cases, I thought that the automation was on when it was not (the autosteer failed to capture on activation for unknown reasons), and in three cases, I did not realize that the ACC was still on after I took over manual control. When the driver presses the brakes, the ACC and autosteer will turn off; however, if the driver turns the steering wheel, only autosteer is canceled, and the ACC remains on. When I turned the wheel to exit the freeway at an off-ramp, for example, I was surprised that I was still traveling very fast and needed to brake as well to disconnect the ACC. This problem also occurred on a sharp curve when I took over manual steering; I was surprised that the ACC was still engaged and that the car was going too fast for the curve."

Feldhütter, A., Härtwig, N., Kurpiers, C., Hernandez, J.M., Bengler, K.. (2019). Effect on mode awareness when changing from conditionally to partially automated driving. In: Bagnara, S., Tartaglia, R., Albolino, S., Alexander, T., Fujita, Y. (Eds.), Proceedings of the 20th Congress of the International Ergonomics Association (IEA 2018).

"In this study, we examined the effect of driving phases and transition condition on the mode awareness in [Level 2 Driving]. We assumed that driving in conditionally automated mode right before driving in [Level 2] mode would lead to a loss of mode awareness resulting in a decrease in monitoring behavior. We found a significantly reduced attention ratio towards driving-relevant areas in [condition 2 of Level 2 Driving], where the preceding automation mode was [Conditionally Assisted], as compared to [condition 1 of Level 2 Driving], where the previous mode was manual driving. Consistently, the attention ratio towards the tablet where the NDRA was provided increased in [condition 2]. That means that in [condition 2], participants increasingly neglected their monitoring task and played the quiz game more intensely. As a consequence, only one quarter of the participants could prevent the vehicle from leaving the lane when a mal-function occurred. The interview revealed that one third of the participants considered the two modes to be difficult to distinguish between due to their similarity."