ROADSENSE:

ROad **A**wareness for **D**riving via a **S**trategy that **E**valuates **N**umerous **S**ystEms

A 5th Framework Programme Project
Key Action "Competitive & Sustainable Growth"

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1.0 Background

1.1 Road Safety in Europe

The number of vehicle accidents in Europe is going down thanks to regularly improved infrastructures, education of drivers and progress in active and passive vehicle protection. However, more than 42 553 people died in 1998[1] on the roads of the 15 European Union countries, while 1 760 777 were injured. OECD also reports that the total annual economic loss resulting from road deaths and injuries is estimated at around 450 billion euros or about 2% of GDP in OECD countries.
Several areas have been addressed to reduce the number of accidents with a certain success (these numbers are equivalent to those of 1956 for people who died on the road in 1998). The main contributing factors identified include:

- the effectiveness of ongoing programmes for improving road safety (e.g speed management)
- the introduction of stricter blood alcohol content limits
- new active and passive car safety components (e.g. anti-lock braking systems, and frontal and lateral airbags)
- improved rescue services

The introduction of new technologies in the car and outside provides new opportunities to better support the driver when confronted by exceptional situations that may result in an accident. These new technologies can in particular prevent driver inattention or provide assistance on how to react.
The industry is going in a direction where several technologies will interact and sometimes fight to attract the user interaction. This may have a counter effect if the driver is more occupied in understanding inappropriate messages that are made available to him, rather than focusing on the potential accident.
To address this emerging problem, the European Motor Vehicle Manufacturers grouped in EUCAR have identified the urgency of conducting joint research into active safety. Today, however, it is not sufficient to focus just on systems designed to increase safety - we have to look at all systems aspects and their interactions;

- Identification of driver behavioural indicators
- Development of standardised models of Human Vehicle Interactions
- Evaluation and testing of new proposals before technology investments constrain Human Vehicle Interactions
- Integration of these new technologies, in particular related Human Machine Interfaces
- Identification of interfaces which must be standardised to enable a free and innovative approach to feature design and to promote company differences; BUT to simultaneously achieve high common levels of safety within the European Union

This urgency is also tightly linked to the EU priorities[1] on Road Safety and addresses the evaluation of systems such as on-trip information RDS-traffic management channel, emergency call systems for automatic incident detection and emergency management. These correspond to one of the highest priorities (rated as 50% weight for “European added value”) identified by the EC. Integrated information systems are

[1] [2] “Priorities in EU road safety - Progress report and ranking of actions” Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the regions, 17 March 2000

among the short/medium term priorities of the EC that are currently not well addressed. (See again [2] where it is stated that it is necessary to perform qualitative prioritisation of safety measures and estimate quantitative aspects, - two key issues to be addressed in RoadSense.)

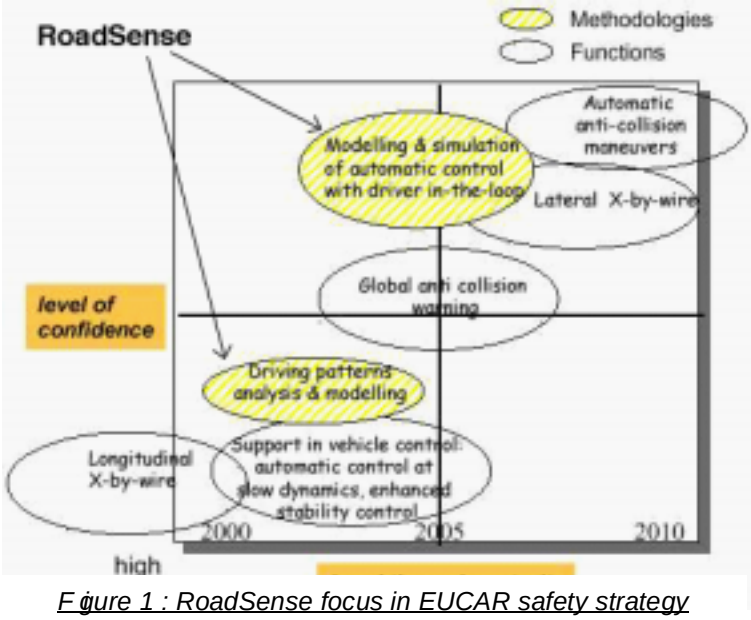

Figure 1 : RoadSense focus in EUCAR safety strategy

1.2 Recent research in field of HVI

Until now, R&D efforts have mainly been dedicated to individual technologies. How they should be used, as part of the total driving experience to bring a real added value to the driver must now be addressed. To illustrate this situation, it is sufficient to look at the impressive number of new HVI projects that are conducted at the European level:

- Use of colour displays (e.g. EC project ACTIVE), use of vocal interfaces (e.g. EC projects CEMCOVAS, SENECA, VODIS II), visibility improvement using far infrared (e.g. EC project DARWIN), dynamic navigation (e.g. EC projects IN-ARTE, DIAMOND, NEXT MAP, PEPTRAN), lateral control (e.g. EC project LACOS), monitoring of driver behaviour (e.g. EC project SAVE), lane keeping (e.g. EC project CHAUFFEUR I & II), etc.

Very few results and actions look at the problem addressed by RoadSense. Some projects worked on standardisation of HMI (for example in the Telematics project STAMMI). Former Telematics programmes on transport reported on this issue but nothing to our knowledge has been done on HVI requirement analysis. Among the most interesting are:-

- IN-ARTE: a Telematics project to increase traffic safety in highway and main extra-urban traffic environment by means of integration of existing driver on-board support systems. It only addresses one set of sensors and does not provide the openness of RoadSense nor HVI design support
- ACHIEVE: a national project to develop understanding of the subjective assessment of vehicle handling characteristics. ACHIEVE has a much more limited scope than RoadSense and will be linked to RoadSense through one of the partners.
- SANTOS - Adaptive driver assistance, this is a German Government funded project which investigates methods for Driver Assistance Systems. It is limited to only one vehicle manufacturer and addresses the development of technologies for HVI and is not an HVI requirement framework.

In addition, none of these projects have gathered the European motor vehicle industry to reach a consensus.

The main innovation in RoadSense will be in addressing this problem, the definition of a HVI evaluation framework supported by the European Motor Vehicle Manufacturers. Additional innovation will be in the characterisation of HMI in the car and in the development of an industry standard validation framework. RoadSense will make a significant contribution to progress in addressing Human Vehicle Interactions and will innovate through this global approach that will have a significant impact on road safety.

2.0 RoadSense HVI evaluation framework

Introducing new technologies that require interaction with the driver into a vehicle can be done in several ways (mock-up, simulation, etc.). The best approach is certainly to use simulation to assess how the technology will be used, and in particular to evaluate how a new feature will compete with others to catch the driver's attention. Together with an understanding of drivers' behaviour in accidents, this allows an in-depth understanding of the requirements regarding driver behaviour when developing and integrating new technologies.

Simply addressing the basic HMI for the technology is insufficient, as it does not solve the problem at large, i.e. the deployment of the technology in the industry and in the road traffic environment.

The problem that the RoadSense approach solves is how to get uniformly *SAFE* HVI, but at the same time enabling consumer choice of HVI to promote product diversity and uniqueness. These are the key things for Competitive & Sustainable growth. The issue with standards is that, by definition, they are all the same, which could limit uniqueness.

Figure 2: The Risk of Driver Information Overload

The RoadSense approach relies on:

- Understanding driver behaviour through characterisation and simulation to develop a requirement validation framework for new HVI strategies
- Ensuring that this framework is open to integrate what is already available and future emerging new HVI strategies
- Bringing together all levels of European motor vehicle industry to reach an agreement on a consistent and co-ordinated approach to HVI guideline provision. The approach guarantees growth capability and re-usability of developed HVI techniques - because they are based on human performance which changes much more slowly than technology.

There is no competing approach to the one proposed in RoadSense apart from individual initiatives of isolated vehicle manufacturers who would like to push their own HVI.

RoadSense aims at being generic and open to allow individuals to adopt a common approach thanks to sharing of resources and experience.

3.0 RoadSense Objectives

The main objective of RoadSense is to develop an industry standard evaluation framework for new Human Vehicle Interactions strategies with a specific focus on Human Machine Interfaces. RoadSense aims to deliver Guidelines for the methods of HVI tests that measure the effects on driver behaviour that any single technology, or combination of technologies, will have.

More precisely, the RoadSense detailed objectives are:

- Scientific objectives:
  - To develop driver behavioural indicators for safety, comfort and support assessment
  - To develop a framework for the integration of existing tools and techniques with regard to driver sensory and cognitive capabilities
  - To identify new tools and techniques derived from critical scenarios and technology case studies being proposed by industry
  - To develop a framework within which HVI requirements validation techniques can be tested and co-ordinated - before vehicle technology is made available
- Technical Objectives
  - To develop a rapid prototyping hardware based on DSP technology and high speed serial communication techniques to simulate vehicle networks
  - To develop programmable tools to simulate system functions and support the consistent assessment of HMI proposals.
  - To develop an open platform allowing a modular approach to the prototyping tool design to support structured upgrade to keep pace with future technology

Where necessary, new tools and techniques will be developed. The tools could be used to look singularly at changing road traffic scenarios in the presence of established or known technologies. With the tools and methods being developed to focus on driver performance characterisation they become **independent of technology**. Therefore they can be used to drive the technology design and not applied at the end of the process, which would have the consequence of extending the development time.

The RoadSense results will be:

- Behavioural indicators for safety, comfort and support of the driver
- Driver Behaviour Interface Test Equipment (D-BITE) to simulate and validate new HVI strategies

The final result to be achieved in RoadSense will be the adoption of the developed framework by the European Motor Vehicle Manufacturers.

4.0 Approach to work

The aim of the project is to deliver Guidelines for the methods of HVI tests and to develop a driver behavioural simulation environment to evaluate and integrate new technologies in future vehicles even before the technologies are available.

RoadSense will start from an analysis of accident data collected from European national accident databases. These data will be used to specify behavioural indicators and to develop typical case study scenarios. RoadSense will then develop Human Machine Interfaces and a complete simulation environment. This environment will be used to simulate and test new technology proposals aimed at supporting drivers in decision making when confronted by specific situations. Two case studies will be implemented to assess the project development.

As a key issue in the project, the participants will make the proposed approach to HVI strategy development available to the whole industry, to enable adoption and then use by the entire European motor vehicle industry.

Analysis of Road Accidents and new HVI systems

The RoadSense project will start from an analysis of accident databases and literature on the assessment of the behaviour of the driver.
As a key starting point, RoadSense will study the data collected by:

- DG Transport in the CARE database about road accidents and their analysis in the European Union.
- OECD in the IRTAD International Road Traffic and Accident Database
- National accident databases and analysis

Partners in the project have already gained experience from using these facilities and therefore their prior art will be useful to the consortium.

RoadSense will also study the corresponding recommendations made on HVI strategies to avoid accidents. The following list gives an idea about what could be made available to the driver and the problems that may arise from their integration:

- Speed limit control
- On trip information (radio data systems, traffic message channel (RDS-TMC)
- Variable speed messages on motorways and on car instrument panels
- Intelligent accelerator pedal
- Adaptive cruise control
- Vision enhancement
- Obstacle detection systems
- Automatic incident detection and emergency management
- Emergency call system

and this list does not contain HVI not related to security such as radio, mobile phones, positioning and guiding, etc.

HVI Requirements

From the data analysis and potential new HVI to be introduced, the project will then develop

- Requirements on behavioural indicators
- Recommendations on technical possibilities to modify driver behaviour

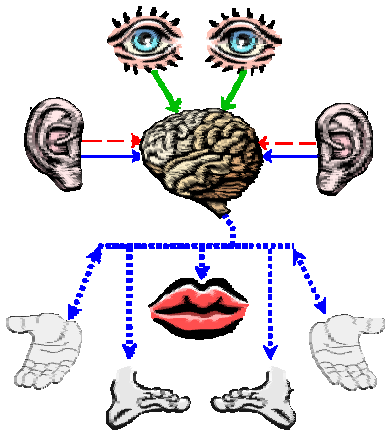

Figure 4: Human Data Network

The focus will be to identify the driver's physiological and psychological stimuli and to evaluate their effects on attention allocation. A systems approach can be considered to highlight the mechanisms for which we need to develop assessment tools. We can consider the driver as a network having specific inputs (eyes and ears) and outputs (hands, feet and mouth) and processing capability (brain). The effect of the driver's immediate environment on the functioning of the network will be the primary focus of this analysis.
We will identify the stimuli (or lack of them) required by the driver for optimum operation within selected scenarios related to situational awareness. By identifying these parameters values can be set as a target for the development of technology in such a manner as to facilitate appropriate driver behaviour.

RoadSense HVI

The requirements will then be exploited to further define HVI testing and evaluation - there is no point in setting a requirement unless there is a test method to prove that the requirement is correct and has been met. HVI will be developed from these requirements while metrics and target values will be defined starting from ISO standards (or last versions of draft standards) and from preliminary work items progress (ISO/TC22/SC13/WG8 and ISO/TC204/WG14) concerning HMI:

- HMI – Dialogue principles
- HMI – Visual presentation of information
- HMI – Auditory information presentation
- Comprehensible presentation of visual message
- ACC Systems – HMI requirements
- Auditory symbols
- HMI – Suitability of TICS while driving
- HMI – Measurement of driver visual behaviour
- HMI – Criteria for determining priority of TICS messages
- Navigation and route guidance accessibility
- FVCW systems – HMI requirements

This will also result in the development of tests and expected measures to be matched against the 2 case studies to be developed.

Cases studies

Two Case Studies will be developed within RoadSense. These case studies will be related to the functional description of an emerging system which is planned by the industry to be used in critical scenarios. The case studies will be chosen following a review of EUCAR Common Priorities set for the automotive industry and the identification of those most pertinent to the scenario definition. Examples of possible case studies are:

- Forward Looking Radar and Cameras to improve Night Vision
- Telematics interface

The system components will be selected based on the technology timelines developed by the EUCAR System Groups.

The RoadSense consortium will select the technology based on:

- technical performance assessments or experiments
- visits to supplier or supplier presentation
- mutual compatibility of selected technology

It is envisaged that the case study technology will be a combination of

- commercial equipment configured to represent automotive equipment
- automotive equipment
- total simulation
- combination of the above

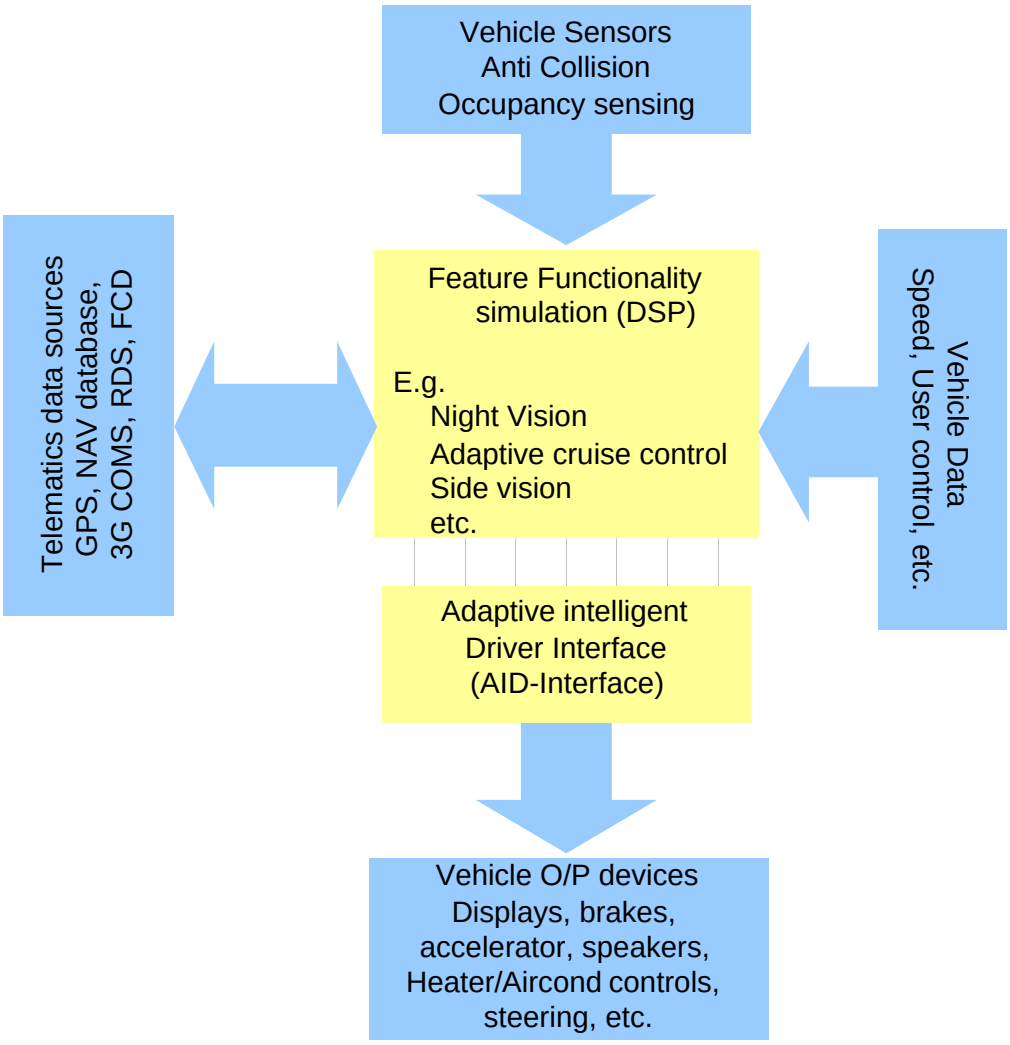

Figure 5: D-BITE Architecture

D-BITE (Driver Behaviour Interface Test Equipment)

A set of technology, specifically for the purpose of supporting the provision of European Guidelines for HVI, is proposed. The functional elements are based on IEEE 1394 (Firewire) and DSP technologies. Firewire enables high bandwidth serial communications and access to readily available technologies such as cameras and displays. DSP technologies will provide a standard programmable module with significant data throughput and computational speeds.

The combination of Firewire and DSP technologies will enable the rapid implementation of the most advanced feature proposals to be functionally realised.
D-BITE has the following simulation attributes that are of relevance to RoadSense:

- Computing Speed
- Easy-to-add new features
- High bandwidth communication channels
- Utilisation of existing hardware, software methods and process

Three D-BITE sub-system items will have to be designed specifically for RoadSense:1394 I/O interface boards for existing automotive technology and technology offered from other projects

- DSP module which may be programmed to provide a particular feature
- RoadSense data packet specification or in other words, an API.

The technologies employed already have excess bandwidth that would enable the next generation of feature proposals to be implemented. In addition, each of the D-BITE simulation technologies chosen have aggressive technology timelines which will ensure that the proposed system can keep pace with automotive feature development.
The DSP and IEEE 1394 Firewire technologies are not implemented with vehicle production in mind but rather to take advantage of commercial electronics to facilitate rapid prototyping.

Project components

The workpackage structure has been organised with 6 technical workpackages, an exploitation and information dissemination workpackage and a management workpackage. Each technical workpackage is related to an important component of the project. Workpackages are further decomposed into Tasks.

- WP0 Project management
- WP1 Scenario definition
- WP2 HMI Requirements
- WP3 Case study requirements
- WP4 D-BITE technology requirements
- WP5 D-BITE Case study implementation
- WP6 Project results dissemination and exploitation

5.0 Project Exploitation

The following is expected from an exploitation point of view in the short, medium and long term for the above developments, including also the expected evolution of the European framework (Note that RS as a time reference, means the end of the project, which is three years from its beginning. The anticipated start date is Feb 2001.)

Development	Short Term	Medium Term	Long Term
European Framework for HVI	Established (RS – 1,5 years)	All European HVI aware of RoadSense (RS + 1year)	Everybody uses the RoadSense Network (RS + 5 years)
HVI tools and techniques	Principles of Driver Behaviour indicators for Safety Comfort and Support established (RS – 1,5 years) List of available tools and techniques identified, some new methods (RS – 1,5 years) Driver in the loop simulation concept proven (RS)	Initial model of driver behaviour prediction (RS + 1 year) Identify other outstanding needs in terms of research (RS + 1 year)	Totally balanced set of behaviour indicator objective (RS + 5 years)
Code of practice	Outline content document (RS – 1,5 years)	Draft for circulation (RS + 1year)	Acceptance by all Industry (RS + 5 years)

6.0 RoadSense Consortium

The RoadSense consortium has been set-up to match the approach. Two types of organisation have been selected for participation:

- 5 major European vehicle manufacturers representing the entire European Motor Vehicle Manufacturers (Jaguar, CRF, PSA, Renault and Porsche) grouped in EUCAR, an association aiming at fostering strategic co-operation in R&D activities. These manufacturers in fact are those in charge of the Safety section of this association and are mandated to represent the others in this project.
- 2 universities (U. of Cranfield and UBP) specialising in Human Machine Interface, software and hardware developments for automotive applications and 2 research centres (TNO and HEUDIASYC) also specialising in human machine Interface and land transport

The consortium deliberately made the choice of this collaboration between automotive manufacturers and academic institutes to ensure that the results will be available for the entire industry without commercial constraints from specific providers.

CONSORTIUM OVERVIEW			
Participant		Business activity / Main Mission / Area of activity	RTD Role in project
Name	N°		
JAGUAR	1	Automotive Manufacturer	Co-ordinator and HMI in-vehicle/ laboratory Validation.
CRF	2	Automotive Manufacturer	Human Factors requirement definition and in vehicle validation
PORSCHE	3	Automotive Manufacturer	Case study requirements definition and in vehicle validation
UBP-LASMEA	4	Research Laboratory - Specialist of multi-sensor integration and multi-sensorial data fusion in intelligent road vehicle	Case study, Driver in the loop Hardware/software development
CRANFIELD	5	Post Graduate Research Institute: Computing for Automotive applications. Human factors for Land Transport & Aerospace	Provision of Driver in the loop hardware & Software tools. Real time DSIP HMI Validation Testing
PSA	6	Car manufacturer	HMI & Case Study Requirements Definition, Validation Testing
RENAULT	7	Car manufacturer	HMI & Case Study Requirements Definition, Validation Testing
TNO	8	Land Transport Research - Human Machine Interaction	HMI Requirements Definition and Validation Testing
CNRS-HEUDIASYC	9	Research laboratory in Intelligent Vehicles with a multidisciplinary approach	Case study, Driver in the loop Hardware/software development

RoadSense was conceived within the EUCAR structure (European Council for Automotive R&D) and as such has support from all the European car manufacturers.