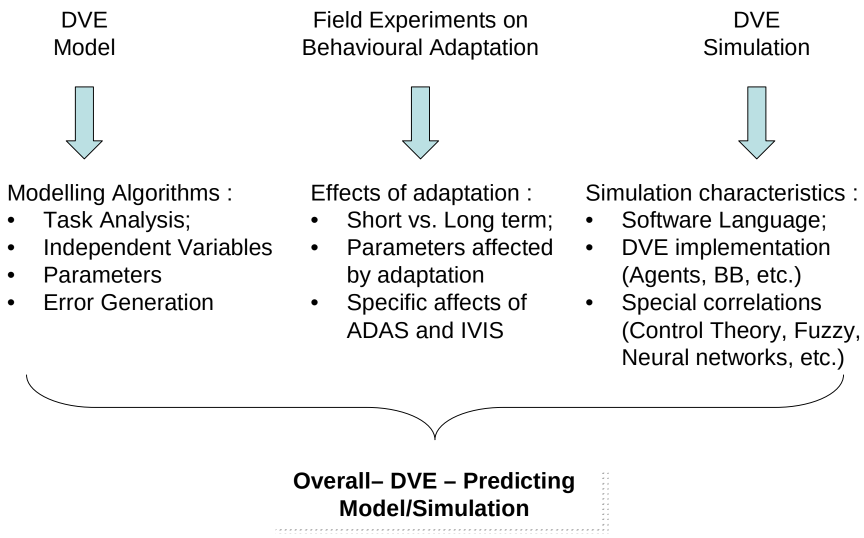
Sub-project 1: Behavioural Effects and Driver-Vehicle-Environment Modelling

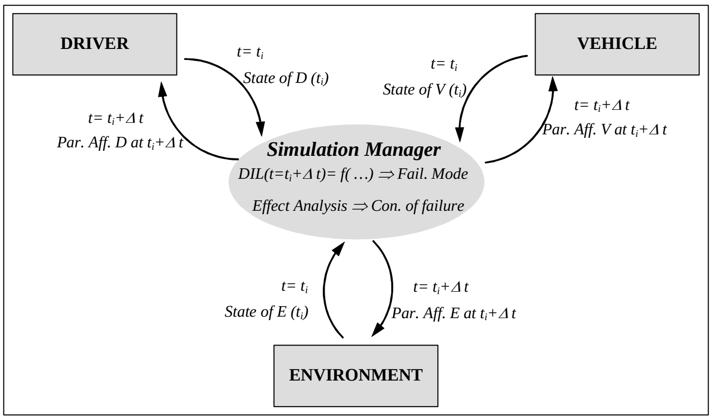
The general objective of Sub-project 1 (Behavioural Effects and Driver-Vehicle-Environment Modelling) is to: 1) develop a basic understanding of the DVE interaction and the behavioural effects of IVIS and ADAS, and 2) develop this into a model and 3) computer simulation for predicting these effects.

These three major lines of development are carried out in parallel exchanging information and data while work progresses towards the final Overall DVE-Predicting Model/Simulation.



DVE Model

The theoretical development of the DVE model is almost complete. Its three components are the Driver, the Vehicle and the Environment. The interaction and dynamic evolution are governed by a fourth module called “Simulation Manager”.



Vehicle

The performance of a Vehicle in a DVE interaction may be characterised by two sets of variables and parameters, which are aimed at defining dynamic response on the road, display of information (indicators) and response of the commands (actuators) on the control panel. The first set of variables and parameters refers to the “primary task” of the driver, that is to say, driving the vehicle within certain traffic and environmental conditions. For instance: steering angle, yaw-rate, number of brakes, brakes status, accelerator pedal position, clutch, indicators status, light status, windshield wipers status, diagnosis of main vehicle sub-system. The second set of variables refers to the “secondary task” of the driver, i.e., performing other activities such as information management, communication, relaxing and amusing, while driving. Examples are: operating the telephone, e-mailing, searching and listening to info-traffic, performing vocal commands, using navigation commands, operating the radio, CD/MC/MP3 player, etc.

Environment

Considering the Environment many variables affect the performance of the Vehicle and Driver. The complexity of the model increases rapidly with the amount of variables considered. A possible set of Environment variables is: number and width of carriageway, presence and width of emergency lane, centreline road marking, lateral road markings, type of guard rail, presence and width of bicycle lane, traffic, road characteristics, road type, physical environment (trees, houses, light posts, etc.) and weather environment (time of day, visibility, rain, etc.).

Driver

The basic assumption made for the development of the driver model is that the driver is essentially performing a set of actions on the vehicle commands and controls that are known and, in many cases, familiar, according to his experience. As the driving process is very dynamic, these actions are continuously selected or developed from the knowledge base of the driver. However, prior to this activity a process of information management and formulation of goals and tasks is necessary.

The “normative” driver behaviour is evaluated through classical “Task Analysis” and description of standard behaviour. Control theory is utilised to represent permanent task performance such as keeping within carriageway, avoiding obstacles, etc.

Effects of behavioural adaptation, errors or inadequate performances are included in the modelling algorithms through a number of *parameters* that account for specific aspects of the driving process, such as stress, attitudes, etc. The *parameters* control also the dynamic sequence of tasks and goals :

- *Attitudes/personality*: static parameters associated with each driver.
- *Experience/competence*: static parameters associated with each driver.
- *Task Demand* (TD): objective dynamic parameter resulting from DVE interaction.
- *Driver State* (DS): subjective dynamic parameter resulting from DVE interaction.
- *Situation Awareness/Alertness* (SA): subjective dynamic parameter resulting from DVE interaction.
- *Intentions/goals*: dynamic variables and parameters that are evaluated during the evolution of the Driver model. This parameter will not be further discussed as *Intentions/goals* are essentially derived (or result) from the Driver Model/Task Analysis and thus can not be correlated to other independent variable.

Field Experiments on Behavioural Adaptation

The literature review on the “Behavioural Effects of Driver Assistance Systems” has highlighted the lack of knowledge about learning processes and the long-term effects of driver assistance systems. It is thus important to perform research into these aspects so as to be able to formulate sound recommendations for the design and development of the AIDE system.
This phase of research was focused on the learning phase, during which the driver becomes familiar with a new driving aid.
During this phase, the driver discovers the system, learns how it operates, identifies the scope and limitations of its capabilities and circumscribes its realms of utility. This learning process is assumed to be crucial for the driver’s representation of the system, for the confidence he/she has (and ought to have) in it and for ensuring optimal usage of it

Six different experiments were carried out to study in different ways the learning phase of the driver. They either focused on the learning process of an ADAS system itself or on the specific learning process of an *Integrated* ADAS system, or on the specific learning process of an *Adaptive* ADAS system.

In order to provide an example of the importance of the work done in the experimental activity, one of the results obtained with the FCW system here is briefly summarised:

- Results show how a Forward Collision Warning system has benefits in terms of safety and, by adapting the system to the prevailing road condition, the benefits are even greater.
- However, extra care has to be taken to improve the driver’s acceptance of the system.
- By adapting the system to personal driving style, the annoying features of the system will be reduced.

Further work has to be carried out to recognize how the number of perceived false or early warnings can be further reduced, fostering improved acceptance.

DVE Simulation

The third line of development focuses on the implementation in a computer simulation for predicting behavioural effects. The simulation is expected to represent a useful tool for evaluation of new HMI concepts and ADAS and IVIS functions early in product development. The simulation could also be used, in combination with accident analysis, for taking behavioural effects into account when predicting the actual safety benefit of different driver assistance functions.

At this stage of development of work, the technological aspects for usage and exploitation of the hardware and software running platform have been selected. The definition of the development languages, frameworks and related technologies have also been identified. Three modules have been identified: the Simulation Manager, the Models Interface and the Data Collection and Representation Engine.