The Chatty Co-Driver: A Linguistics Approach to Human-Automation-Interaction

Alexander ERIKSSON and Neville A STANTON

Transportation Research Group, Faculty of Engineering and the Environment, University of Southampton, Boldrewood campus, SO16 7QF, UK

Keywords. Automation, Human-Automation Collaboration, Cognitive Systems, Automated driving.

1. Introduction

It is predicted that Driving Automation (DA) systems available to the consumer in the foreseeable future will approach autonomy during highway conditions (Gasser et al., 2009; NHTSA, 2013), leaving only the highest level of decision making to the driver when the system is engaged, albeit relying on driver intervention when the operational limits of the automated system are reached, e.g. when exiting the highway or when sensor reliability has decreased below a certain threshold (Stanton et al., 1997). When the driver is assumed to resume control of a vehicle when its operational limits are reached, a critical weakness in the system is exposed. As the drivers have been out of the control loop for an extended period of time, they may be a victim of some of the ironies of automation, where situation awareness is reduced. Having spent time in a state of significantly reduced workload, they may also suffer from a size reduction of the attentional resources pool (Endsley, 1996; Young & Stanton, 2002). Research by Woods and Patterson (2000) indicates that the need for coordination increases as cognitive activities escalate. This implies that coordination between driver and automation is of utmost importance to ensure successful driver takeover in a situation where the driver's attentional capacities are hampered. In such a situation it is important that the driver receives the support and guidance needed to safely re-enter the control loop and resume vehicle control (Cranor, 2008). One way of supporting the driver may be by designing the automation to act as a chatty co-driver (Stanton, 2015).

2. The chatty co-driver

Using a chatty co-driver paradigm by providing continuous feedback to the driver (e.g. via user interfaces in a similar fashion as a co-driver) has been shown to increase performance (Stanton et al., 2011). Norman (1990) illustrated the importance of continuous feedback in automated systems by comparing two aviation cockpit configurations, one flying on autopilot and one with the co-pilot as pilot-flying with a captain acting as pilot-not-flying. The actions taken by both the pilot-flying and autopilot may appear very similar but the way said actions are communicated to the captain differs significantly as the autopilot commands the ailerons in silence whereas the pilot-flying takes physical action in the cockpit to move the ailerons, actions that are visible to the captain.

To ensure that system feedback is of adequate quality, the authors propose the use of the Gricean Maxims of successful conversation (Grice, 1975). The four maxims proposed by Grice are the Maxims of Quantity (MoQa), Quality (MoQu), Relation (MoR) and Manner (MoM). MoQa states that any contributions should be made as informative as required without adding unnecessary information. MoQu states that the information provided should be true and not based on information that lacks evidence. MoR states that information provided should be contextually and temporally relevant to the current task. The MoM states that obscurity and ambiguity should be avoided and information should be conveyed in a brief and structured manner. Eriksson and Stanton (2015) applied the maxims to the case of Air France 447 and found that the aircraft system feedback violated the maxims on numerous accounts, which led to a skewed mental model and incorrect actions by the pilots.

Based on the aforementioned maxims, the authors propose that adhering to the Gricean maxims would decrease the gulf of evaluation (Norman, 2013) and increase system transparency (Christoffersen & Woods, 2002), thus ensuring sufficient coordination and facilitating a coherent mental model of the automated system and its actions. This would increase the likelihood of a successful, safe, transfer of control from automated driving to manual driving, where situation awareness is restored and a coherent mental model is maintained.

Acknowledgement

The presented research have been conducted as a part of the European Marie Curie ITN project HFauto-Human factors of automated driving (PITN-GA-2013-605817)

References

Christoffersen, K., & Woods, D. D. (2002). How to Make Automated Systems Team Players. Advances in Human Performance and Cognitive Engineering Research, vol 2, pp 1-12.

Cranor, L. F. (2008). A framework for reasoning about the human in the loop. Paper presented at the Proceedings of the 1st Conference on Usability, Psychology, and Security.

Endsley, M. R. (1996). Automation and Situation Awareness. In R. Parasuraman & M. Mouloua (Eds.), Automation and human performance: Theory and applications.

Eriksson, A., & Stanton, N. A. (2015). When communication breaks down or what was that? – The importance of communication for successful coordination in complex systems. Paper presented at the 6th International Conference on Applied Human Factors and Ergonomics, Las Vegas, NV.

Gasser, T. M., Arzt, C., Ayoubi, M., Bartels, A., Bürkle, L., Eier, J., et al. (2009). Legal consequences of an increase in vehicle automation.

Grice, H. P. (1975). Logic and Conversation. In P. Cole & J. L. Morgan (Eds.), Speech Acts (pp. 41-58). New York: Academic Press.

National Highway Traffic Safety Administration. (2013). Preliminary Statement of Policy Concerning Automated Vehicles.

Norman, D. A. (1990). The Problem of Automation, Inappropriate Feedback and Interaction, Not Over-Automation. Philosophical Transactions of the Royal Society of London.

Norman, D. A. (2013). The Design of Everyday things. New York: Basic Books.

Stanton, N. A. (2015, March 2015). Responses to Autonomous Vehicles. Ingenia, Issue 62, pp. 9.

Stanton, N. A., Dunoyer, A., & Leatherland, A. (2011). Detection of new in-path targets by drivers using Stop & Go Adaptive Cruise Control. Appl Ergon, vol 42, no 4, pp 592-601.

Stanton, N. A., Young, M., & McCaulder, B. (1997). Drive-by-wire: The case of driver workload and reclaiming control with adaptive cruise control. Safety Science, vol 27, no 2-3, pp 149-159.

Woods, D. D., & Patterson, E. S. (2000). How Unexpected Events Produce An Escalation Of Cognitive And Coordinative Demands. In P. A. Hancock & P. Desmond (Eds.), Stress Workload and Fatigue. Hillsdale: NJ: Lawrence Erlbaum Associates.

Young, M. S., & Stanton, N. A. (2002). Malleable attentional resources theory: a new explanation for the effects of mental underload on performance. Hum Factors, vol 44, no 3, pp 365-375.