Human Foreseeable Misuse while Interacting with EHMI (External Human Machine Interface) mounted on Urban Road, Water, Rail Autonomous Vehicles

Gallina, Barbara
Mälardalen University
barbara.gallina@mdu.se

In the automotive domain the term External Human Machine Interface (EHMI) has been coined to indicate the interface mounted on or protruding from a vehicle's exterior that can communicate with other vehicles or vulnerable road users (VRUs), such as pedestrians or cyclists. The role of EHMIs is becoming crucial in the context of highly automated driving systems, where the driver is absent. Such term has been recently borrowed by the maritime and rail domain. In all these different transportation domains, studies (field studies as well as controlled or video studies) with diversified samples (based on age, perceptual capabilities, etc.), methods (using interventional methods with e.g., Wizard-of-Oz vehicles, observations, and video studies) have been conducted in order to reach convergence on the design of EHMI based on e.g., automation transparency. In these studies, the Safety Of The Intended Functionality (SOTIF), i.e., absence of unreasonable risk due to hazards resulting from functional insufficiencies of the intended functionality or its implementation, has not been in focus so far. Analysing the insufficiency of the specification (specifically, focusing on poor human factors consideration/foreseeable misuse at the interplay of ergonomics, usability, and SOTIF) that may lead to hazardous behaviour or even less controllable or uncontrollable hazardous behaviour is paramount to derive essential safety measures for ensuring SOTIF, while optimising human well-being and overall system performance. In this abstract, we consider three different EHMIs mounted on different vehicles, i.e., urban road, water and rail vehicles. We analyse the above-mentioned insufficiency of the specification of each EHMI by using a process FMEA (Failure Mode Effect Analysis)-like method to account qualitatively for the foreseeable misuse and its corresponding performance shaping factors, i.e., specific error precursors that influence human performance and the likelihood of occurrence of a human error. Specifically, we focus on a set of interaction scenarios, and we use P-VASA (People-variability-aware Safety Analysis) and we guide the analysis by considering human variability not only with respect to perception, cognition, and motoric but also with respect to cultural variability such as the need for negotiation. For each EHMI, the outcome of our analysis is a set of counter measures, elaborated for addressing human foreseeable misuse and related failure scenarios by considering the interplay of SOTIF, ergonomics, and usability. To cross-fertilise the different transportation domains, we highlight the commonalities and variabilities that characterise the counter measures.

Keywords. Foreseeable Misuse, P-VASA, Safety Of The Intended Functionality (SOTIF).