INFORMATION SOCIETY TECHNOLOGIES (IST) PROGRAMME

adaptive integrated driver-vehicle interface

AIDE
IST-1-507674-IP

Considerations on Test Scenarios

Deliverable No. (use the number indicated on technical annex)		**D2.1.3**	
SubProject No.	**SP2**	SubProject Title	**Evaluation and assessment methodology**
Workpackage No.	**WP1**	Workpackage Title	**Generic evaluation methodology**
Activity No.	**A2.1.3**	Activity Title	**Scenario development**
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Status (F: final; D: draft; RD: revised draft):		**F**	
File Name:		**AIDE_D2.1.3_Test_scenarios_v03.doc**	
Project start date and duration		**01 March 2004, 48 Months**	

List of Abbreviations and Glossary

ABS Anti Blocking System.

ACC Adaptive Cruise Control.

Acceptability The characteristic of a product to be perceived positive by an user under the dimensions of Cost, Support, Reliability, Compatibility and Usefulness.

ADAS Acronym for Advanced Driver Assistance System, "interacting" with the driver with the main purpose of supporting the driving task on the tracking and regulating levels.

AIDE Adaptive Integrated Driver-vehicle Interface.

AIDE design scenario A driving situation, specified by at least one *action* and one or more *DVE state* parameters, acted upon by the *AIDE system* (usually a conflict situation between parts of the AIDE system and/or DVE conditions).

AIDE meta-function The response of the AIDE system to an *AIDE design scenario*.

AIDE system The Adaptive Integrated Driver-vehicle Interface targeted by the AIDE IP, implementing the *AIDE meta-functions.*

Assessment Process of determining the performance and/or impacts of a candidate application, usually in comparison with a reference case (existing situation or alternative applications), and usually including an experimental process based on real-life or other trials, often involving users.

BS Blind Spot.

CAA Cockpit Activity Assessment.

CAN Controller Area Network (bus).

CAVE Cave Automatic Virtual Environment.

CWA Collision Warning and Avoidance.

DAE Driver Availability Estimation.

DCS Driver Convenience Systems (including Telephone, Radio, CD player, Internet services, but also Air Conditioning System, …).

DDE Driving Demand Estimation.

DOF Degree(s) of Freedom.

DMS Drowsiness Monitoring System.

DSD Driver State Detection (used to be "Degradation", but it could be applied in a more general sense).

DVE driver-vehicle-environment state: A set of dynamic parameters representing certain aspects of the driver, the vehicle and the environment.

FCW	Frontal Collision Warning) is a system able to warn the drivers if the host-vehicle is approaching too fast an ahead obstacle. The warning information given to the user can be visual, acoustical or both.
FOV	Field of View.
GPS	Global Positioning System.
GUI	Graphics User Interface.
HDD	Head-down Display.
HMD	Head Mounted Device.
HMI	Human Machine Interface/Interaction.
HUD	Head Up Display.
ICA	Interaction and Communication Assistant.
I-HMI	Integrated Human Machine Interace.
IM	Information Manager.
IP	Integrated Project.
ISA	Intelligent Speed Adaptation.
ISO	International Standardisation Organisation.
ISO/ CD	ISO Committee Draft.
ISO/ TR	ISO Technical Report.
ISO/ TS	ISO Technical Specification.
ISO/ WD	ISO Working Draft.
IVIS	In-Vehicle Information & Communication System.
LCD	Liquid Crystal Display.
LCS	Lane Change Support: It Informs the driver in case of other incoming vehicles coming along the lateral lanes; moreover, it warns the user if an overtaking manoeuvre is started when other vehicles – not seen by the driver – are approaching.
LCW	Lane Change Warning.
LDWS	Lane Departure Warning System: It is a system that supports the driver in his / her lateral driving task and in particular when an unintentional lane change manoeuvre occurs. The warnings to the users are provided using different HMI channels, such as visual, tactile, and so on.
LED	Light Emitting Diode.
LKAS	Lane Keeping Assist System.
LP	Lateral Position.
LSS	Lateral Support System.
NASA	National Aeronautics and Space Administration.
NASA-TLX	NASA Task Load indeX.
NS	Navigation System.

NV	Night Vision.
PC	Personal Computer.
PDT	Peripheral Detection Task: Method whose purpose is to measure the driver's mental workload and visual demands by means of a visual stimulus presented at the periphery of the ocular field; the user is asked to press a button in response to the stimulus.
Performance	It refers to the quantitative measurement of one or more variables with respect to changes in *speed* (reaction time) and *accuracy* (hit rate).
Reliability	The reproducibility of measurements over time; it refers to the consistency of the measure on different occasions or with different sets of equivalent tasks.
RDS	Radio Data System.
RSME	Rating Scale of Mental Effort.
SA	Situation Awareness.
SD	Standard Deviation.
S&G	Stop & Go.
Selectivity	The measure has to be sensitive only to the desired dimensions/parameters.
Sensitivity	The ability to measure small changes [ISO WG8 N266].
SMS	Short Messaging System.
SP	Sub-Project .
Subjective WL	The amount of increasing mental resources to be used by an user when interacting with a system according to his own perception of it.
Suitability for road trials	The possibility to gather metrics in real conditions.
TERA	Traffic & Environment Risk Assessment.
TIS	Travelling and Traffic related Information System.
Transferability	The ability of a measure to be used in other applications.
TTC	Time To Collision.
Usability	The extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use. (ISO/IEC 9241-11: Guidance on Usability (1998) [**53**]).
Use case	An intended or desired flow of events or tasks that occur within the vehicle and are directed to or coming from the driver in order to accomplish a certain system-driver interaction.
UCD	User Centred Design.
Utility	The functionality of a device to do what it is built for.
Validation	Process of verifying that an application performs as expected, often based on assessment results. In this sense, validation is

	usually considered as an extension to the assessment process, and sometimes the generic term assessment will be used to encapsulate validation.
Validity	The extent to which the variable is diagnostic for the concept being investigated. A measure is valid if it measures what it intends to measure. A reliable measure is not necessarily valid.
VCS	Vehicle Communication Systems.
VE	Vision Enhancement.
WL	Workload: amount of information processing capacity used to perform a task.
VR	Virtual Reality.
WP	Work package.

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Executive Summary

The main objective of this document is to present a review of issues relevant to the field of testing environments (scenarios, simulators and/or driving environments, cohorts, use cases, etc.). Several goals can be organised within this general scope:

- Support for the choice, implementation and execution of experimental trials to be carried out in WP 2.1.4 for the assessment and specification of the best evaluation methodologies for different IVIS/ADAS, their adaptivity and integration.
- Categorisation of analytic knowledge about scenarios, including relevance criteria and building blocks.
- Build up a basis reference for the definition of the final methodology to evaluate the AIDE prototype.

From the definition of usability (ISO 9241-11), “the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use”, it follows that a major issue in the evaluation and assessment of (prototype) HMI is the choice of appropriate contexts, that is to say scenarios for testing.

As the basis for the evaluation and assessment of integrated adaptive HMI a set of different issues will be addressed in this report: starting with the definition of the IVIS/ADAS categories (WP2.1.1) the evaluation scenarios will be correlated and matched with the Design Scenarios developed within SP3 and integrated with a general classification of simulators and virtual reality test environments as well as hints to different cohort selections (Chapter 2).

Core of the report will be the Relevance Table of “building blocks” for the development of evaluation scenarios as developed and filled by different experts groups by each project partner (Chapter 3).

At least one concrete example for each of the 15 AIDE Design Scenarios will be included, matching the given formal definition from SP3. Nevertheless it needs to be remembered that each formal AIDE Design scenario can correspond to many different evaluation scenarios (Chapter 4).

A brief review of the international research projects (HASTE and COMUNICAR) will be reported in Chapter 5, stressing the relevance of their methodological findings on simulator environments, testing scenarios and self evaluating procedures.

Further remarks on open issues will conclude the deliverable (Chapter 6).

Revision chart and history log

Version	File name	Date	Reason
1	AIDE_D2.1.3_Test_Scenarios_v01.doc	20/07/2005	First draft of the D.2.1.3 released to the contributors.
2	AIDE_D2.1.3_Test_Scenarios_v02.doc	18/08/2005	Updated draft of D.2.1.3 released by RB to the contributors, WP and SP leaders. Start of the reviewing process.
3	AIDE_D2.1.3_Test_Scenarios_v03.doc	11/11/2005	Final version including reviewers´ remarks

1. Introduction

From the definition of usability (ISO 9241-11), " …the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use", it follows that a major issue in the evaluation and assessment of (prototype) HMI is the choice of appropriate contexts, that is to say scenarios for testing.

Other working packages within AIDE have reviewed existing tools and methods and are investigating subjective assessment as well as risk estimation techniques. On the basis of the taxonomy of IVIS/ADAS applications this deliverable focuses on the "building blocks" of scenario development including considerations on simulator and cohort choices.

The components identified as necessary to consider in scenario building are:

- the vehicle
- the road infrastructure
- the traffic conditions
- the environmental conditions

One way of illustrating the scenario concept is shown in Figure 1. It is important to note that the significance of the different scenario components may vary in different assessments. Also, the components are related to each other and interact in different ways in different cases.

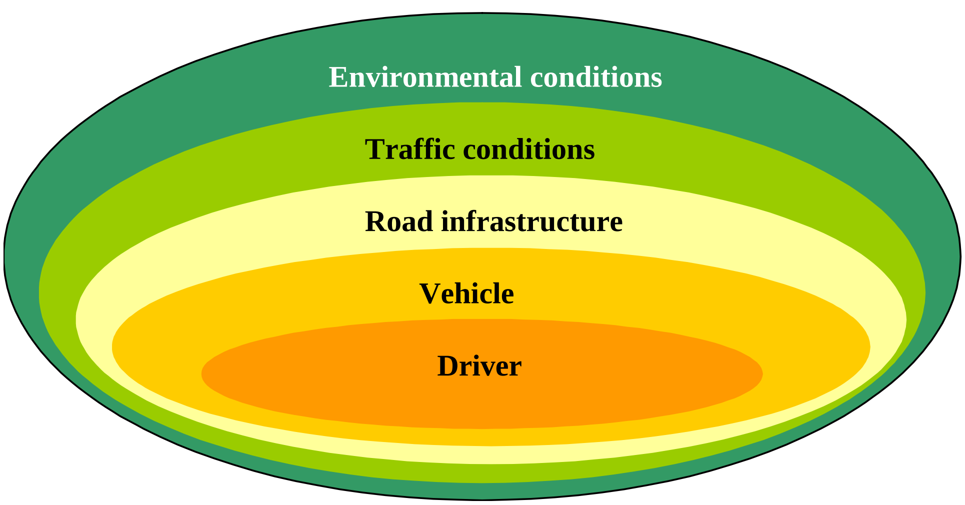

Figure 1: Main components in building assessment scenarios.

Since AIDE is mainly concerned with the issues of adaptivity and integration, it follows that special use cases (AIDE design scenarios) need to address the conflict potentials of such complex systems in order to evaluate the (positive) impact of a coordinated information management with AIDE meta-functions (SP3). The AIDE design scenarios are exemplifying all situations were possible conflicts between ADAS and IVIS warning and information messages can occur and which can lead to problems for the driver, always taking into account the Driver's, Environment and Vehicle's situation (DVE condition). Special attention was given also to the creation of specific use cases related to Nomadic devices and their use within the vehicle environment and the personalisation of the AIDE HMI. SP3 (D3.1.2) developed a methodology for describing the relevant conflict scenarios in a generalised way. In Chapter 4 we introduce the same format in this deliverable and offer at least one example for each of the 15 devised categories to serve as starting point for testing scenarios and protocols.

2. Scenarios and Simulators

Many single “puzzle tiles” are necessary in the assessment process of IVIS/ADAS, their adaptive and integrated interactions with the driver and their impact on traffic safety. In this chapter we review some of these “pieces” before introducing the scenario building blocks themselves (Ch. 3). The systems to be assessed need to be defined and categorized (2.1), just as the test environment, specifically the kinds of simulators involved, needs to be characterised (2.2). Moreover the different driver cohorts address very different interactions and support issues (2.3) that need to be specifically taken into account. Last but not least the AIDE actions and conditions (2.4) and the AIDE driving scenarios with special focus on the interactions conflicts will be described (2.5). Other use cases including nomad devices are listed in 2.6.

2.1 IVIS/ADAS categories from deliverable D2.1.2

The categorization of IVIS/ADAS according to AIDE Deliverable 2.1.2 in its general form is reported below and will be adopted throughout this report as well:

IVIS:

- Navigation Systems (NS)
- Travelling/Traffic related Information Systems (TIS)
- Vehicle Communication Systems (VCS)
- Driver Convenience Systems (DCS)

ADAS:

- Lateral Control (Lat)
- Longitudinal Control (Lon)
- Reversing/Parking Aid (RPA)
- Vision Enhancement (VE)
- Intelligent Speed Adaptation (ISA)
- Driver Monitoring (DM)
- Pre-Crash Systems (PCS)
- Vulnerable Road Users Protection Systems (VRU)
- Road Low Friction Warning Systems (RLF)

2.2 Driving Simulators classification

Although one of the conclusions of the HASTE project about “Simulator Type” was that ”the type of simulator or laboratory used in the assessment did not have an effect“ on the test results in case of visual and cognitive distraction generated by IVIS, this might not be generalized for each IVIS/ADAS interaction. Therefore we include in this report a classification of test environments to be chosen from for the implementation of the evaluation procedure. Moreover different kinds of simulators may differ in their ability to integrate or implement AIDE meta-functions or be suitable for test with different cohorts.

We describe the following examples

- Entry-level systems
- (proper) Driving Simulators
- Immersive Virtual Reality Driving Simulators.

2.2.1 Type A: Low-level system

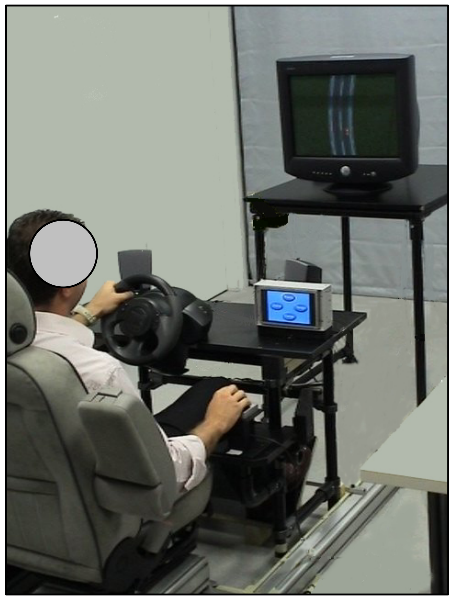

Figure 2. Type A "simulator": Low-level system.

Visualisation system	Vehicle mock-up	Primary controls and force feedback	Motion system	Sound system	VR Interaction device
PC monitor or Plasma screen	Car seat and simple primary control support	Videogame-like steering wheel and pedals (e.g. Microsoft SideWinder)	No	Multimedia PC speaker system	No

Advantages	Weaknesses
• Low cost • Easy to move • Simplicity	• Low level of fidelity • No suitable for ADAS simulation • Low immersivity level • Very narrow field of view • Lack of dynamic motion sensation

2.2.2 *Type B: static or semi-dynamic simple driving simulator*

Figure 3. Type B simulator: static or semi-dynamic simple driving simulator.

Visualisation system	Vehicle mock-up	Primary controls and force feedback	Motion system	Sound system	VR Interaction device
Retroproject multiscreen	Car seat and simple mock-up of dashboard	Automotive steering wheel and pedals with simple force-feedback	No or simple limited degree of freedoms motion based (not more than 2 or 3 DOF)	Multimedia PC speaker system	No

Advantages	Weaknesses
• Low to medium cost • Easy to move • Simplicity	• Medium level of fidelity • Medium immersivity level • Difficult to change type of vehicle

2.2.3 Type C: fixed driving simulator

Figure 4. Type C simulator: fixed driving simulator.

Visualisation system	**Vehicle mock-up**	**Primary controls and force feedback**	**Motion system**	**Sound system**	**VR Interaction device**
Multiscreen or semi-circular screen	Real vehicle	Real steering wheel with force feedback and pedals	No	Immersive sound system	no

Advantages	**Weaknesses**
• Large field of view • High level of fidelity	• Lack of dynamic motion sensation • Difficult to move • Difficult to change type of vehicle

2.2.4 Type D: dynamic driving simulator

Figure 5. Type D simulator: dynamic driving simulator.

Visualisation system	Vehicle mock-up	Primary controls and force feedback	Motion system	Sound system	VR Interaction device
multiscreen or semi-circular screen	Real cab	Real steering wheel with force feedback and pedals	Six DOF motion platform	Immersive sound system	No

Advantages	Weaknesses
• Large field of view • High level of fidelity • Dynamic motion sensation • High immersivity level	• Cost • Fixed installation • Difficult to change type of vehicle

2.2.5 *Type E: advanced driving simulator*

Figure 6. Type E simulator: advanced driving simulator.

Visualisation system	Vehicle mock-up	Primary controls and force feedback	Motion system	Sound system	VR Interaction device
Circular screen	Real cab or real vehicle	Real steering wheel with force feedback and pedals	Six DOF motion platform with longitudinal and lateral rails	Immersive sound system	No

Advantages	Weaknesses
• Wide field of view • High level of fidelity • Complete dynamic motion sensation • High immersivity level	• High Cost • Fixed installation • Large space occupied • Difficult to change type of vehicle

2.2.6 Type F: Head-Mounted-Device (HMD) simulator

Figure 7. Type F simulator: Head-Mounted-Device (HMD) simulator.

Visualisation system	Vehicle mock-up	Primary controls and force feedback	Motion system	Sound system	VR Interaction device
Head Mounted Display	Car seat and primary control support	Real steering wheel with force feedback and pedals	No or six DOF motion platform	Immersive sound system	Data-glove, motion tracker , optionally gloves with touch and force feedback

Advantages	Weaknesses
• Good level of fidelity • It could have dynamic motion sensation • High immersivity level • Easy to move • Easy to change type of vehicle • Easy to change cab interior (virtual interior)	• Narrow field of view • Intermediate cost • A broader field of view lowers the image quality • Low fidelity of interaction with virtual interiors (difficult to reproduce force and touch feedback)

2.2.7 Type G: CAVE© simulator

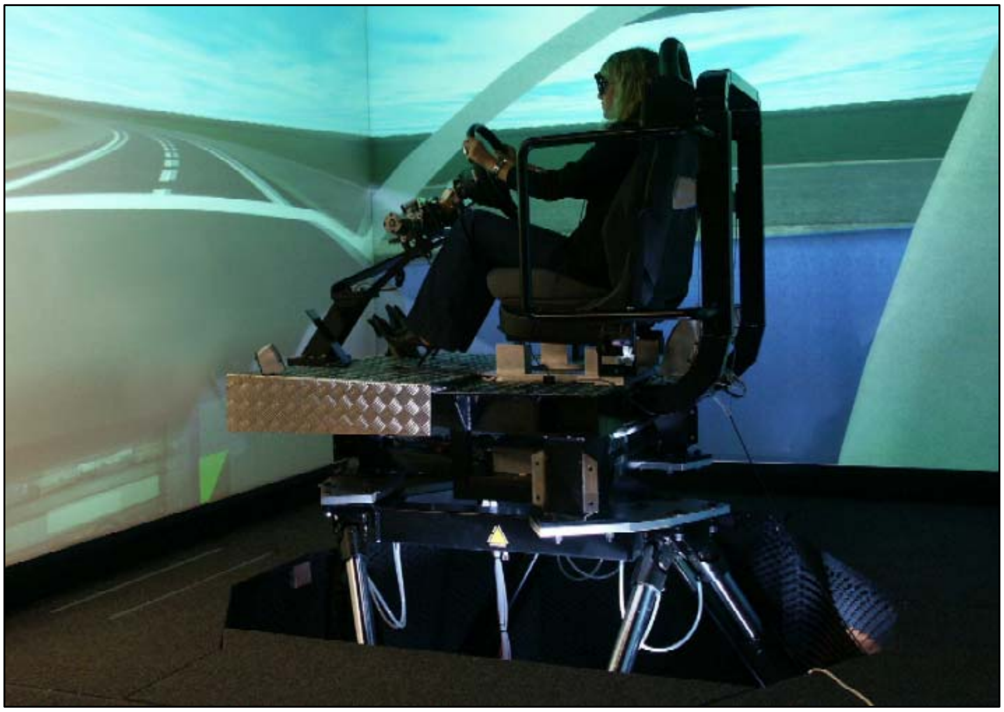

Figure 8. Type G simulator: CAVE© simulator.

Visualisation system	Vehicle mock-up	Primary controls and force feedback	Motion system	Sound system	VR Interaction device
One to five screens	Car seat and primary control support	Real steering wheel with force feedback and pedals	Six DOF motion platform	Immersive sound system (i.e. auralization)	Motion tracker, optionally data-glove

Advantages	Weaknesses
• Wide field of view with more than one screen • High level of fidelity • Dynamic motion sensation • High immersivity level • Easy to change type of vehicle • Easy to change cab interior (virtual interior)	• High cost • Fixed installation • Medium space occupied

2.3 Scenarios for various drivers cohorts

On the one hand, it is true that specific evaluation ideas can be best realised with specific cohorts, on the other hand, other cohorts might even require special attention to their needs. It can be suggested that final AIDE demonstrators will also address different strategies of integration and adaptivity for different user groups. This chapter focuses directly on the type of simulator characteristics and scenarios adequate for three particular driver cohorts, namely elderly, novice and disabled drivers. The categorisation of simulators follows the outline of Chapter 2.2.

The needs for scenarios are different for different driver groups, as each one has its own characteristics and problems. The scenarios that are provided in the report arise from relevant studies that have been performed within three EC projects TRAINER, AGILE, IDEA.

For example, novice drivers require scenarios which render adequate even simulators of type B. However, elderly (and experienced) drivers need more complex scenarios that can be only realised with a better type of simulator. Considering also their enhanced simulator dizziness-related problems, they seem to require at least a simulator of type D with wide FOV. For disabled drivers the issue is more complex and diversified according to their particular disability. However the most important aspect to be considered is the accessibility and adaptation required for the simulator typically leading to the use of simulators of lower classes (easier and cheaper to adapt). Still, it is worth mentioning that type E simulator of VTI has been adapted within the TELAID project for use by mobility impaired people.

2.3.1 Older Drivers

Older drivers show no evidence of age-related risk taking behaviour (Siren et al 2001). On the contrary, personal attitudes and driving goals contributing to safe driving behaviour are more prevalent in older drivers. If older drivers have insight into their own driving skills they will usually adapt their driving style by applying compensatory and coping techniques. The subgroup of older drivers most probably lacking insight into their own driving skills is older persons with cognitive deficits, in particularly seniors with dementia and associated illnesses in progressed stages. It is in mastering the complexity of traffic situations that potential psychomotor and cognitive age-related deficits become noticeable for the first time, and where they have their most severe impact. Impairments become salient due to the complex and dynamic nature of most situations requiring manoeuvring skills.

As decreased driving skills are likely to become salient in complex situations, scenarios including demanding interactions with other road users should have highest priority in the case of older drivers. Thus, the scenarios considered by AGILE project are (in brackets: main skills addressed by each scenario):

- Intersections of varying complexity, left and right turns (speed and distance judgements, decision, information processing, reaction time).
- Yielding right of way (situation awareness, inhibition of dominant responses).

- Merging (speed and distance judgements, decision, information processing, reaction time).
- Complex traffic situations (selective attention).
- Driving for a longer period (sustained attention).
- Driving with a secondary task, e. g. phoning (divided attention).
- Way finding in an unfamiliar area (task switching, scheduling of subtasks, working memory).
- Passing and overtaking (speed and distance judgements, decision, information processing, reaction time).
- Interaction with pedestrians at zebra crossings (situation awareness, mental flexibility, inhibition of dominant responses).
- Emergency braking (reaction time).
- Turning on a narrow lane (physical mobility and car control).
- Adverse weather conditions, night driving (driving behaviour in unusual situations).
- High informational load (threshold information overload).
- Driving under time pressure (driving behaviour under stress).
- Driving in narrow lane (visual-spatial abilities).

The list was prioritised among the AGILE consortium members and presented to external experts in the area of aging and driving. The results, based on mean ratings of external experts and the AGILE consortium are presented in Table 1 in decreasing order of relevance. The original rating from the consortium was assigning the following points: 1 = not so relevant, 2 = relevant, 3 = very relevant; in the same Table a third column was included for better comparison with Table 9 (red) with the different notation that AIDE WP2.1 has adopted, where on the contrary 3 = not so relevant, 2 = relevant, 1 = very relevant.

Table 1. Traffic scenarios for older driver ordered by priority.

	SCENARIO	RATING (AGILE)	RATING (AIDE)
1	Intersections	2.75	**1,25**
2	Yielding right of way	2.65	**1,35**
3	Merging	2.60	**1,40**
4	Driving in a complex area	2.55	**1,45**
5	Interaction with pedestrians	2.55	**1,45**
6	Driving with a secondary task	2.50	**1,50**
7	High informational load	2.30	**1,70**
8	Passing and overtaking	2.10	**1,90**
9	Adverse weather condition	2.05	**1,95**
10	Emergency braking	2.00	**2,00**
11	Driving for a longer period	1.70	**2,30**
12	Driving under time pressure	1.70	**2,30**
13	Way finding in an unfamiliar area	1.65	**2,35**
14	Turning in a narrow lane	1.50	**2,50**
15	Driving in narrow lane	1.45	**2,55**

In the scenario design, turning manoeuvres should be avoided if not necessary because of simulator sickness. Also, scenarios for older drivers should not be too long.

2.3.2 Novice Drivers

All statistics report a very high accident rate for novice drivers, especially males under 25; outside Europe the problem is even more enhanced including teenagers from age 15-16 that can already obtain a driver´s licence. With a special focus on the training aspects, the TRAINER project (GRD1-1999-10024) dealt with the development of an innovative methodology for training novice (especially young) drivers and surveyed driving simulators as innovative tools. Simulators can let the driver trainees and novice driver experience hazardous situations, higher speed and complexities than real traffic situations would safely allow. It can also test (and not only train) peripheral vision and scanning of the environment, risk estimation, overtaking manoeuvres, and so on. In our specific case of assessing the behaviour of novice drivers and their interactions with IVIS/ADAS, the use of simulators can be strongly recommended. The influence of distractors (in-car: mobile phone, driver support systems, out of car: ambulance horn) and behaviour to cope with them could be highlighted without real risk. Novice drivers could as well experience the impact of car control aids (ABS, ACC and other ADAS) in order to understand their possibilities and limitations. On the other hand the simulator is not a suitable tool for some emergency manoeuvres due to motion sickness in fast changes of direction (e.g. hard brake, obstacle avoidance).

Following, not comprehensive list could give some hints into special manoeuvres and settings as addressed by the TRAINER project:

- Car-Following and Tailgating
- Lane changing and Overtaking
- Entering and leaving the traffic (incl. motorways)
- Scanning the road (eye cues)
- Reacting to other vehicles
- Reacting to pedestrians
- Negotiating intersections
- Negotiating hills/slopes
- Negotiating curves
- Reacting to traffic signs and traffic lights
- Reacting to direction signs and in-car devices
- Emergency breaking
- Obstacle avoidance technique
- Urban driving
- Rural driving
- Motorway driving
- Adapting to road surface conditions
- Weather conditions (fog, rain, snow)
- Night driving
- Convoy driving

Driver's condition (stress, mood, fatigue) will have to be taken into account as introduced in former chapters: for this particular cohort knowing also about the influence of passengers in the car might be of particular relevance. In contrast to the finding of the HASTE project, the TRAINER project found that assessment parameters need to be tailored to the simulator, as else even experienced drivers might be assessed negatively. Also simulators with view angle of only 120^0-135^0 seem to be adequate to realise most novice drivers priority scenarios.

Finally, it is important to highlight that the simulator dizziness is increased dramatically if the installation of the simulation has not been performed correctly, i.e. if the distance of the driving seat to the projection screens or monitor is not the correct one, or if the motion system is not working properly.

2.3.3 Disabled drivers

Special attention should be devoted to the assessment of the interaction of disabled drivers with the vehicle as well as with the environment, including IVIS/ADAS impact.

Within the IDEA project, a list with 14 priority simulator scenarios, rated as important for training and/or assessment of the disabled drivers, has been produced, some of which are reported in the following table (Table 2 on the next page). Simulators of Type B are usually sufficient for the task assessment and do not require expensive hardware adaptation.

Regarding the adaptation of controls of a driving simulator for disabled persons, the following list gives some suggestions:

- The distances and orientations of the elements in the car (front panel, steering wheel, seat, pedals, etc.) must be variable.
- The resistances of the buttons and controls must be simulated.
- Equipment is needed to measure the movement and forces applied to the different controls.

The adaptations required by the disabled driver to be able to drive, must be simulated or installed in the car (i.e. hand control, joystick steering, etc.).

Table 2. Simulator scenarios for disabled drivers.

Simulator scenarios	Disability Group	Equipment / adaptations needed	Assessment / training
Deceleration	- All drivers - Especially persons with problems on the lower limbs	Adaptation for the brake pedal	☑ Training of Elderly & Disabled ☑ Assessment of E&D
Curve	- All drivers - Persons with problems on the lower and upper limbs	Adaptation for - brake pedal - the accelerator - steering wheel	☑ Training of E&D ☑ Assessment of E&D
Crash speed	- All drivers - Persons with problems on the lower limbs	Adaptation for the brake pedal (controlled by hand, alternative brake)	☑ Training of E&D
Looking direction	- Persons with problems on the upper limbs or neck - Elderly persons	Adaptation for the steering wheel	☑ Training of E&D ☑ Assessment of E&D
Start and gear shift	- All drivers		☑ Training of E&D
Security check	- All drivers		☑ Training of E&D
Tyre condition	- All drivers		☑ Training of E&D
Visibility	- All drivers - Persons with visual problems		☑ Training of E&D
Braking technique	- All drivers - Persons with problems on the lower limbs	Adaptation for the brake pedal and the clutch	☑ Training of E&D ☑ Assessment of E&D
Way finding with a navigation system	- Elderly drivers - Persons with limited arm movement and problems with hand/ fingers.	Navigation system UI must be in a place easy to reach and its buttons & knobs must be easy to operate for persons with problems in the upper limbs, hands and fingers.	☑ Training of assessors ☑ Training of E&D
Brake alertness	- All drivers - Persons with problems at the braking leg	Adaptation for the brake pedal to the available foot	☑ Training of E&D ☑ Assessment of E&D

2.3.4 Other cohorts

For the development and assessment of IVIS/ADAS also other cohort groups can be directly addressed as they show different behaviours, goals and scope of usage, e.g. the business traveller, a parent with child or the leisure/fun driver. The same person could belong to all these categories, at different times, but the kind of information and assistance that he/she might need or desire could eventually be best characterised by analysing each of the categories separately.

The setting/environment of the trip might be primarily urban for the parent, rural for the leisure driver and the motorway for the business traveller; the trip length and the number of stops with eventual “goal reset” as well as the grade of knowledge of the environment may also vary between groups more intensively than among each of them. Time of day and time pressure constraints might lead to following pairs: “daytime with medium to high pressure” for the parent, “24h with high pressure” for the business traveller, “daytime, little or no pressure” for the leisure traveller. Also the degree of acquaintance with the car might play a role in designing and testing learnability issues (own car versus rent car), etc.

2.4 AIDE actions and conditions (from D3.1.2)

A key objective of the AIDE system is to resolve HMI-related conflict situations. This includes conflicts between different systems interacting with the driver as well as conflicts between this interaction and the driving situation. A major difficulty in describing these conflicts is that there are infinitely many possible combinations of interactions and driving situations.

In D3.1.2 an innovative scheme for describing the relevant conflict scenarios in a generalized way was developed. These generalized *AIDE design scenarios* define the scope of the AIDE system and will be used to derive the general AIDE functional requirements (in WP3.2).

The driver-system interaction is represented in terms of (driver/vehicle initiated) *actions* and the driving context defined in terms of *Driver-Vehicle-Environment (DVE) conditions*. The generalized scenario descriptions are derived from the parameterisation and categorisation of the actions and DVE conditions.

In this paragraph we report the classification of actions and conditions elaborated in the AIDE project within the deliverable D3.1.2

2.4.1 AIDE actions

The main objective of the action parameters is to group actions in order to derive generalized scenario descriptions. The scenarios consider both driving and in-vehicle interaction situations which will affect the input/output behaviour of the AIDE system. As far as the actions are concerned this influence or management of the interactions is done on the basis of the importance of an action which is called priority of the action. Therefore the parameters are mainly used to derive the priority of all considered actions.

Within AIDE a two step approach has been adopted to identify the action categories based on the parameterisation described above:

1. Parameterisation of all possible actions
2. Grouping of the actions into categories.

This approach offers maximum flexibility for the vehicle manufacturers, but nevertheless it allows a common generalized description of the scenarios and finally a modular architecture. It has to be stressed that it must be checked whether the assignment is unique, i.e. one parameter combination can only be assigned to one class. Since the mapping of the parameter combination to the priority classes is flexible, the system behaviour can be adapted for example to different solution strategies without changing the scenario description. This characteristic of the AIDE system also needs to be assessed in different scenarios.

Within AIDE the following **three action classes** (Table 3) have to be distinguished:

1. Warnings, which present very urgent information to the driver and which comes mainly from driving assistance systems like a lane departure warning system or collision avoidance systems. Such an information is of highest priority for the driver and has to be presented in any case.
2. Dialogs should be answered or followed by the system immediately, because they are directly desired and initiated by the driver. Nevertheless the first "warning" class is of higher priority and might even allow an interruption of a dialog.
3. Other output messages which comprises all output information not belonging to class 1 and 2. The output message class is further divided into 3 sub-classes (OP_1 to OP_3) in order of importance. Output messages are mainly issued by information systems, but assistance systems can also issue important messages OP_1.

These actions can involve different IVIS/ADAS (in blue italics) and can be also grouped according to the different objectives and scopes they address:

- “Pure Information Exchange”, involving only NS, TIS, VCS (rarely DCS)
- Comfort and Infotainment, basically involving DCS
- Safety addressing ADAS of all kinds.

Table 3. Classes of actions.

Classes	Definition (verbal description)	Set definitions	Comment (Reasons for choosing those classes)
W (warning) ***(ADAS)***	Actions indicating high traffic/ environment risk	SafetyCriticality=HIGH **AND** TimeCriticality=HIGH	Those warnings have obviously the highest priority for the driver
D (dialog) ***(IVIS/ADAS)***	Actions which have been activated by the driver	Initiator=USER	Driver initiated actions have to have a direct response, which should only be influenced by warnings
OP_1 (output prio 1) ***(ADAS/IVIS)***	Time critical, mandatory real time or preferred actions.	TimeCriticality= HIGH, **OR** Mandatory=YES **OR** (RealTime= YES **AND** Preferred= YES) **OR** (TimeCriticality=LOW **AND** Prefered = YES)	These output classes can be created according to the subjective I/O-philosophy of each OEM, i.e. they can change and also the mapping of the individual actions to the classes may change
OP_2 (output prio 2) ***(IVIS/ADAS)***	Transient actions relevant to the driving task	Safety criticality=LOW **OR** Time criticality= LOW **OR** Preferred=YES	
OP_3 (output prio 3) ***(IVIS)***	Sustained information for or about the primary task, not requiring an action in the near future. Also, messages or information related to secondary tasks	((Initiator=System **AND** Duration=Sustained **AND** DrivingRelevance= YES) **AND** TimeCriticality=None) **OR** (Initiator=System **AND** Duration= Transient **AND** DrivingRelevance= NO)	

2.4.2 AIDE conditions

Different condition categories flow into the description of the Driver-Vehicle-Environment (Table 4 on the next page). It should be noted that the intermediate stage could be also mean either low reliability of the calculated value or that the value is not computed.

For example, the general DVE parameter “distraction” could be further divided into cognitive and visual distraction. Moreover, distraction could be measured as a momentary value (e.g. “eyes-off-road”) or as a time averaged value (e.g. average time spent on the road within a 5-second time window). The final operational definitions of these parameters depend on the detailed definition of AIDE meta-functions they are intended to support (in this case warning adaptation).

Table 4. DVE conditions categories.

ID	DVE parameter	Explanation	Value	Motivation
DVE1	Driving demand (output of DDE)	Requirements of the current driving task which can result in a reduced availability of the driver to process and receive information	{high, low, intermediate stage}	The demand of the driving task (and the resulting Driver Availability to receive information) is a key parameter for meta-functions related to re-scheduling of non-critical information. These types of parameters were central for the DVE/workload monitoring in previous work e.g. GIDS (Michon,1993) COMUNICAR (Amditis, 2002), CEMVOCAS (Bellet, 2002), and CoDrive (Zoutendijk, 2003)
DVE2	Distraction (partly output of CAA)	Cognitive load or shift of visual attention away from the road ahead, induced by an external event or a secondary task.	{high, low, intermediate stage}	Distraction is important, mainly for enabling driver-adaptive ADAS functions. This is a key focus in the ongoing Delphi-led SAVE-IT project (e.g. SAVE-IT, 2002).
DVE3	Driver impairment (output of DSD)	The **physical IN-ability** of the driver to drive (due to fatigue, sleepiness, etc.)	{high, low, intermediate state}	Like distraction, driver impairment-related parameters (in particular drowsiness) are important for driver adaptive ADAS functions (SAVE-IT, 2002).
DVE4	Driver intent (joint output of TERA and CAA)	The driver's intention, e.g. for a lane change	{manoeuvring, non manoeuvring} *intention only	Predicting the intention of the driver can be used for warning optimisation (e.g. reducing false warnings). It is one of the key focuses in the SAVE-IT project (SAVE-IT, 2002).
DVE5	Traffic and environmental risk (output of TERA)	Total level of risk concerning environmental and traffic conditions	{high, low, intermediate stage}	Traffic risk estimation has been previously used e.g. in COMUNICAR (Amditis, et al., 2002) and AWAKE (Bekiaris and Amditis, 2002)

2.5 AIDE design scenarios (from D3.1.2)

The AIDE design scenarios target at illustrating conflict situations that the AIDE system is intended to solve. A potential conflict could refer to messages occurring simultaneously and either demanding the same modality or having different priorities. Potential conflict could also refer to messages initiated in a “bad” or “difficult” DVE condition. In that case, a potential solution would be to adjust its outputs according to the current DVE state. Thus, a conflict within AIDE occurs either between concurrent actions or between actions and DVE conditions.

In order to achieve a general description for the AIDE scenario in a way that takes into consideration the importance of the actions according to the combination of the DVE conditions in where the combination of actions occur, D3.2.1 considers all meaningful combinations of actions and DVE conditions. The combinatory explosion is avoided by means of the categorization schemes defined in the previous sections. The general format for design scenario descriptions is illustrated below and can easily be applied to AIDE design scenarios as well as to normal use cases..

The general format of AIDE design scenarios generated in SP3 and applicable to both AIDE design scenarios and normal use cases is illustrated in the following table:

Table 5. Format of AIDE design scenarios (D3.1.2).

AIDE design scenario An application action or a combination of application actions is/are initiated/in progress in a single or complex DVE condition, DVEi.
Action/s = {…}
DVE Condition/s = {…}
Flow of events
Possible AIDE solutions(*) ...
Example : ...

Also **three general groups of scenarios** have been defined in SP3, based on the type of conflict they represent:

1) Conflict between concurrent actions
2) Conflict between one action and DVE conditions
3) Conflict between multiple actions and DVE conditions.

We will not get into the elaboration of possible AIDE solutions and refer in this case to the work within SP3, instead single examples for each category will be presented for clarification in chapter 5; one example is shown in Table 6.

Table 6: Example of an AIDE design scenario.

AIDE design scenario 3.3: Conflict between a driver initiated action and a warning in critical driving situation
Action/s = {D+W}, where D = User-initiated actions (dialogs or inputs) W = Warning indicating high traffic risk
DVE Condition/s: DVE_{1-4}=LOW/NO, Traffic/Environment Risk(DVE_5)=LOW&HIGH
Flow of events 1. Traffic/Environment Risk turns from LOW to HIGH 2. Driver starts executing D 3. W is initiated 4. Traffic/environment Risk turns from HIGH to LOW
Possible AIDE solutions(*) Delaying of D until W has caused a DVE_5 – transition to LOW.
Example: *Conflict scenario:* The driver is in the middle of a phone call conversation while he drives on the highway. He/she drifts out of the lane while an approaching vehicle is detected from the blind spot camera. *Possible solution:* D is paused/interrupted while the warning is issued. When the corrective action of the driver has reset DVE_5 to LOW, D is recovered.

On the following page we report the 15 AIDE design scenarios divided in three categories, depending on the type of conflict they address: conflicts between concurrent actions, conflicts between an action and a situation, conflicts between multiple actions AND a (demanding or risky) situation.

Conflicts between concurrent actions (category 1)

AIDE design scenario 1.1: Conflict between concurrent warnings *(ADAS with at least 2 warning outputs or warnings from 2 different ADAS)*

AIDE design scenario 1.2: Conflict between warning and driver initiated action *(ADAS/IVIS)*

AIDE design scenario 1.3: Conflict between warning and output message *(ADAS/IVIS)*

AIDE design scenario 1.4: Conflict between a driver-initiated action and an important output message (OP_1) *(IVIS/IVIS)*

AIDE design scenario 1.5: Conflict between a driver-initiated action and an output message (OP_i,i>1) *(IVIS/IVIS)*

AIDE design scenario 1.6: Conflict between two output messages *(IVIS/IVIS)*

Conflicts between one action and DVE conditions (category 2)

AIDE design scenario 2.1: An output message is initiated in a demanding driving situation *(IVIS + DrivingDemand [DDE and/or similar indicators])*

AIDE design scenario 2.2: An important output message (OP_1) is given while driver is distracted. *(IVIS + DriverDistraction [CAA or DSD])*

AIDE design scenario 2.3: An important output message (OP_1) is given while driver is tired and drives during night. *(IVIS + DriverFatigue [DSD])*

AIDE design scenario 2.4: Warning is given while driver is distracted *(ADAS [Lat, Lon, VE, ISA, DM, PCS, VRU, RLF] + DriverDistraction [CAA or DSD]*

Conflicts between multiple actions and DVE conditions (category 3)

AIDE design scenario 3.1: Multiple output messages (OP_i, i>1) are presented in a demanding situation *(IVIS + DrivingDemand [DDE and/or similar indicators])*

AIDE design scenario 3.2: Multiple important output messages (OP_1) are presented in a demanding situation *(IVIS + DrivingDemand [DDE and/or similar indicators])*

AIDE design scenario 3.3: Conflict between a driver initiated action and a warning in critical driving situation *(HighTrafficRisk [Lat, Lon, ISA, VE, DM, PCS, VRU, RLF] +IVIS)*

AIDE design scenario 3.4: Conflict between a driver-initiated action and an important output message (OP_1) in a demanding situation *(IVIS + DrivingDemand [DDE & above])*

AIDE design scenario 3.5: Conflict between concurrent warnings (ACC, LDW) when driver's intention to perform a maneuver is detected *(ADAS + DrivingDemand [DDE & above])*

The blue italics refer to the systems addressed in each scenario.

2.6 Additional scenarios

Some additional scenarios from SP3 not directly related to conflict situations can also be defined:

- Scenarios that handle individual ADAS/IVIS functions (normal use cases, no conflict involved)
- Scenarios that handle personalisation and adaptation to driver characteristics
- Scenarios that handle nomad devices integration when the driver enters the vehicle.

In the case of nomadic devices a new version of the European Statement of Principle was prepared in summer 2005 with special attention to this issue. They apply to both information and communication systems but not to systems providing vehicle stabilisation or ADAS.

SP2 needs to evaluate both **additional scenarios** and **conflict scenarios**. Main goal of the AIDE project is that the conflicts identified by AIDE scenarios will be resolved by (1) the basic HMI design (which minimises conflicts in the first place) and (2) the AIDE meta-functions (which resolves conflicts in real time, e.g. by prioritization, scheduling or I/O re-allocation).

In the final version of the deliverable 3.1.2 use cases for functions not captured in the design scenarios (referred as normal use cases) were added, which deal with mainly:

1) Interface adaptability (e.g. adjust timing of warnings to DVE conditions regarding driver characteristics)
2) Integration of nomad devices

The additional normal use cases for these two categories are summarised below:

(Normal) use case 1: Nomad device integration (initialization) (Table 7)

1.1: initialisation phone

1.2: initialisation navigator

1.3: initialisation PDA

(Normal) use case 2.1: A warning is adapted to the driver personal characteristics

(Normal) use case 2.2: An output message is adapted to the driver type of use

(Normal) use case 2.3: A warning is adapted to the driver driving attitudes and preferences

Table 7. Examples of nomad devices integration.

Nomad Devices Integration			
	Action	**Steps during initialization**	**Other functionality**
Mobile Phone	Enter car/ car stopped and parked	Synchronize device	Adding /modifying address book
		Synch/download phone book	Web/wap access
		Synchronize SMS	Accessing phone status
			Complex call activity
PDA device	Enter car	Synchronize device	Internet access
		Synchronize agenda	Email access
		Synchronize address book	Games and other apps access

Table 8 describes adaptability to user characteristics (normal use cases 2.1 - 2.3) as defined by SP3.

Table 8. User adaptation parameters.

Driver profile/ vehicle status	Parameters - examples	Objective (use cases for adaptation)
Driver personal characteristics (static)	Age	Adapt warnings or output messages
	Skilled/ novice	
	Language	
	Hearing impaired	
Type of use (semi-dynamic)	Business traveller	
	Leisure traveller	
Driver driving attitude and preferences (dynamic)	Average headway (or TTC)	
	Average lane position (TLC)	
	Tbrake-own	
	Tbrake-ahead	
	GPS clock	
	Average demand of services	
Others user preferences	Preferential phone-book	Prioritize/filter the incoming phone call
	Preferred kind of information	Prioritize/filter the incoming information messages
	Preferred colours or format	Adapt graphics
	Preferred voice or style	Adapt speech dialogue

These additional scenarios obviously generate new potential evaluation scenarios as AIDE will deal with nomad devices as well as with adaptation to the driver.

3. "Relevance Table" of Scenario Building Blocks

In order to assess the IVIS and ADAS as well as the potential benefits of their adaptivity and integration in a finite amount of time and effort it is crucial to select the most relevant situations, conditions, environments, tasks for the vehicle, the driver and the surroundings to undergo such process.

Main objective of the "relevance table" of scenario building blocks is to be a tool for the plan and realisation of test routines of IVIS/ADAS and their interactions with the driver and the driving task to be performed in AIDE WP2.1.4. It can be used as guideline or source of suggestions in the wide choice of experimental settings, conditions and protocols, far from being at the same time complete under any point of view.

It has been developed in an iterative refinement process on the basis of the characterisation of IVIS and ADAS from WP2.1.2 as reported on paragraph 2.1: the main categories (and some subcategories) define the rows of the table. The columns describe building blocks in three categories that can be put together to yield a single "trial scenario":

- Road type & conditions, visibility
- Traffic type and actors
- Tasks and goals.

The first category addresses the (relatively) "static" part of the environment while the second one describes the "dynamic" road user constellation. The third belongs rather to the set of actions and tasks that the "individual" driver can or should perform during a test drive, some of which pertaining to the primary driving task and others representing artificial measurement procedures.

The chosen first category elements are:

- Type of road: city roads
- Type of road: highways
- Type of road: motorways
- Type of road: rural
- Road conditions
- Visibility conditions
- Weather conditions

It must be stressed at this point that they do not represent disjunctive (independent) variables since e.g. the weather (present and past) can affect both road and visibility conditions.

The choice for the second category fell on:

- Traffic in the same direction

- Oncoming traffic
- Crossing traffic
- Pedestrians
- Platoon driving

The “pedestrians” item could be easily generalized to “vulnerable road users” in different settings to include bicycles and small motorbikes.

The third category includes different kinds of actions, most directly pertaining to the driving task (car following, use of mirrors), while others, such as the distraction task and the rather “artificial” Lane Change Task, could be seen as experimental “constructs” to measure driving performance, workload, etc.

- Car following
- Lane Change Task (LCT)
- Overtaking manoeuvres
- Distraction task
- Object and event detection outside the car
- Use of mirrors

The average rating reported in Table 9 represents the arithmetical mean of the “relevance scores” given by all project partners on a scale from 1 to 3 where 1 is “most/very relevant”, 2 is “somehow relevant” and 3 “not relevant” (compare also with Table 1, p. 21). The green colour is assigned to values below 2 (very relevant), the orange to values below 3 (somehow relevant) and the blue to values equal 3 (scored “not relevant” by all partners).

Table 9. Relevance of scenario building blocks for ADAS/IVIS assessment.

General means in the ratings

Possible Scenarios	Road type & conditions, visibility: Type of road: city roads	Type of road: highways	Type of road: motorways	Type of road: rural	Road conditions	Visibility conditions	Weather conditions	Traffic type and actors: Traffic in the same direction	Oncoming traffic	Crossing traffic	Pedestrians	Platoon driving	Tasks and goals: Car following	Lane Change Task (LCT)	Overtaking manoeuvres	Distraction task	Object and event detection outside the car	Use of mirrors
IVIS:																		
Navigation Systems	1,5	2	2,5	2,5	2	3	3	3	3	3	2	3	3	3	3	2	2	3
Travelling/Traffic Related Information Systems	2	2	2	2	2	2,5	2,5	2	2	2,5	2	2	2	2	2	2	3	2
Vehicle Communication Systems	1	2	3	1	2	2	2	2,5	2	2,5	2	3	2	2	2	2	3	2
Driver Convenience Systems	1	1	1	1	2	2	2	2	2,5	2	2	2	2	2	2	2	2,5	2
ADAS:																		
Lateral Control	2	1	1	1	1	2	2	3	2	3	3	2	1	1	1	2	1	2
Lane Keeping and warning	2	1	1	1	1,5	2	2,5	2	2	2	2	2,5	1,5	2	2	1,5	2,5	2
Blind spot monitoring	2	2	2	2	3	1,5	2	1,5	2	1,5	2	3	1,5	1	1,5	2	2	1
Lane change and merge collision avoidance	2	1	2	1	2	2	2	2	2	1	2,5	2,5	2,5	1,5	2,5	1,5	1,5	2
Longitudinal Control	2,5	2	2	2	3	2	2	1	2	2	2	3	1,5	2	3	2	1,5	2
Intelligent Speed Adaptation	1	1	2	1	2	1	2,5	2	3	1,5	1	2,5	3	2	1	2	2	2
Road Low Friction Warning Systems	1	2	1	1	2	2,5	2	3	2	2,5	1	2	1	2	1	2	2	1
Reversing/Parking Aid	1	3	3	3	3	1	3	3	3	3	2	3	3	3	3	3	1	1
Vision Enhancement	3	2	2	1	2	1	1	2	2	2	1	3	2	3	3	2	1	3
Driver Monitoring	3	1	1	1	3	2	3	2	2	3	3	2	2	3	3	3	2	3
Pre-Crash Systems	2	1	1	1	2	1	1	1	1	1	1	2	1	3	3	2	1	3
Vulnerable Road Users Protection Systems	1	2	3	1	3	1	1	2	2	2	1	3	3	3	3	1	1	1

In a second step the preferred matching and scalability over with different categories of simulator was also assigned and a suggested, far from exhaustive, set of AIDE design scenarios was linked to each IVIS and ADAS mentioned in the rows. These results are reported in Table 10 below. More detailed examples are described in the following Chapter 4.

Table 10. Suggested simulator category and AIDE design scenario for each ADAS/IVIS

		Scalability over types of simulators							Vehicle on the road	Examples of AIDE driving scenarios
		A	B	C	D	E	F	G		
IVIS:										
Navigation Systems		LS	S	**P**	S	OD			S	1.5 or 2.1
Travelling/Traffic Related Information Systems		LS	S	**P**	S	OD			S	1.7 or 2.2
Vehicle Communication Systems		LS	S	**P**	S	OD			E	1.3 or 1.4
Driver Convenience Systems		S	S	**P**	S	OD			S (evtl. D)	1.2 or 1.6
ADAS:										
Lateral Control									S (evtl. D)	3.3
Lane Keeping and warning		LS	S	**P**	S	OD			S (evtl. D)	3.3
Blind spot monitoring		NS	NS	S	**P**	S			S (evtl. D)	3.3
Lane change and merge collision avoidance		NS	NS	LS	**P**	S			D	3.3
Longitudinal Control		S	S	S	**P**	S			S	3.3
Intelligent Speed Adaptation		NS	S	**P**	OD	OD			S	3.3
Road Low Friction Warning Systems		NS	NS	LS	**P**	S			T (S)	3.3
Reversing/Parking Aid		LS	S	S	S	S		**P**	S	3.3
Vision Enhancement		NS	NS	LS	LS	LS			S, T	3.1
Driver Monitoring		NS	NS	**P**	S	OD			D, T	2.3 or 2.4
Pre-Crash Systems		NS	NS	NS	LS	S		S	D, T	1.1
Vulnerable Road Users Protection Systems		LS	LS	LS	LS	LS	S	S	D, T	3.3

Legend for the **simulator**:
NS = not suitable (red field)
LS = less suitable (orange field)
S = suitable (pale green field)
P = preferable (bright green field)
OD = over-dimensioned (blue field)

Legend for the **road**:
S = suitable
D = dangerous
E = expensive
T = test track

It must nevertheless be recalled that these tables are far from being comprehensive and are only meant to support the actual design of test environments and protocols by pointing out to different issues and choice backgrounds.

Last but not least: no experiment is thoroughly designed without the accurate planning of a protocol including the subjects´ instructions. According to the different descriptions of the task and the purpose (including hidden hints) that can be given to the participants very different results can and will be obtained. The design of carefully worded instructions embedded in a controlled sets of interactions with the subject are a necessary ingredient to sound experimental design.

4. Scenario examples (AIDE Design scenarios from D3.1.2)

It is one of the main objectives of WP2.1 to generate the most appropriate scenarios under which IVIS/ADAS applications should function, in order to tune the most appropriate evaluation methods to them. Furthermore to develop a generic and cost efficient methodology for industrial human factors safety evaluation of integrated IVIS and ADAS.

As it was described in Chapter 2.5 the AIDE design scenarios target at illustrating conflict situations that the AIDE system is intended to solve. In this chapter we want to give an example for each of the fifteen AIDE design scenarios, involving as many different IVIS and ADAS interactions as possible (see the categorisation in Chapter 2.1), with the aim of supporting the development of actual evaluation protocols to be implemented in WP2.1.4 and later for the final testing of the AIDE demonstrators in SP4. In case the system to be assessed presents only reduced feature availability the systems reported in the examples can be exchanged with others of the same category. The generic format of the AIDE design scenario is again reported below.

AIDE design scenario An application action or a combination of application actions is/are initiated/in progress in a single or complex DVE condition Ci.
Flow of events This field is intended to quantify the precise nature of the conflict. If there are several possible flows of events leading to the conflict, they are described separately.
Action/s = {…}
Condition/s = {…}
Example : …

4.1 Conflicts between concurrent actions

In this paragraph we present examples for the six kinds of conflicts between concurrent actions. The scenarios proposed involve following systems:

- IVIS : NS, TIS, VCS, DCS
- ADAS : Lat, Lon, VE, PCS, VRU, RLF.

AIDE design scenario 1.1: Conflict between concurrent warnings **(ADAS)**
Action/s = {W + W}, where W = Warning indicating high traffic risk.
DVE Condition/s: DVE_1= LOW/NO (otherwise see 3.5), DVE_{2-4}=irrelevant Traffic/environment Risk (DVE_5)=HIGH.
Flow of events 1. W_1 is initiated 2. W_2 is initiated while W_1 is executing
Example *Conflict scenario:* The driver swerves out of the lane. The lane departure warning system gives a warning (**Lat**). However, at the same time, the vehicle ahead brakes suddenly, triggering the forward collision warning (**PCS**).

AIDE design scenario 1.2: Conflict between warning and driver initiated action **(ADAS/IVIS)**
Action/s = {W, D}, where W = Warning indicating high traffic risk D = User-initiated action (dialog or input).
DVE Condition/s: DVE_{1-2}=LOW/NO (otherwise see 3.3, 2.4,), DVE_{3-4}=irrelevant, Traffic/environment Risk (DVE_5)=HIGH.
Flow of events 1 1. D is executed by the driver 2. W is initiated while D is executed
Example: *Conflict scenario 1:* The driver is entering a new destination into the route guidance system, using an input device (**NS**). The input text is displayed in the head-up display (HUD). At the same time the vision enhancement system issues a visual warning in the HUD (**VE**). *Conflict scenario 2:* The driver is writing an SMS (**DCS**) while the pedestrian detection system detects a child moving towards the road and issues a warning (**VRU**)

AIDE design scenario 1.3: Conflict between warning and output message **(ADAS/IVIS)**
Action/s = {W, OP_i}, where i=1...3 W = Warning indicating high traffic risk OP_1 = Mandatory message **OR** important info related to the instant driving task OP_2 = Temporary info related to the driving task, requiring an action in the near future OP_3 = Permanent status-info related to the driving task, not requiring an action in the near future, **OR** output message related to the secondary task
DVE Condition/s: DVE_{1-3}=LOW/NO (otherwise see 2.x), DVE_4=irrelevant, Traffic/environment Risk (DVE_5)=HIGH.
Flow of events 1 1. OP_i is initiated by an application 2. While OP_i is executing, W is initiated
Example: *Conflict scenario:* A traffic announcement is initiated by the TMC application by means of voice (**TIS**). However, while the message is playing, an acoustic take over request from ACC is issued (**Lon**).
Flow of events 2 1. W is initiated 2. OP_i is initiated while W is executing
Example: *Conflict scenario:* The road low friction warning application issues a sound warning (**RLF**). While the warning is "played", an incoming phone call is initiated (**DCS**).

AIDE design scenario 1.4: Conflict between a driver-initiated action and an important output message (OP_1) **(IVIS/ADAS)**
Action/s = {D, OP_1}, where D = User-initiated action (dialog or input) OP_1 = Mandatory message **OR** important info related to the instant driving task
DVE Condition/s: DVE_1=LOW/NO (otherwise see 3.4), DVE_{2-5}=irrelevant.
Flow of events 1 1. OP_1 is initiated and executed 2. The driver initiates D while OP_1 is executing. D requires I/O resources occupied by OP_1
Example: *Conflict scenario:* A route guidance information "turn right immediately" is presented both visually and as voice message (**NS**). Meanwhile, the driver begins to enter a new destination into the route guidance system, which is also normally displayed in the HUD (**NS**).
Flow of events 2 1. The driver executes D 2. While D is executed, OP_1 is initiated
Example: *Conflict scenario:* The driver is operating the climate system (**DCS**) when a visual and acoustic route guidance message "turn left immediately" is initiated (**NS**).

AIDE design scenario 1.5: Conflict between a driver-initiated action and an output message (OP_i,i>1) **(IVIS/IVIS)**
Action/s = {D, OP_i}, where i=2, 3 D = User-initiated action (dialog or input) OP_2 = Temporary info related to the driving task, requiring an action in the near future OP_3 = Permanent status-info related to the driving task, not requiring an action in the near future, **OR** output message related to the secondary task
DVE Condition/s: DVE_1=LOW/NO (otherwise see 2.1), DVE_{2-5}=irrelevant.
Flow of events 1 1. OP_i is initiated and executed 2. The driver initiates D while OP_i is executing. D requires I/O resources occupied by OPi
Example: *Conflict scenario:* The TMC application outputs a traffic announcement in the HUD and as a voice message (**NS**). Meanwhile, the driver begins to enter a new destination into the route guidance system, which is also usually displayed in the HUD (**NS**).
Flow of events 2 1. The driver executes D 2. While D is executed, OP_i is initiated
Example: *Conflict scenario1:* The driver is operating the climate system (**DCS**) when a route guidance message is initiated (**NS**). Conflict *scenario 2:* The driver is entering a new destination into the route guidance system (**NS**) when a washer fluid message is initiated, which competes for the same display (**VCS**).

AIDE design scenario 1.6: Conflict between two output messages **(IVIS/IVIS)**
Action/s = {OP_i, OP_j}, where i=1...3, j=1..3 OP_1 = Mandatory message **OR** important info related to the instant driving task OP_2 = Temporary info related to the driving task, requiring an action in the near future OP_3 = Permanent status-info related to the driving task, not requiring an action in the near future, **OR** output message related to the secondary task
DVE Condition/s: $DVE_{1,2,3,5}$=LOW/NO (otherwise see 2.x or 3.1), DVE_4=irrelevant.
Flow of events 1 1. OP_i is executed 2. OP_j is initiated
Example: *Conflict scenario:* A route guidance message is given (**NS**). While the message is executed, an incoming phone call is initiated (**DCS**).

4.2 Conflicts between one action and DVE conditions

In this paragraph we present examples for the four kinds of conflicts between one action and Driver-Vehicle-Environment conditions. The scenarios proposed involve following systems:

- IVIS : NS, DCS
- ADAS : Lon, ISA, PCS.

AIDE design scenario 2.1: An output message is initiated in a demanding driving situation
Action/s = {OP_i}, where i=1...3 OP_1 = Mandatory message **OR** important info related to the instant driving task OP_2 = Temporary info related to the driving task, requiring an action in the near future OP_3 = Permanent status-info related to the driving task, not requiring an action in the near future, **OR** output message related to the secondary task
DVE Condition/s: Driving Demand (DVE_1)=HIGH, DVE_{2-5}=LOW/NO.
Flow of events 1 1. DVE_1 turns from LOW to HIGH 2. OP_i is initiated 3. DVE_1 turns from HIGH to LOW
Example: *Conflict scenario:* The driver enters a busy intersection. While negotiating the inter-section, a phone call is received (**DCS**).

AIDE design scenario 2.2: An important output message (OP_1) is given while driver is distracted.
Action/s = {OP_1}, where OP_1 = Mandatory message **OR** important info related to the instant driving task
DVE Condition/s: Driver Distraction (DVE_2)=HIGH, $DVE_{1,3-5}$=LOW/NO.
Flow of events 1 1. DVE_2 turns from LOW to HIGH 2. OP_1 is initiated 3. DVE_2 turns from HIGH to LOW
Example: *Conflict scenario:* A message notifying the driver for over-speeding (**ISA**) has to be presented while the driver is visually distracted by an external event.

AIDE design scenario 2.3: An important output message (OP_1) is given while driver is tired and drives in high risk situation (e.g. during night).
Action/s = {OP_1}, where OP_1 = Mandatory messages **OR** important info related to the instant driving task
DVE Condition/s: Traffic/environment Risk(DVE_5)=HIGH, Driver Fatigue (DVE_3)=HIGH, $DVE_{1,2,4}$=LOW/NO .
Flow of events 1 1. DVE_5 is HIGH and DVE_3 turns from LOW to HIGH 2. OP_i is initiated
Example: *Conflict scenario:* The driver is tired and travels on a highway during night and/or with fog (DVE_5=HIGH) when a route guidance information "turn left immediately" is given from the navigation system (**NS**).

AIDE design scenario 2.4: Warning is given while driver is distracted or tired
Action/s = W where W = Warning indicating high traffic risk.
DVE Condition/s: Driver Distraction (DVE_2)=HIGH OR Driver Fatigue (DVE_3)=HIGH , $DVE_{1,4\text{-}5}$=LOW/NO
Flow of events 1 1. Driver Distraction=HIGH OR Driver Fatigue=HIGH 2. W is initiated
Example: *Conflict scenario:* The driver is looking at a roadside commercial sign. While visual attention is directed towards the sign, the lead vehicle brakes suddenly and a forward collision warning is initiated (**PCS, Lon?**).

4.3 Conflicts between multiple actions and DVE conditions

In this paragraph we present examples for the five kinds of conflicts between multiple actions and Driver-Vehicle-Environment conditions. The scenarios proposed involve following systems:

- IVIS : NS, TIS, VCS, DCS
- ADAS : Lat, Lon, VE, ISA.

AIDE design scenario 3.1: Multiple output messages (OP_i, i>1) are presented in a demanding situation
Action/s = {OP_i, OP_j}, where i=2...3, j=2...3 OP_1 = Mandatory message **OR** important info related to the instant driving task OP_2 = Temporary info related to the driving task, requiring an action in the near future OP_3 = Permanent status-info related to the driving task, not requiring an action in the near future, **OR** output message related to the secondary task
DVE Condition/s: Driving Demand (DVE_1)=HIGH, DVE_{2-5}=LOW/NO
Flow of events 1 1. Driving Demand turns from LOW to HIGH 2. OP_i is initiated 3. OP_j is initiated 4. Driving Demand turns from HIGH to LOW
Example: *Conflict scenario:* The driver enters a busy intersection. While negotiating the intersection, information from the traffic information system (**TIS**) and a meeting reminder from the PDA Calendar (**DCS**) application are received.

AIDE design scenario 3.2: Multiple important output messages (OP_1) are presented in a demanding situation
Action/s = {OP_1+ OP_1}, where OP_1 = Mandatory message **OR** important info related to the instant driving task
DVE Condition/s: Driving Demand (DVE_1)=HIGH, DVE_{2-5}=LOW/NO.
Flow of events 1 1. Driving Demand turns from LOW to HIGH 2. OP_i is presented 3. OP_j is presented 4. Driving Demand turns from HIGH to LOW
Example: *Conflict scenario:* The driver enters a busy intersection. While negotiating the intersection a “turn left immediately” advice (**NS**) and an indication of high water temperature are received (**VCS**).

AIDE design scenario 3.3: Conflict between a driver initiated action and a warning in critical driving situation
Action/s = {D+W}, where D = User-initiated actions (dialogs or inputs) W = Warning indicating high traffic risk
DVE Condition/s: Traffic/Environment Risk (DVE_5)=HIGH, DVE_{1-4}=LOW/NO
Flow of events 1 1. Traffic/Environment Risk turns from LOW to HIGH 2. Driver starts executing D 3. W is initiated 4. Traffic/environment Risk turns from HIGH to LOW
Example: *Conflict scenario:* Driver is tired and travels in a highway. While the driver is in the middle of a phone call conversation (**DCS**) he/she drifts out of the lane (**Lat**) while an approaching vehicle is detected from the blind spot camera (**VE?**).

AIDE design scenario 3.4: Conflict between a driver-initiated action and an important output message (OP_1) in a demanding situation
Action/s = {D, OP_1}, where D = User-initiated actions (dialogs or inputs) OP_1 = Mandatory messages **OR** important info related to the instant driving task
DVE Condition/s: Driving Demand (DVE_1)=HIGH, DVE_{2-5}=LOW/NO
Flow of events 1 1. OP_1 is initiated and executed 2. The driver initiates D while OP_1 is executing. D requires I/O resources occupied by OP_1
Example: ...while driving in a high traffic density zone: *Conflict scenario:* A route guidance information "turn right immediately" (**NS**) is presented visually and as a voice message. During this, the driver wants to initiate a phone-call (**DCS**).
Flow of events 2 1. The driver executes D 2. While D is executed, OP_1 is initiated
Example: *Conflict scenario1:* The driver is operating the climate system (**DCS**) when route guidance message "turn left immediately' is initiated (**NS**). *Conflict scenario 2:* The driver is entering a new destination into the route guidance system (**NS**) when an indication for high speed is initiated, which competes for the same display (**ISA**).

AIDE design scenario 3.5: Conflict between concurrent warnings (ACC, LDW) when driver's intention to perform a manoeuvre is detected
Action/s = {W + W}, where W = Warning indicating high traffic risk.
DVE Condition/s: $DVE_{1,2,3}$=LOW/NO, Traffic/Environment Risk (DVE_5)=HIGH, Driver Intent (DVE_4)= YES
Flow of events 1. W_1 is initiated 2. W_2 is initiated while W_1 is executing
Example *Conflict scenario:* The driver receives an ACC take over request (**Lon**) and in order to avoid the heading vehicle swerves out of the lane. The lane departure warning system wants to initiate a warning (**Lat**).

5. Results from other projects (HASTE & COMUNICAR)

In the following we report some results from two other projects that have focused on assessment methodologies and user centred design of IVIS and ADAS as they can offer both theoretical hints and some experimental findings that can easily be integrated in the AIDE perspective. Similar consortia, similar systems and approaches allow questions as well as findings to serve as transferable outline.

5.1 The HASTE project

While AIDE concentrates on the adaptive and integrated aspects of IVIS and ADAS, the aim of HASTE (Human Machine Interface And the Safety of Traffic in Europe) was to develop assessment methodologies and guidelines focusing on IVIS with the intention of devising an assessment regime that could be independent of the design of the IVIS itself. The assessment regime would rather be based on an evaluation of driving performance while using the system as compared with driving performance when not using the system (baseline driving) with particular stress of following aspects:

- Is technology-independent;
- Has safety-related criteria;
- Is cost effective;
- Is appropriate for any system design; and
- Is validated through real-world testing.

The impact of IVIS task load on driving performance was investigated, addressing various levels of cognitive and visual load separately. Surrogate IVIS (S-IVIS) were implemented for the testing environments & protocols.

In spite of the different scope the purpose of HASTE was very similar to the one of SP2 in AIDE, i.e. to identify the advantages and disadvantages of the different assessment methods (laboratory, simulator, field), and finally to identify which road types and scenarios are the most productive for testing IVIS. Different groups of drivers were used and scenarios varied in accordance with the protocol and procedure for safety assessment of IVIS as outlined in HASTE Deliverable 1.

The effect of IVIS use in three distinct road categories — urban, rural, and motorway — was investigated. To do this, a total of 14 separate driving simulator experiments were conducted, with each participant experiencing only one type of S-IVIS. All seven driving simulators were used to investigate driving with both S-IVISs on a common rural road. For the most part, each simulator road type had three levels of difficultly with the most difficult being driving when some critical event was triggered (the motorway had only two levels of difficulty: without and with events). For the field (real road) studies, both types of S-IVIS were included in the drives for each participant, with the order of S-IVIS tasks counterbalanced. The three field studies used different combinations of the road types and all roadway types were completed in a single session.

The overall number of experiments, both simulator and field, was 17. A total of 527 participants were used, in different age cohorts ("average" vs. elderly) as well as different nationalities (Portuguese vs. UK drivers).

A large number of indicators of driving performance, particularly related to longitudinal and lateral control, were collected. Also collected was information on secondary task performance (acting as the Surrogate IVIS), both static (not driving) and dynamic (whilst driving). The indicators can be classified into:

- Self-reported driving performance
- Lateral control
- Longitudinal control, i.e. control of speed and distance to a lead vehicle
- Workload, such as physiological measures and gaze behaviour
- Expert observations of driving performance

Following the analysis of this data, a meta-analysis was carried out to compare the various studies and to identify the most effective indicators. This meta-analysis was intended to single out the most powerful scenarios and to assist in showing which indicators could be dispensed with in subsequent work. These results could be compared with the outcomes of AIDE SP2 and especially the test series that will be performed within WP 2.1.4.

We report here the main results of the project:

S-IVIS Type: The two types of S-IVIS had quite different effects on driving performance:

- The visual task had pronounced effects in terms of steering and lateral behaviour as increased distraction leads to problems in lateral control.
- The cognitive task instead caused reduced lateral deviation: it "improved" steering behaviour with increased glance frequency focussed on the road ahead, at the expense of the periphery. At the same time there were indications in some of the results that the predominant negative effect of the cognitive task on driving performance was on longitudinal control in car following.

S-IVIS level: Drivers were not always able to manage the trade-off between primary and secondary task, and there were many indications of driving performance being poorest when the secondary task demand was the highest. The elderly drivers were particularly poor at this task management.

Static S-IVIS Performance vs. Dynamic Performance: Static testing cannot predict how an IVIS will affect steering behaviour or interaction with other road users as static performance did not reliably predict dynamic performance: a driving context is required in assessing an IVIS.

Simulator vs. Field: The field studies tended to pick up somewhat different effects of the systems than the simulator studies providing additional information. Moreover, it was not possible to test elderly drivers in the simulator with the visual task due to motion sickness. This shows the value of the field tests, but also suggests the development of some additional scenarios or tasks in the simulator roads that can provide analogous information. There may also be scope for the inclusion of peripheral detection tasks (PDT) in the driving task, in order to gain a better understanding of drivers' ability to assimilate information in the periphery, which is crucial to safety.

Simulator Type: The broad conclusion is that the type of simulator or laboratory used in the assessment did not have an effect. This does not have to be necessarily the case for more complex ADAS or for special kinds of cohorts.

Road Category:

- In the simulator studies, the rural road was the most diagnostic and the motorway the least diagnostic, i.e. the effect sizes from the rural road were generally larger. The urban road did not pick up any additional information that was not provided by the rural road.
- In the field studies with the cognitive task, the motorway produced the only indicator with a consistent effect.

Road Level: Road difficulty level is an important factor but the easiest level of the road can be dispensed with.

"Average" vs. Elderly Drivers: The findings have confirmed the hypothesis proposed in HASTE Deliverable 1, that there would be severe problems for elderly drivers exhibiting very risky behaviour in using IVIS while driving, particularly at higher levels of task demand.

UK vs. Portugal: The controlled comparison of the British and Portuguese showed the expected effect: the Portuguese drivers exhibited riskier driving behaviours but with just as reliable results as those obtained with drivers from northern Europe.

The results also confirm the value of using a very large number of indicators. Some of these indicators have turned out to be non-diagnostic and therefore can be abandoned in the next phase of the project. Others have turned out to be superfluous in that what they reveal overlaps with the diagnosis provided by other indicators. The meta-analysis has helped to sift through the indicators and test environments to identify the most powerful ones.

Following driving performance measures were found to be mandatory for a proper system assessment:

- Vehicle speed
- Vehicle speed variation (standard deviation of speed)
- Vehicle lateral position
- Vehicle lateral position variation (standard deviation of the above)
- Lane departure (in percentage of time)
- Time to line crossing
- Steering wheel reversal rate

- Time to collision, Time headway, Distance headway
- Brake reaction time
- Observer rating (yielding behaviour, speed choice).

Moreover, some performance measures were indicated as optional:

- Speed change (while attending the IVIS)
- Steering angle variation (standard deviation of steering angle)
- High frequency components of steering wheel angle variation (0.3-0.6 Hz)
- Rapid steering wheel turning
- Steering entropy
- Abrupt onset of brakes.

For the workload assessment four measures were found mandatory:

- Self reported driving performance
- Glance frequency
- Glance duration
- IVIS task performance, including
    - reaction time,
    - correct responses,
    - missed responses and
    - false responses.

Two physiological measures were listed as optional:

- Inter-beat intervals and heart rate variability
- Skin conductance (level and variation).

Although restricted to IVIS the very valuable findings of HASTE offer a good starting point for the AIDE investigations. It will be of special interest to compare their results with the ADAS and especially the adaptive / integrated environment of the AIDE demonstrator.

5.1 The COMUNICAR project

The COMUNICAR project (COmmunication Multimedia UNit Inside CAR) was focused on the design, development and evaluation of an easy to use Multimedia Human Machine Interface (HMI) that is able to manage all the information exchanges between the driver and the vehicle according to the driving conditions and the driver's activity. For this purpose a User Centred Design approach was adopted consisting of three main steps:

1. Virtual prototype design phase and laboratory test
2. Tests in a driving simulator

3. Tests in real cars on the road in Sweden and Italy

All three steps have been described extensively in separate deliverables. We report here only a short description of the main results and conclusions regarding the performance of the Information Manager (that part of the Human Machine Interface that prioritises and postpones messages to the driver in order to avoid driver overload) and regarding the User Centred approach.

In general, it is concluded that the User Centred Design approach works very well in the design and test cycle of an in-vehicle HMI. It is, however, not very useful to describe in great detail all the test procedures and experimental set-ups, because these will be changed continuously during the process.

With respect to the IM and its effects on traffic safety, a positive impact was expected through the decrease of the information overload and the driver's workload during the driving task. But despite the high plausibility of the advantages of information management, it was difficult to demonstrate its efficiency in an experimental laboratory set-up, as the subjective data (ratings on workload) provided no evidence in favour of information management.

Nevertheless it could be shown from indirect measures that driver workload did decrease when presenting information to the driver that is managed by this system with a positive effect on traffic safety but only when the situation for the driver becomes critical (i.e. already a high workload situation): in other words, the system will only seldom have an opportunity to demonstrate its advantages. This result implies a special attention to the process of scenario design in the AIDE project for the purpose of sensitivity enhancement.

Demonstrating effects of rare events is generally difficult in empirical research with human subjects because it either takes an unacceptable long testing time or - if presented with higher frequency, like in the COMUNICAR case - the events might induce special strategies by the drivers.

This idea is also supported by results of the simulator tests where the COMUNICAR team found evidence that the RSME data might be prone to biases by memory effects (see Hoedemaeker et al., 2003). The Driving Quality Scale (DQS) data from both the Swedish and the Italian study also showed an interaction with the order of the drives. Implications of these results are mainly methodological in nature and might define some restrictions on the use of subjective measurements of workload and driving behaviour that should be taken into account in the AIDE assessment process as well.

The COMUNICAR design process was based both on the tight co-operation of experts coming from different fields (Human Factors, Communications, Virtual Prototyping, Automotive engineering, Computer science) as well as on the involvement of the final users from the early design stages.

A User Centred Design (UCD) approach has been followed so to assure the compliance between the innovation of the technological solution identified, the user needs and the acceptance issues. More than 100 users coming from three different

European countries (Germany, Sweden and Italy) tested the system on different road types and driving scenarios.

The iterative design cycle can be considered a significant achievement for the COMUNICAR project as it proved to be very effective in the adjustment and improvement of the Interactive HMI (I-HMI) and the IM on the basis of the results of the previous stages. Moreover it was adapted to the specific needs of the automotive domain: test techniques and software tools have been targeted and grouped into the adopted methodology, therefore the whole design cycle.

However, writing the so called validation plan, in which all the details of the tests in all three stages had to be defined at a very early stage of the project, turned out to be not very useful. Because of the growing insights during the project and the, mostly practical, decisions that had to be taken, the validation plan suffered from severe losses of relevance during the course of the project.

Two distinct areas of prototyping were covered, the first concerning the adequate integration of driver assistance systems at the warning level (collision warning, lane departure warning, and so on) while the second addressed all other integrated functions (e.g. navigation and traffic information, mobile communication and entertainment functions). The latter was covered by two comprehensive alternative solutions, the Visual and the Haptic Prototype.

User needs analysis and state-of-the-art studies helped the design team to gather useful information for the first concepts design and rapid prototyping tools have been used for the implementation of the virtual prototypes to be evaluated during the laboratory tests. The virtual prototypes of the multimedia HMI have been tested in two rounds of laboratory experiments, the pre-tests and the main lab tests. The pre-tests were carried out as desktop experiments using the virtual prototypes together with commodity hardware and also with special interaction devices with haptic feedback. The main tests were performed in a simulator environment.

The real prototypes designed according to the results of the laboratory tests have been assessed again in the DaimlerChrysler fixed-base driving simulator. A number of important results concerning the functioning and the impact of the IM and I-HMI in simulated traffic conditions have been gathered. The second redesign stage led towards the identification and the development of the final prototypes. The final demonstrators have been tested in real driving conditions, both in Italy and in Sweden and post test questionnaires have been filled by more than 60 users.

Through the UCD approach, the prototypes of the I-HMI have been improved avoiding any discrepancy between the concepts development and the users´ needs. Moreover, the rules defined for the Information Manager have been validated in order to assess the expected benefits on the on-road safety.

The Laboratory Tests had special emphasis on:

- acceptance,
- willingness,
- task execution,

- HMI,

while the Driving simulator Tests focused on:

- safety enhancement,
- workload reduction under controllable conditions.

Finally the On-Road Tests analyzed

- usability,
- workload and
- safety in real driving situations.

From the methodological point of view the iterative test approach can be transferred to the AIDE project remembering that different aspects can be best dealt with in different settings. The problem of calibrating the DVE conditions for the effective testing of integrate and/or adaptive systems is very well exemplified by the COMUNICAR experiments.

6. Further remarks and link to WP2.1.4

As “closing” remarks for a very open field we would like to hint to other issues that could not be integrated in the relevance table or in other chapters but nevertheless play a key role in test design and in the development of an assessment protocols could be formulated as open questions.

It is of primary importance to choose and define the relevant parameters in each test since they determine the design of test environment and scenario.

Furthermore, in the context of a European project and in general within an international context, cultural or country-based specific driving behaviours must be taken into account because it could influence the test protocol, e.g. the speed choice, the degree of subjective risk that is considered acceptable.

On top of the special focus of AIDE on adaptivity and interaction, exemplified by the conflicts in the AIDE design scenario, there are several aspects and criteria for the evaluation of IVIS/ADAS that might be addressed, each of them requiring a different approach and “baseline” to compare with and a proper definition before the experimental plan can be devised. We give here a short list of what issues might be addressed:

- the “successful” USE of a system,
- the question of MISUSE,
- the learning curve for new systems,
- the system understanding by the driver,
- the effects of the system on traffic in general (safety, density, …) according to penetration degree (e.g. dynamic navigation: what happens to alternative routes if every car is redirected?),
- the effects of the system on the individual driving behaviour,
- the portability of the use experience between different IVIS/ADAS categories,
- system limitations and/or system failures,

These and many other issues will guide the choice and design of experiments to be conducted in WP2.1.4 with the parallel aims of getting insight in the AIDE systems and at the same time a better assessment of the evaluation methodology itself.

Conclusions

The main objective of this document was to present a review of issues relevant to the field of testing environments (scenarios, simulators and/or driving environments, cohorts, use cases,…). It represents an organized summary of findings and knowledge from other projects (HASTE and COMUNICAR), from other WP and Deliverables within AIDE as well as original work centred on the development of test scenario, their building blocks and the requirements of the environment.

The next step will involve a choice of examples to be assessed and validated within WP2.1.4. These outlines will just as well serve as general guidelines for the investigation of the AIDE system prototype as a whole (WP2.4), after integration with the appropriate definition of risk (WP2.3) and of subjective rating (WP2.2).

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