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A Conceptual Model of the 'Driver – Highly Automated Vehicle' System

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Abstract : The current trend in the automotive industry towards automatic vehicles is creating new challenges related to human factors. This occurs due to the fact that the driver is increasingly relieved of the need to be constantly involved in driving the vehicle, which can negatively impact his/her situation awareness when manual control is required, and decrease driving skills and abilities. These new problems need to be studied in order to provide road safety during the transition towards self-driving vehicles. For this purpose, it is important to develop an appropriate conceptual model of the interaction between the driver and the automated vehicle, which could serve as a theoretical basis for the development of mathematical and simulation models to explore different aspects of driver behaviour in different road situations. Well-known driver behaviour models describe the impact of different stages of the driver's cognitive process on driving performance but do not describe how the driver controls and adjusts his actions. A more complete description of the driver's cognitive process, including the evaluation of the results of his/her actions, will make it possible to more accurately model various aspects of the human factor in different road situations. This paper presents a conceptual model of the 'driver – highly automated vehicle' system based on the P.K. Anokhin's theory of functional systems, which is a theoretical framework for describing internal processes in purposeful living systems based on such notions as goal, desired and actual results of the purposeful activity. A central feature of the proposed model is a dynamic coupling mechanism between the decision-making of a driver to perform a particular action and changes of road conditions due to driver's actions. This mechanism is based on the stage by stage evaluation of the deviations of the actual values of the driver's action results parameters from the expected values. The overall functional structure of the highly automated vehicle in the proposed model includes a driver/vehicle/environment state analyzer to coordinate the interaction between driver and vehicle. The proposed conceptual model can be used as a framework to investigate different aspects of human factors in transitions between automated and manual driving for future improvements in driving safety, and for understanding how driver-vehicle interface must be designed for comfort and safety. A major finding of this study is the demonstration that the theory of functional systems is promising and has the potential to describe the interaction of the driver with the vehicle and the environment.

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