

Integrated Human Modelling and Simulation to support Human Error Risk Analysis of Partially Autonomous Driver Assistance Systems



March 2010

Number 1

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PROJECT OVERVIEW

The main objective of ISI-PADAS project is to provide an innovative methodology to support risk based design and approval of Partially Autonomous Driver Assistance Systems (PADAS) focusing on elimination and mitigation of driver errors by an Integrated Driver-Vehicle-Environment (DVE) modelling approach.

ISI-PADAS produces innovations on four complementary research dimensions:

- Improved Risk Based Design
- Advanced Driver Modelling
- Joined Driver Vehicle Environment Simulation Platform
- New knowledge about driver behaviour including errors.

ISI-PADAS project encompasses 7 Work Packages (WPs), numbered from 1 to 7.

In WP1 experiments with human drivers are performed in order to generate an empirical basis for the driver model development and validation in WP2. The experiments in WP1 and the modelling in WP2 are organised in two phases (phase 1 and phase 2) covering empirical investigation, modelling and validation of driver behaviour respectively without and with PADAS.

In WP3 PADAS target systems are designed and prototypically implemented. These systems are used in second phase driver experiments in WP1 to investigate the influence of PADAS on driver behaviour.

In WP4 a simulation platform is developed that integrates the driver models from WP2 with models of the vehicle and the road environment. This platform provides an execution environment for the driver models and allows to predict emergent behaviour including driver errors in realistic traffic scenarios.

WP5 develops an improved methodology for risk based design. This methodology is demonstrated by performing a Human Error Risk assessment for the PADAS prototypes from WP3.

WP6 is dedicated to dissemination and exploitation of the results, while WP7 deals with project management.

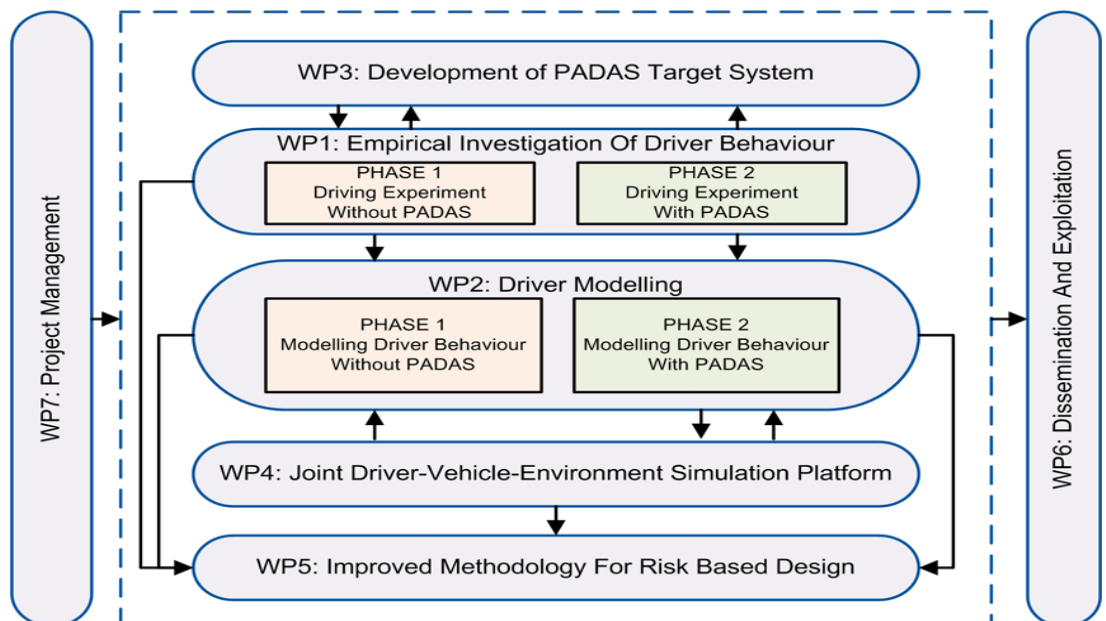


Figure 1: Structure of ISI-PADAS project



The research leading to these results has received funding from the European Commission's Seventh Framework Programme (FP7/2007-2013) under grant agreement n°218552 Project ISI-PADAS.

Empirical Investigation of Driver Behaviour

Leader: Deutsches Zentrum fuer Luft- und Raumfahrt e.V. (DLR) - Germany

Key persons: Martin Baumann, Mark Vollrath, Elke Muhrer, María Alonso, Henar Vega

'Empirical Investigation of Driver Behaviour' deals with the investigation of stability and predictability of individual driving behaviour and relevant influence factors with regard to unassisted (project phase 1) and assisted (project phase 2) longitudinal control. A first sub-set of these data provides the empirical knowledge required for the driver modelling without and with PADAS. The second sub-set is used to validate these driver models.

'Empirical Investigation of Driver Behaviour' encompasses four tasks.

The first task was the definition of traffic scenarios relevant for assisted longitudinal control, based on a use-cases analysis. This task was achieved in October 2008.

Merging information coming from the accident analysis and from literature review about the same topics addressed in the project, the most relevant traffic scenarios have been defined, considering some longitudinal functions, Adaptive Cruise Control (ACC) and Forward Collision Warning (FCW) above all.

The scenario description includes the following elements:

- spot and its geometry;
- traffic conditions;
- environmental / weather conditions;
- traffic participants and their behaviour.

Secondary tasks have been also taken into account, in order to consider driver's distraction.



The second task was the empirical investigation of driver behaviour without PADAS. It was achieved in August 2009.



Two driving studies in real traffic were performed: one driving study in Spain, one in Germany. Data on driving performance during various manoeuvres, driver characteristics and secondary task performance were collected, analysed and shared with the partners to be used in the modelling activities.

In order to extend the real driving studies, the results from in-depth accident studies and literature reviews have been used to generate hypotheses about causes of errors. In accordance with the aim of ISI-PADAS project, the analyses were focused on near-end crashes. These hypotheses have been tested in driving simulator studies by systematically varying influence factors found relevant. Finally the results have been processed and presented in a way which is needed for the driver modelling.

The results of the second task are documented in the deliverable "Report on the influence of relevant factors (driver characteristics, driver state, driving situation) on driving behaviour and driving errors".

The third task, in progress, is the empirical investigation of driver behaviour with PADAS. Currently, behavioural effects of the PADAS

prototypes developed in the project are being studied. In future, automation effects will be taken into account. Four kinds of scenario will be considered: 1) vigilance reduction, sleepiness fatigue; 2) loss of situation awareness by shifting attention to secondary tasks; 3) behavioural adaptation; 4) mode confusion.

Complementary to the

second task, the optimum transfer of knowledge to driver modelling will be ensured. For the validation, a sub-set of the data will be used by the driver models with PADAS for the prediction of behaviours which

can be compared with actual behaviour shown in the driving simulators.

Finally, the last task is related to the knowledge-base of driving behaviour, which will include the results of the different empirical investigations and will be made available to research public at the end of the project. Currently, a software framework

to access data collected in the second task has been defined and implemented.



Driver Modelling

Leader: OFFIS e.V. (OFF) - Germany

Key persons: Andreas Luedtke, Bertram Wortelen, Thierry Bellet, Pierre Mayenobe

The objective of 'Driver Modelling' is to develop executable driver models for different driver groups enabling prediction of context dependent human cognitive processes and (risky) behaviour in an empirical valid way.

In tasks 4-7, two classes of driver models are investigated and developed:

- Statistical (probabilistic) models, depending on measurable driver and context conditions, which represent the simplified and

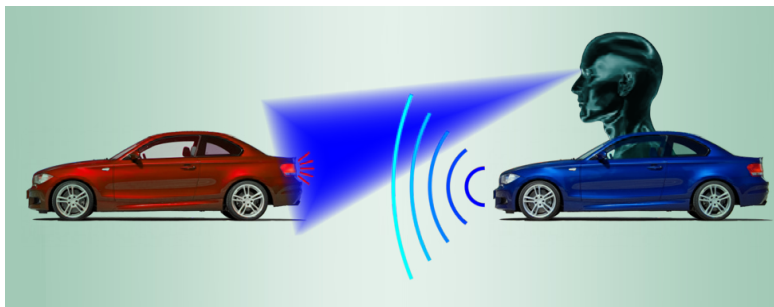
In eighth task both cognitive driver models and probabilistic models are validated.

The tasks 4-8 are performed twice:

- one time during phase 1 to build and validate basic driver models;
- a second time during phase 2 to extend these basic models with elements for PADAS interaction.

Phase 1 of these tasks is completed; phase 2 is ready to start.

Finally, in order to guide the model development towards common goals and common theoretical foundations, all models and model components are conceptually integrated in the last task. This task is in progress: integration from an application point of view and from a theoretical point of view is being investigated.



'Driver Modelling' encompasses nine tasks.

The first and second tasks were respectively the definition of a task representation language and ontology of the concepts, attributes and driving situations used in the project.

These results were used in the third task to produce a driving task model, which describes the situation dependent sequences of driver actions in the scenarios investigated in the project.

These three tasks were achieved during 2008 and a document entitled "Ontology of the driving task" is available.

abstracted relationship between traffic situations, latent characteristics of the driver and his overt behaviour (task 4). In a single simulation run the probabilistic structure of a sample of risky behaviour traces is generated (task 7).

- Cognitive models, which make explicit assumptions about how drivers perceive, process and evaluate traffic situations and how they derive or plan a course of actions (task 5). In a single simulation run one single behaviour trace is generated. Hence in validity checks monte-carlo-like model-generated traces are aggregated (task 6).

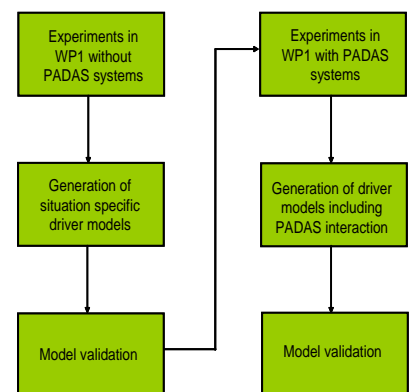


Figure 2: Structure of 'Driver Modelling'



During a meeting...

Development of PADAS Target Systems

Leader: CENTRO RICERCHE FIAT S.C.P.A. (CRF) - Italy

Key persons: Fabio Tango, Luca Minin, Christine Megard, María Alonso, Henar Vega

'Development of PADAS Target Systems' aims at definition and implementation of PADAS target system prototypes, whose main purposes are:

- to investigate the driver-PADAS interaction in phase 2 of 'Empirical Investigation of Driver Behaviour' as a basis for the driver modelling;
- to demonstrate the advantages of the new risk based design methodology developed in ISi-PADAS project.

'Development of PADAS Target Systems' includes five tasks.

The first task was related to the functional design of PADAS target systems focused on the capacity of partially autonomous intervention. Drivers' needs were identified through results coming from empirical studies, other projects and literature. This task was achieved in March 2009 and a document has been produced entitled "Functional design and definition of PADAS target systems".

The second task dealt with the definition of the system requirements and specifications.

The third task was the definition of the user interface for new PADAS. For this process, the interaction cycle between the driver and the system has been observed and details have been provided considering a multi-modal approach.

Both the second task and the third task were achieved in August 2009.

Basically, the target PADAS is named Longitudinal Support System (LOSS) and it is made up of two modalities:

- Advanced Forward Collision Warning (FCW+)
- Advanced Adaptive Cruise Control (ACC+)

In turn, FCW+ is composed by 3 main functions:

- the classical Forward Collision Warning (FCW), which has the aim to alert drivers for a risky situation due to an obstacle ahead (too short headway or excessive speed);
- Assisted Braking (AB), which controls the strength as depending on the external conditions, but only after the driver has started the braking;
- Emergency Braking (EB), which is a full-automatic braking action, acted by the system when the danger is imminent, in order to avoid a collision or anyway to reduce the consequences of the impact.

Also ACC+ is composed by 3 main functions:

- the classical Adaptive Cruise Control (ACC), a system able to keep the Host-Vehicle speed and distance respectively within a pre-defined value and a pre-defined headway threshold;
- Assisted Braking (AB);
- Emergency Braking (EB).



Figure 4: ACC+ interface

The task 4, in progress, is the prototypical implementation of PADAS.

The last step of work will be final PADAS improvements based on the results of Human Error Risk Analysis performed with the new methodology provided by the project.

The following documents are available:

- "System requirements, specifications and user interface of the PADAS target systems"
- "PADAS target system prototypes - initial version ready for phase 2".



Figure 3: FCW+ interface

During a coffee break...



Some participants to the meeting held in Valladolid, Spain



Joint-Driver-Vehicle-Environment Simulation Platform

Leader: Deutsches Zentrum fuer Luft- und Raumfahrt e.V. (DLR) - Germany

Key persons: Julian Schindler, Christian Harms, Pierre Mayenobe, Thierry Bellet, Dominique Gruyer

With the same software environment, the implementation of a Joint-Driver-Vehicle-Environment (JDVE) Simulation Platform allows PADAS prototypes:

- to be developed and tested with human drivers in real time in simulators and vehicles;
- to be tested in accelerated time with varieties of environment and interaction data.

'Joint-Driver-Vehicle-Environment Simulation Platform' encompasses five tasks.

The first task, achieved in December 2008, dealt with the implementation of time for accelerated and real-time testing as a basis for the Human Error Risk Analysis of prototypes.

The second task, achieved in May 2009, was related to:

- Development of a situation-specific DVE ontology by extending the ontology produced by driver modelling partners.

- Implementation of a basic DVE simulation platform, guided by the requirements of PADAS designers from the perspective of the new risk based design methodology.

The third task, which is near to end, deals with the development and integration of environment models in the basic DVE simulation platform. During work, the general needs of different environment models for the project have been defined. It has been decided that the most relevant environmental characteristics include:

- good weather conditions;
- rural roads as well as expressways and urban road nets;
- traffic lights and different rights of ways, especially in urban areas;
- lead cars with different behaviours.

Therefore, one example scenario on

an expressway has been added.

The fourth task, which is currently in progress, relates to integration of driver models in the DVE simulation platform. This includes the definition and implementation of a communication link that allows to feed data into the driver model on an adequate level of detail and to temporally synchronise the driver and PADAS models with the time concepts of the basic simulation platform as implemented in the first task.

Finally, the fifth task, which has just started ahead of the schedule, is integrating the PADAS target systems on the platform.

The following documents are available:

- "Ontology and basic version of the Joint DVE Simulation Platform"
- "Joint DVE Simulation Platform for phase 1"

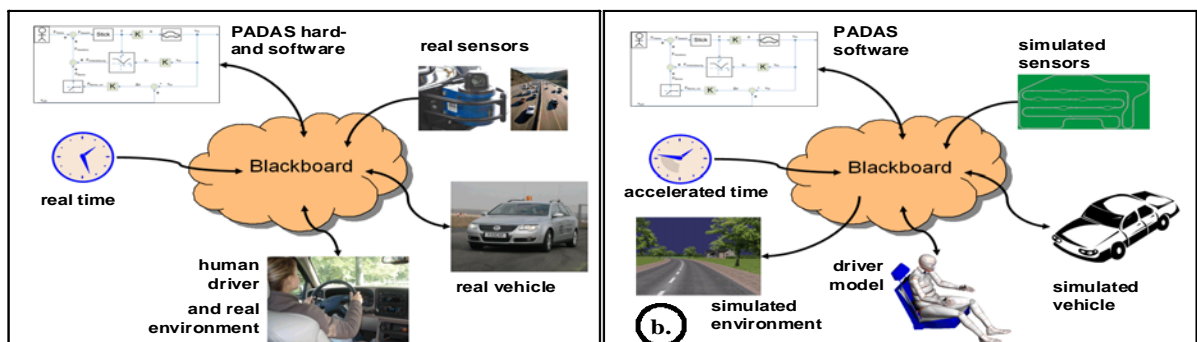


Figure 5: Blackboard architecture in the real world with real DVE elements (a.) and the same blackboard in the accelerated simulation with corresponding models (b.)

Improved Methodology for Risk Based Design

Leader: Kite Solutions s.n.c. (KIT) - Italy

Key persons: Carlo Cacciabue, Mirella Cassani, Aladino Amantini, Nabil Sadou, Hervé Gueguen

The objective of 'Improved Methodology for Risk Based Design' is to improve the current design process of driver assistance systems, such as PADAS, by effectively introducing a risk based design methodology for the evaluation of hazards associated to human errors and inadequate driver behaviour based on the driver models and the Joint DVE Simulation Platform.

'Improved Methodology for Risk Based Design' encompasses four tasks.

The first task aimed at the critical review and analysis of current design processes of PADAS and driver support systems in general. User needs and requirements were identified by means of an appropriate field study based on interviews and questionnaires. This task was achieved in May 2009: the distribution of the questionnaire to a number of experts received little feedback. However some preliminary indications of what could be the needs of designers in terms of Human Reliability Analysis have been obtained. In particular, it seems too premature to propose a very complex tool for performing Human Reliability Analysis in a complex and articulated way as users want a simple and easy to use tool. A deliverable issued at the end of the task contains all these information and findings.

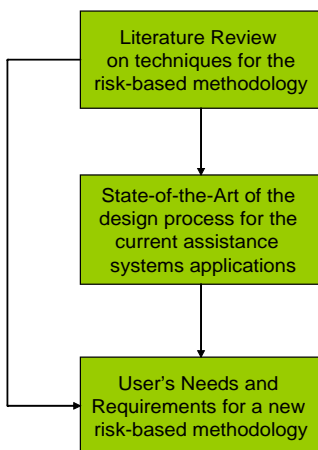


Figure 6: Main steps of the first task

The main objective of the second task is the definition of a methodological framework for an improved Human Error Risk Analysis based on existing classical safety analysis techniques as well as human error risk assessment techniques. Driver models and the Joint DVE Simulation Platform must be integrated in the methodological framework in order to use the driver models within the simulation platform to simulate and analyse a vast number of scenarios in accelerated time to predict human error probabilities and risk.

Inside this second task of 'Improved Methodology for Risk Based Design', also software specifications have to be defined.

At present the task is in progress:

- The safety analysis techniques, users' needs and requirements analysed in the first task have been considered.

- A methodology based on Expanded Human Performance Event Trees and classical THERP approach for human error analysis has been conceived. The Expanded Human Performance Event Tree expands over the classical Event Tree by providing the possibility of considering different modes of performance at each branch (see figure below).

- A sample case study is being developed for demonstrating the potentiality of the methodology.

The third task, which is being started, consists in the real development of the tool for risk based design process.

The last task will deal with the demonstration of the new Risk Based Design methodology by performing a Human Error Risk Analysis on the PADAS prototypes developed inside the project.

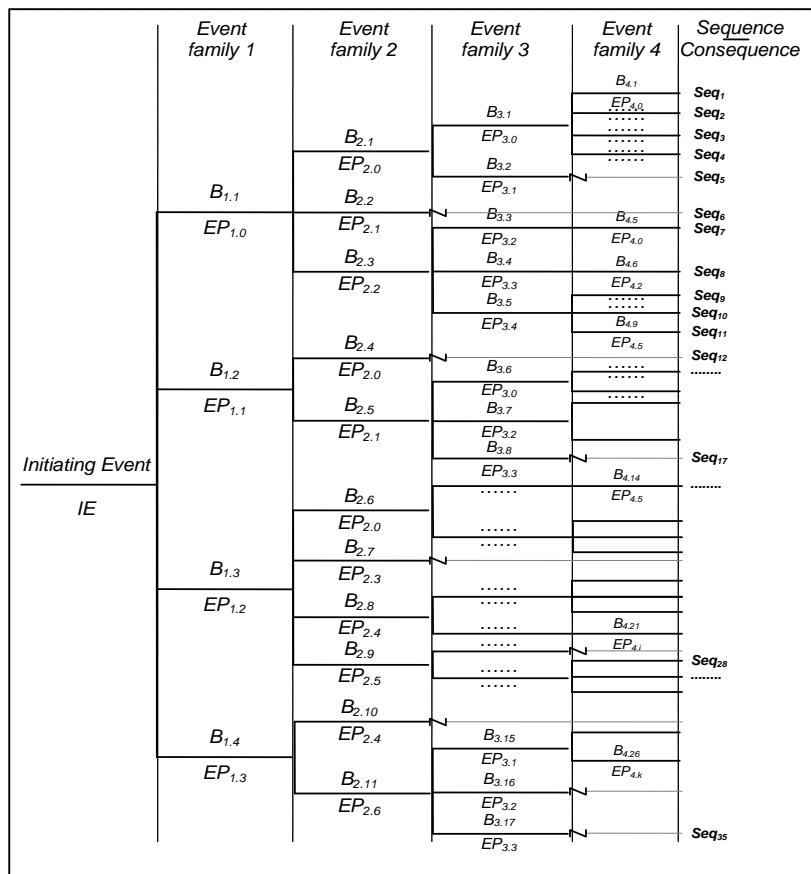


Figure 7: Expanded Human Performance Event Tree

Dissemination and Exploitation

Leader: Kite Solutions s.n.c. (KIT) - Italy

Key persons: Aladino Amantini, Mirella Cassani, Carlo Cacciabue

The activity of dissemination and exploitation is very important and is required for the entire duration of the project. The project results, intermediate and final, have to be disseminated to the automotive domain as well as to other industries within the transportation domain with similar needs, such as avionics, rail or ship.

This implies participation to conferences, mainly in the areas of human factors, human-machine interaction and system design, as well as organisation of dedicated dissemination events. The results are exploited internally by the project's industrial partners.

Currently, many steps have already been performed.

The web page www.isi-padas.eu, aimed at presenting the findings and objectives of ISI-PADAS, has been produced.

A first set of leaflets and poster have been designed and developed. This material has been distributed to all

participants.

It is also available to the external world whenever project members participate at conferences and workshops.

In order to guarantee a high level of quality for the ISI-PADAS outcomes, a board of experts in the transportation domain has been set up. This group was called Advisory Group. It will start the activity soon.

First dissemination activities have been performed in form of publications at the conference

- "13th International Conference on Human-Computer Interaction", 19-24 July 2009, San Diego, CA, USA.

Future conferences are:

- "IEEE Intelligent Vehicle (IV)", 21-24 June 2010, San Diego, CA, USA
- "Workshop HMAT-2010 - Human Modelling in Assisted Transportation", 30 June 30 - 2 July 2010, Belgirate, Italy

- "IADIS International Conference on Intelligence Systems and Agents 2010", 29-31 July 2010, Freiburg, Germany
- "ECAI-2010 - European Conference on Artificial Intelligence", 16-20 August 2010, Lisbon, Portugal
- "11th IFAC/IFIP/IFORS/IEA, Symposium on Analysis, Design, and Evaluation of Human-Machine Systems", 31 August - 3 September 2010, Valenciennes, France
- "ITSC-2010 - Intelligent Transportation Systems Conference", 19-22 September 2010, Madeira Island, Portugal
- "ICMLA-2010 - International Conference on Machine Learning Applications", 12-14 December 2010, Washington D.C., USA
- "HCI International 2011", 9-14 July 2011, Hilton Orlando Bonnet Creek, Orlando, Florida, USA

Special attention must be reserved to HMAT-2010 Workshop.

Workshop HMAT-2010 - Human Modelling in Assisted Transportation

The HMAT-2010 (Human Modelling in Assisted Transportation) will be held from 30th June to 2nd July 2010, in Belgirate, a beautiful location situated beside Lake Maggiore, in the lake district of Lombardy, Italy.

It is sponsored by ISI-PADAS, in collaboration with two other European projects, namely ITERATE and HUMAN.

The conference deals with the human modelling into design processes and in safety assessments of innovative technologies in highly assisted systems. The aim of the model is to provide an improved understanding of the human factors and to predict performance and behaviour of the human in interaction with new technologies in normal and emergency situations, for all surface transport modes and for cockpit environments.

The topics of the Workshop are:

**First
HMAT
2010**



HMAT-2010:
the location

- Advanced human models in transportation.
- Human Errors and Risk Assessment in design processes of assistance systems.
- Methods and tools to prevent erroneous behaviour to mitigate its consequences.

The HMAT-2010 Workshop will offer the opportunity to compare ongoing research at international and European level with the EC funded actions on assisted transportation.

The complete announcement of the HMAT-2010 conference is attached at the end of the newsletter.

Project Management

Leader: OFFIS e V. (OFF) - Germany

Key persons: Andreas Luedtke, Jens Alsen, Fabio Tango

The project was launched on the Kick-Off meeting in Oldenburg - Germany (23-24 September 2008).

The main purposes of the management structure are:

- To supervise and delegate work.
- To allocate resources in order to achieve the technical objectives within the time and cost constraints.

The progresses of the ISi-PADAS project are documented through milestones, deliverables and reviews.

The Project Leader OFF produces periodical status reports with intermediate results of the project and discussion about the progress in relation to the objectives and to the planning. Risks are assessed and addressed.

A final report at the end of the project will describe the results, their compliance with the objectives and the results of the dissemination and exploitation.

The Technical Leader CRF coordinates the development and application of the methods, techniques and tools and anticipates and solves problems in order to reach the highest level of technical quality.

Some faces of the project...



All participants to last ISi-PADAS meeting held in Valladolid, Spain

Visit www.isi-padas.eu

Read our newsletter

Here you can find background material concerning:

- Project structure
- Partners
- Contacts

Detailed articles will inform you about:

- Recent news
- Incoming events
- Achieved results

Consortium



Advisory Board

Members of the Advisory Board are:

- Prof. Dr. Klaus Bengler - Technische Universität München - Germany
- Prof. Dr. Toshiyuki Inagaki - University of Tsukuba - Japan
- Dr. Andrew Liu - MIT Man Vehicle Lab - United States of America
- Prof. Dr. Josef F. Krems - TU Chemnitz - Germany
- Prof. Dr. Andry Rakotonirainy - CARRS-Q, Queensland University of Technology - Australia

Contacts

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The research leading to these results has received funding from the European Commission's Seventh Framework Programme (FP7/2007-2013) under grant agreement n°218552 Project ISI-PADAS.
Project Officer: Grzegorz Domanski



Important Dates:

Abstract Submission: 1 March 2010
Review Notification: 1 April 2010
Final paper Submission: 1 May 2010

Programme Chair:

M. Hjalmdahl, magnus.hjalmdahl@vti.se
A. Luedtke, andreas.luedtke@offis.de

Scientific Committee:

M. Baumann	C. Möbus
T. Bellet	F. Reuzeau
P.C. Cacciabue	D. Shinar
O. Carsten	F. Tango
A. Cavallo	J. Vanderdonckt
R. Heers	F. Vanderhaegen
M. Lützhöft	M. Van Esch

Local Organising Committee:

A. Amantini	J.-P. Osterloh
M. Cassani	C. Riccioli
M. Green	G. Russo

E-mail for information: info@hmat-ws.eu

Venue:

Hotel Villa Carlotta – Belgirate: a beautiful location situated beside Lake Maggiore, in the lake district of Lombardy. Participants should organise their stay individually by contacting directly the hotel.

E-mail: info@villacarlottalagomaggiore.it

Web site: www.villacarlottalagomaggiore.it

Single room (breakfast incl.): 120 €/day.

Gala Dinner optional not included in conference fees: 70 €.

Conference Fees:

Conference fees are in Euro and include Coffee breaks, lunches, and proceedings.

	Early Before 1/5/10	Late After 1/5/10
Project Members	450 €	500 €
Other Members	550 €	600 €
Students	350 €	350 €



Organised by



1st ANNOUNCEMENT & CALL FOR ABSTRACTS

www.hmat-ws.eu

Human Models, Risk/Errors, Methods and Tools in Assisted Transportation

Goal of Workshop:

In modern society, the human being is considered the central element of the design process, as well as the major source and contributor to accidents. Therefore, the human error modelling has to be implemented into design processes and in safety assessments of innovative technologies to ensure the appropriate consideration of human factors in highly assisted systems.

To this end, the projects ISI-PADAS, ITERATE and HUMAN will provide, in different domains, an overall model of the joint cognitive systems, represented by the human in control, the governed machine and the working environment. This model will be able to provide an improved understanding of the human factor and to predict performance and behaviour of the human and interaction with innovative technologies in normal and emergency situations, for all the surface transport modes and for cockpit environments. Moreover, the implementation of the model of human error in a design perspective can be integrated in risk-based approaches that enable to assess the consequences of erroneous behaviour and to develop appropriate countermeasures.

The objective of this Workshop is to confront models, methods and tools developed within the projects with the ongoing research worldwide and to provide an environment for fruitful exchange of ideas.

The main topics are:

1. Advanced human models in transportation.
2. Human Errors and Risk Assessment in design processes of assistance systems.
3. Methods and tools to prevent erroneous behaviour to mitigate its consequences.

Keynote lectures as well as peer reviewed presentations will be presented and discussed in a three days Workshop.

Scope:

This Workshop will offer the opportunity to compare ongoing research at international and European level with the EC funded actions on assisted transportation. For these reasons, in addition to normal presentations, a number of keynote lectures have been planned on the themes of the Workshop:

1. Erik Hollnagel (MINES ParisTech, France)
2. Toshiyuki Inagaki (UT - University of Tsukuba, Japan)
3. Nick McDonald (TCD - Trinity College Dublin, EIRE)
4. Andrew Liu (MIT - Massachusetts Institute of Technology, USA)
5. Truls Vaa (TØI - Institute of Transport Economics, Norway)
6. Klaus Bengler (TUM - Technische Universität München, Germany)
7. Brian Gore (NASA – National Aeronautics and Space Administration, USA)
8. Magnus Hjalmdahl / Oliver Carsten / David Shinar (*Keynote ITERATE*)
9. Pietro Carlo Cacciabue / Marc Vollrath (*Keynote ISI-PADAS*)
10. Andreas Luedtke / Denis Javaux (*Keynote HUMAN*)

Submissions:

Abstract submissions: short descriptions of proposed work – Deadline 1 March 2010

Accepted submissions: 8 – 10 pages submitted for review – Deadline 1 May 2010

Publication: all papers will be peer reviewed and will appear in a book published by Springer after the Workshop. All participants will receive a copy of the book.

The procedure for submission is via e-mail at the following address:

submission@hmat-ws.eu