

# Global evaluation methodology

SP 2.1 work description

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# SP 2 General organization



TOWARDS FUTURE AUTOMOTIVE HMI

AIDE final workshop and exhibition April 15-16, 2008, Gothenburg

## SP 2

to develop a cost efficient and industrially applicable methodology for quantifying behavioural effects of IVIS and ADAS functions, and their relation to road safety

### SP 2.1

#### Generic evaluation methodology

To develop a generic and cost efficient methodology for industrial human factors safety evaluation of integrated IVIS and ADAS.

#### Approach

The methodology developed should specify **methods, tools, scenarios** as well as guidelines and how and when apply them

### SP 2.2

#### Workload and Distraction assessment method and tools

While WP2.1 will focus on the development of a general evaluation and assessment methodology, WP2.2 will focus on specific methods and tools for workload and distraction measurement, to be incorporated into the general methodology

### SP 2.3

#### Estimating the risk reduction potential of Integrated Adaptive HMI

The objective of this WP is to develop methods for extrapolating from behavioural effects of IVIS and ADAS (e.g. the workload and distraction metrics developed in WP2.2), to actual road safety

## 2.1 Cookbook

To provide a detailed guide that allows readers to develop and apply an appropriate evaluation methodology of integrated as well as non - integrated ADA/IVI Systems.

## 2.4 Prototype evaluation

To perform the final evaluation of the three AIDE prototype vehicles developed in SP3. The main objective is to assess the AIDE concept with respect to its potential safety-enhancing effects (compared to non-integrated, non-adaptive IVIS and ADAS and driving with no IVIS/ADAS at all).



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# SP 2.1 Preparatory tasks



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Which evaluation methods and tools are present in literature?

2.1.1

## Review of existing tools and methods

The aim is to collect methodologies for the evaluation of **usability** and **acceptability** of IVIS/ADAS in-vehicle applications during **different steps of system development**

Which IVI and ADA systems were developed until now?

2.1.2

## Review and taxonomy of IVIS/ADA applications

The main objective is to carry out a reasoned analysis of the IVIS (In Vehicle Information System) and ADAS (Advanced Driver Assistance System) applications in order to organize them in several categories

Which typology of scenario could be applied to different type of IVI/ ADA systems

## 2.1.3 Scenario development

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.).



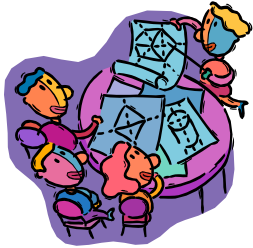
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# Output 2.1.1: Review of existing tools and methods



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The state of the art of the methodologies used to evaluate IVIS and ADAS applications was collected. In particular, this activity focused mainly on techniques **used to estimate user mental model, usability and acceptability**. This work is strictly linked with 2.2.1 (focused on Workload) work and they are the starting point to define a common framework of tools and methods in order to conduct behavioural and usability evaluations of IVI / ADA systems and integrated ones.



The work provided an exhaustive overview about:

- The design cycle based on the **User-Centred Design**, the starting point to develop usable systems, prone to be positively accepted by final user;
- Specific dimensions, important to the Design Cycle, as User Mental Model, Usability, Acceptance, Subjective Workload, Situation Awareness.
- Relative methods and techniques to evaluate these dimensions, beyond experimental description and main results;

At the end, it was derived :

- A list of dimension to take into consideration during a behavioural test. The dimensions are grouped on the basis of different modalities of interactions;
- Step-By-Step procedure for Test Design considering different phases of system development.



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## Output 2.1.3: Scenario development



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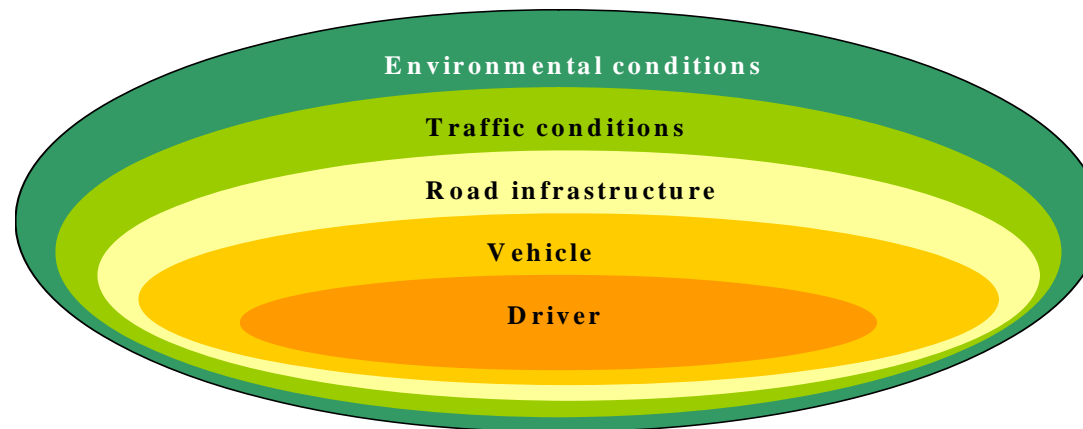
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The work focused on the “building blocks” of scenario development including considerations on simulator and cohort choices.

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

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

The general scope is support 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.



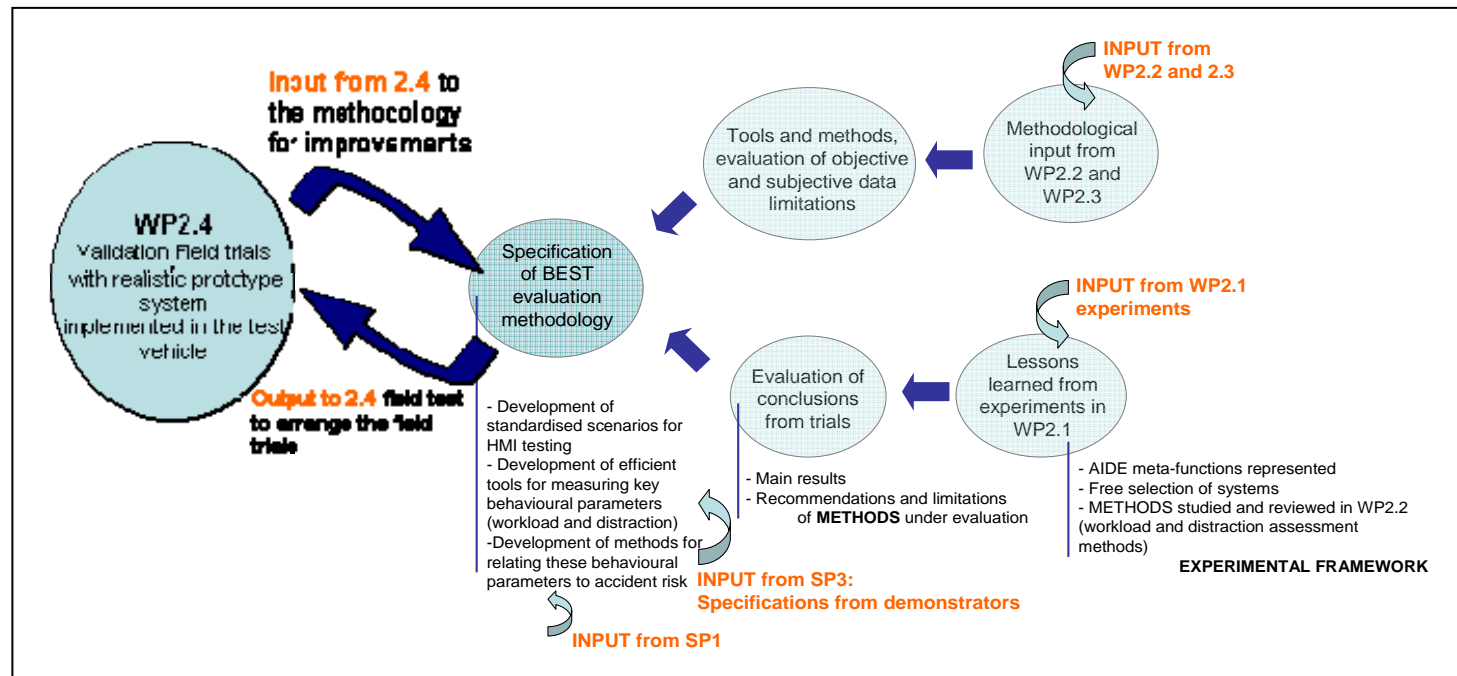
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# Sp 2.1.4 the operative task



The previous revision tasks and experimental studies carried out in 2.1, 2.2 and 2.3 tasks were used to select the best methodologies and tools for the evaluation of INTEGRATED and ADAPTIVE system



# Sp 2.1.4 the operative task



## Four outputs

- a description of **several experimental studies** to test systems, scenario, methods and tools provided by previous review tasks (partners involved were REGIENOV, HIT/ CERTH study; USTUTT, BMW, BOSCH, TNO)
- An **exhaustive questionnaire** with the aim to measure different dimensions of usability and acceptability (partner involved was CRF)
- A **cookbook**: a chapter that suggests specific steps that should be followed to define the evaluation procedure of the AIDE final demonstrators in WP2.4 (Prototype evaluation). However, the AIDE cookbook is general enough to be successfully applied to other evaluation demands that are not directly linked to the AIDE project (partners involved were TNO, BMW, CIDAUT, CRF)
- **Transformation of behavioural/driver state data to risk**



# Sp 2.1.4: CRF questionnaire



CRF developed a subjective tool:

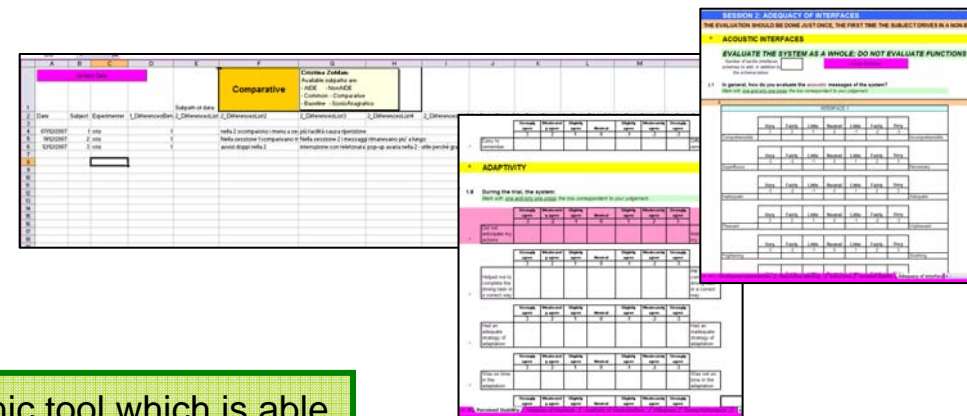
- **as general as possible**, in order to apply it to different systems both adaptive and not adaptive;

- focused on **the aspects** that seem to be **important to understand whether a system could be acceptable by potential final users** and therefore successful on the market;

- **with a modular structure**, divided in different sub-dimensions which can be applied totally or partially, accordingly to the specific analysed system.

The sub-dimensions explored are

- **Perceived usability**
- **Adequacy** of different modalities (visual, haptic, auditory)
- **Perceived Utility**
- **Perceived Safety**
- **Reflective Dimensions**



The questionnaire was implemented as an electronic tool which is able to automatically collect and organize data. The organized data can be easily imported into several statistical tools (i.e. SPSS)

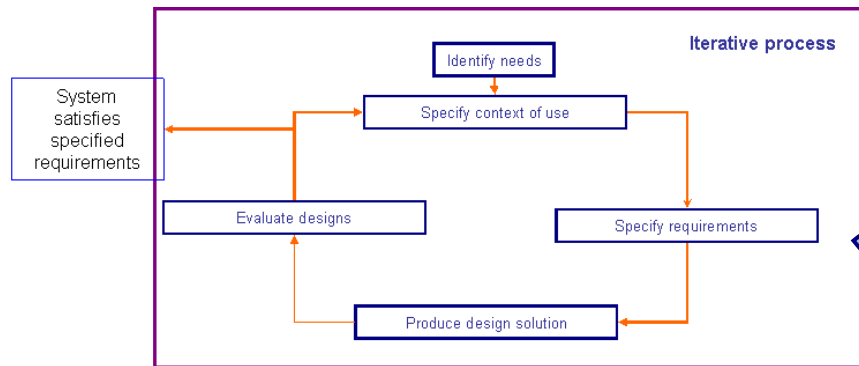


# Sp 2.1.4: the cookbook

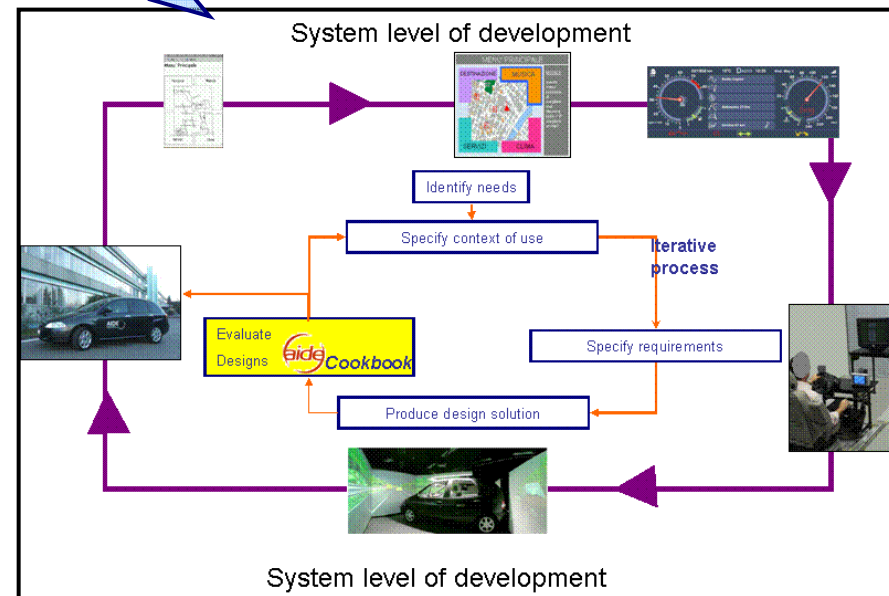
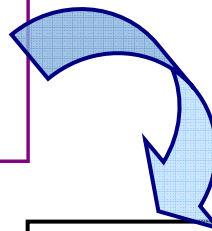


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The UCD process



AIDE Cookbook in the UCD process



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# Sp 2.1.4 The Cookbook



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The aim is to provide a detailed guide that allows to develop and apply an **evaluation methodology** with end-users of integrated as well as non- integrated ADA/ IVI Systems.

All the results of the research carried out within AIDE SP2 are used here to **create a practical instrument for Human Factor experts to develop an evaluation methodology** able to maximize the different types of validity and the reliability

## *The cookbook describes the following steps to carry out the evaluation:*

- To define the aims of the evaluation
- To describe the system to be evaluated
- To define a scenario
- To define the subject sample
- To define subjective and objective parameters and instruments to collect them
- To define the experimental design
- To develop experimental instruction both for participants and for experimenters
- To finalize the experimental set-up
- To carry out the experiment
- To analyse the data
- To produce summary indications about the system



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# Sp 2.1.4 The Cookbook: an example the first step



- To define the aims of the evaluation

System level of development	Paper mock-up (only for initial development phases)		Bench Prototype (simulated on a PC computer or with its own display and junction box);		Simulated prototype		On-Board prototype		Final on-board system already on the market;	
	IMS	ADAS	IMS	ADAS	IMS	ADAS	IMS	ADAS	IMS	ADAS
Usability evaluation first impact	Suitable for		Quite Suitable	Quite Suitable	Preferable	Suitable/Preferable	Preferable	Suitable/Preferable	Suitable	Suitable
	Effective	Not suitable	Effective	Effective	Effective	Effective	Effective	Effective	Effective	Effective
	Efficient		Efficient	Efficient	Efficient	Efficient	Efficient	Efficient	Efficient	Efficient
	Error Tolerant		Error Tolerant	Error Tolerant	Error Tolerant	Error Tolerant	Error Tolerant	Error Tolerant	Error Tolerant	Error Tolerant
	Easy to Learn		Easy to Learn	Easy to Learn	Easy to Learn	Easy to Learn (first impact)	Easy to Learn (first impact)	Easy to Learn (first impact)	Easy to Learn (first impact)	Easy to Learn (first impact)
Not suitable for		Not suitable	Not suitable	Adaptivity (first impact)	Adaptivity (first impact)	Adaptivity (first impact)	Adaptivity (first impact)	Adaptivity (first impact)	Adaptivity (first impact)	
Engaging		Engaging	Engaging		It depends on the scalability of simulator					
Adaptivity		Adaptivity	Adaptivity			it could be dangerous	it could be dangerous	it is expensive to obtain objective logging data. it could be dangerous	it is expensive to obtain objective logging data. it could be dangerous	
Usability evaluation long term	Not suitable	Not suitable	Not suitable	Not suitable	Suitable	Suitable	Preferable	Suitable/Preferable	Suitable	Suitable/less suitable
					Effective	Effective	Effective	Effective	Effective	Effective
					Efficient	Efficient	Efficient	Efficient	Efficient	Efficient
					Engaging	Engaging	Engaging	Engaging	Engaging	Engaging
					Error Tolerant	Error Tolerant	Error Tolerant	Error Tolerant	Error Tolerant	Error Tolerant
				Easy to Learn (deeper learning)	Easy to Learn (deeper learning)	Easy to Learn (deeper learning)	Easy to Learn (deeper learning)	Easy to Learn (deeper learning)	Easy to Learn (deeper learning)	
				Adaptivity (deeper learning)	Adaptivity (deeper learning)	Adaptivity (deeper learning)	Adaptivity (deeper learning)	Adaptivity (deeper learning)	Adaptivity (deeper learning)	
						it could be dangerous	it could be dangerous	it is expensive to obtain objective logging data, it could be dangerous	it is expensive to obtain objective logging data, it could be dangerous	
Workload and safety evaluation (first impact)	Not suitable	Not suitable	Not suitable as no primary task exists	Not suitable as no primary task exists	Preferable	Suitable/Preferable	Preferable	Suitable	Suitable	Suitable/Less suitable
					Both subjective and objective parameters	Both subjective and objective parameters	Both subjective and objective parameters	Both subjective and objective parameters	Good for subjective parameters and visual behaviour.	Good for subjective parameters and visual behaviour.
						It depends on the simulator scalability	It could be dangerous	It could be dangerous	Difficult for objective parameters	Difficult for objective parameters. It could be dangerous
Workload and safety evaluation (long term)	Not suitable	Not suitable	Not suitable as no primary task exists	Not suitable as no primary task exists	Less Suitable	Less Suitable	Preferable	Suitable/Preferable	Suitable	Suitable
					Both subjective and objective parameters	Both subjective and objective parameters	Both subjective and objective parameters	Both subjective and objective parameters	Good for subjective parameters and visual behaviour.	Good for subjective parameters and visual behaviour.
					It depends on the simulator scalability	It depends on the simulator scalability	It could be dangerous	It could be dangerous	Difficult for objective parameters	Difficult for objective parameters. It could be dangerous
Acceptability evaluation	Not suitable		Not suitable	Not suitable	Less suitable	Less suitable	Preferable	Preferable	Preferable	Preferable
					It depends on the scalability of simulator	It depends on the scalability of simulator				

use the following table organized for level of system development vs. aim of evaluation



## Sp 2.1.4 The Cookbook: its characteristics



1. it is **GENERAL** as it can be applied to different systems, with different level of development, both IVI and ADA;
2. it is a **phase of the UCD**;
3. it is focused on **EVALUATION phase** and not on the initial requirement phase;
4. it is an evaluation that requires **END-USERS** involvement.;
5. it allows to evaluate **USABILITY, ACCEPTABILITY, WORKLOAD and SAFETY** dimensions;
6. it provides a **number of subjective and objective measurements** to evaluate the impact of these dimensions;
7. it provides a method to collect data that can be used by technicians and designers to **improve prototypes and/ or products**;
8. It provides **a modular questionnaire** able to evaluate different perceived aspects listed in point 5.



# CONCLUSIONS



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- The Global Evaluation Methodology allowed to developed a number of steps necessary to be made for setting up, conducting and analysing an experiment on HMI evaluation.
- This test protocol can decrease the costs of the final validations of this kind of systems since the time to market can be reduced. Moreover, this protocol could help to focus the attention in the important aspects when testing the prototypes with real drivers
- This method was applied finally in the final exploitation of the three AIDE demonstrators.
- Further improvements of cookbook could come from three AIDE demonstrators studies



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