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Preliminary model application to existing ADAS and IVIS and guidelines for implementation in design process

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Authors		**P.C. Cacciabue, L. Macchi, E. De Grandis, M. Alonso, A. Amditis, O. Carsten, E. Carusi, J. Engström, E. Hollnagel, Z. Letziou, V. Papakostopoulos, F. Saad, F. Tango**	
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Executive Summary

This deliverable builds on the results Deliverables D 1.1.1a and b, and discusses how a Driver, Vehicle and Environment (DVE) model has to be devised in order to meet designers' needs and requirements for considering driver behaviour during system design and development.

The theoretical formulations have been discussed in previous deliverables that have focused on the general modelling architecture of the DVE Interaction (Deliverable D1.1.1a) and on a more elementary representation of such architecture that enables the development of a computerised tool for predicting DVE interactions by a computerised dynamic simulation (Deliverable D 1.1.1b). Even though more theoretical work remains to be done, especially on the basic parameters governing the model and simulation, a preliminary attempt to apply the elementary model/simulation of the DVE can be performed, even if at qualitative level. This is the work of the present deliverable and leads to the definition of a set of guidelines for the designers on how to apply the DVE simulation in the design development.

In this report, firstly the potential application of the DVE simulation for developing Human Machine Interfaces is discussed. A number of generic application studies are considered, such as, for example, "Predicting effects of IVIS interaction while driving", "Predicting behavioural effects of ADAS", "Predicting behavioural effects of multiple ADAS and IVIS". In addition, the application of the DVE to the analysis of interactions in the presence of an adaptive integrated (AIDE-type) interface is also considered with specific reference to the work carried out within SP 3, of design and development of the AIDE system. In this context, the AIDE Design Scenarios are discussed as possible snapshots of dynamic DVE simulations.

A detailed description, both at qualitative and quantitative level is then performed, for the three components of the DVE model, namely, the Vehicle, the Environment and the Driver. The latter component is left as last in order to include the effects of both, the vehicle and the environment, on the driver behaviour model.
The Vehicle model includes basic standard hardware, and specific systems, as well as sophisticated driver support and information systems, i.e., typical ADAS and IVIS. A simplified model of vehicle is described accounting for the basic motion variables, taking into account separately the longitudinal and the lateral task.
The Environment model considers traffic scenarios to be simulated in the test phases. Particular attention is given to the identification of the most risky and critical scenarios and crucial variables that describes dynamic conditions, such as traffic, weather, roads, etc.
The Driver model represents human behaviour by means of a wide range of variables and parameters, related to driver state, learning and long-term behavioural effects. A preliminary list of parameters and variables that characterise driver behaviour and performance are identified, on the basis of expert judgement. The experts are selected amongst the partners active in SP 1. In particular, those partners that will play a relevant role in the experimental phase of SP 1 (namely the partners involved in WP 2 on experimental studies on behavioural adaptation) have been elicited.

These parameters and related measurable variables will be refined and updated according to the tests performed. The overall Task will span over a long period, as it will need continuous and iterative improvement coming from the results of long-term tests on behavioural effects and field assessments.

With particular reference to the driver model, the Open Issues for Driver and DVE Modelling are considered. This implies focusing on 1) Parameters Affecting Behaviour, 2) Correlation of parameters with respect to measurable variables, and 3) Correlation of parameters with respect to driver behaviour. A specific reference of these parameters with the corresponding ones considered in SP 3 is carried out, with the aim of setting logical and numerical correlations amongst them. Detailed discussion on the analytical expressions describing these parameters will be carried in a dedicated work to be presented in Deliverable D 1.1.3.

Remaining focused on the driver model, particular attention is then devoted to the process of analysis of the tasks typical of driving. The Task Analysis approach utilised for this purpose is described in appendix. The type and content of driving tasks is discussed, considering two types of tasks, namely: elementary and complex tasks. In addition the concept of elementary functions is introduced. In practice, Elementary Functions represent the simplest activity that can not be further subdivided into simpler components; Elementary Tasks are tasks made of Elementary functions only; and Complex Task, are tasks made of a combination of Elementary Tasks and Elementary Functions.
A whole set of Elementary Functions Elementary Tasks and Complex tasks are developed in order to enable to generation of several dynamic interactions simply by combination of these functions and tasks in different environmental contexts.
As an example, the procedure to “stop the vehicle”, e. g. at a traffic light, can be considered a procedure made of known actions performed by the Driver, once he/she has decided to stop. The Task Analysis is developed according to the chosen level of granularity of the design study, i.e. the level of detail that should be associated to “procedures”.

In order to devise an initial qualitative simulation, a number of design scenarios for evaluating the effects of DVE interaction, in presence of different ADAS and IVIS, are then discussed. This will result in a set of guidelines for implementation of DVE model in design processes. In this context, the number and types of ADAS and IVIS that will be accounted for in this preliminary exercise is identified.

A qualitative preliminary typical simulation is then discussed. The classic designer’s approach to evaluate performance for a whole range of conditions, from normal to extreme circumstances, is followed also for the case of the AIDE System. The driver, vehicle and environment are analysed under different initial and boundary conditions and the DVE model is utilised to simulate the interaction in order to evaluate the performance and contribution of the AIDE system to safety. Sets of scenarios and dynamic conditions for interaction are defined, namely: normal driving, Normal driving + making phone call; Driving with ACC; Driving with ACC + making a phone call; Normal driving + phone use + forward collision warning; and Driving in city environment with AIDE system scheduling phone calls. An example of qualitative simulation is discussed, by combining Task Analysis environmental and vehicle simulation.

Finally, the validation process of such modelling architecture and the correlations to the simulation tool are discussed in combination with the Guidelines for implementation in design processes that can be devised in order to support design and safety analysis associated with tools such as AIDE.