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Human Centred Design for Safety Critical Transport Systems

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Abbreviations

Abbreviation	Meaning
ADAS	Advanced Driver Assistance System
ACC	Advanced Cruise Control
ARAS	Advanced Rider Assistance Systems
BAS	Brake Assist Systems
C2X	Car-to-Everything
CAS	Collision Avoidance Systems
ECTRI	European Conference of Transport Research Institutes
ERTRAC	European Road Transport Research Advisory Council
ESoP	European Statement of Principles
EUCAR	European Council for Automotive R&D
EV	Electric Vehicle
FEV	Full Electric Vehicle
FOT	Field Operational Test
GPS	Global Positioning System
HCD	Human Centred Design
HEV	Hybrid Electric Vehicle
HMI	Human Machine Interaction
I2V	Infrastructure–to-Vehicle
ICT	Information and Communication technology
ISA	Intelligent Speed Adaptation
ISO	International Standardisation Organisation
ITS	Intelligent Transport System

IVIS	In-vehicle Information System
LDWS	Lane Departure Warning / Lane keeping Systems
ND	Nomadic Device
NDF	Nomadic Device Forum
OBIS	On-Bike Information Systems
OEM	Original Equipment Manufacturer
POI	Point-of-interest
PTW	Powered Two Wheelers
SafeAPP	Safety of applications
SSE	Safety State Estimator
TIO	Tangible Interactive Object
V2V	Vehicle-to-Vehicle
V2I	Vehicle-to-Infrastructure
V2X	Vehicle-to-Everything
VCE	Vapour Cloud Explosion
VMS	Variable Message Signs
VRU	Vulnerable Road Users

Executive summary

The scientific seminar on "Human Centred Design for Safety Critical Transport Systems" organized in the framework of DECOMOBIL has been held the 8^{th} of September 2014 in Lisbon, Portugal, hosted by ADI/ISG.

The aims of the event were to present the scientific problematic related to the safety of the complex transport systems and the increasing importance of human-centred design, with a specific focus on Resilience Engineering concept, a new approach to safety management in highly complex systems, on knowledge and experience from other transport modes, particularly aviation and space, in which automation processes are accompanied by an increase in safety and security and on the safety of vulnerable road users and its potential link to automation. To close the workshop, an analysis of safety vs. ecomobility highlighting research priorities has been presented to the audience.
As a special speaker, Myriam Coulon-Cantuer, EC Project Officer of the DG Connect, presented the view of the EC on the future research challenges for ICT and transport.

This report gathers a summary of each presentations and the full set of their slides in annex.

In addition, all the presentations (slides and video recordings of the presentations) are available for downloading on the DECOMOBIL website http://decomobil.humanist-vce.eu/Downloads.html.

Announcement and Agenda of the Workshop

DECOMOBIL

User centred **D**esign for **ECO**-multimodal **MOBIL**ity

FINAL WORKSHOP

HUMAN CENTRED DESIGN FOR SAFETY CRITICAL TRANSPORT SYSTEMS

September, 8th 2014,
ISG/Business & Economics School,
Lisbon, Portugal

WORKSHOP AGENDA

09:00 – Welcome coffee

09:15 – Opening session

09:30 – Transport safety a matter of technology, organisation and people, Guy Boy, Director of the HCI, FIT, Chief Scientist for HCD at NASA Kennedy Space Center, USA

10:30 –The Pervasive Copilot: How ITS could support a shared Situation Awareness between road users ? Thierry Bellet, Researcher at LESCOT, IFSTTAR.

11:00 – Coffee-break

11:30 – Road traffic accident causation and ITS: how do we chose the most effective solutions? Oliver Carsten, Professor of Transport Safety, Institute of Transport Study, University of Leeds, UK.

12:00 – VRU safety and potential link to automation and future research priorities in the field", Researcher Centre for Research & Technology Hellas, HIT, Greece.

12:30 –The contribution of resilience to sustainable transport systems, Pedro Ferreira, Researcher ISG/DREAMS

13:00 – Lunch

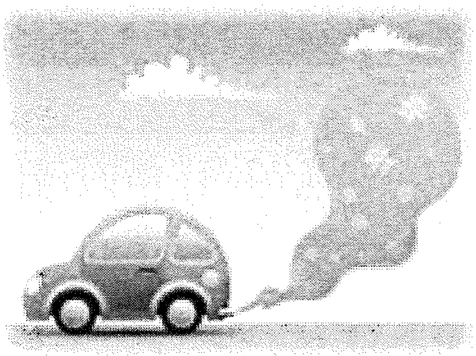
14:30 – Round Table, chaired by Guy Boy, FIT/NASA

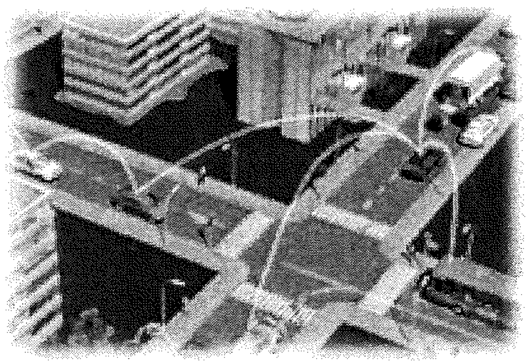
15:30 – Coffee-break

16:00 – Safety versus Ecomobility; setting priorities right, Angelos Bekiaris, President of Humanist, Research Directorat Centre for Research and Technology Hellas, HIT, Greece

16:30 – View of the EC on the future research challenges for ICT and transport, Myriam Coulon-Cantuer, Scientific and Technical Project Officer, European Commission, DG Connect

17:00 – Closing ceremony





1. Introduction

In the framework of the DECOMOBIL project, organisation of this scientific seminar on "**Human Centred Design for Safety Critical Transport Systems**" aims at presenting the scientific problematic in terms of challenges and research issues linked to safety critical systems in transport, in order to discuss with external stakeholders challenges to face, process and approach to develop, methods to use, future priorities and perspectives to identify.

Speakers have been identified as experts in the area, presenting main issues, scientific perspectives and challenges, based upon their high expertises and vision in this area.

The workshop announcement was made firstly via e-mail, disseminated to the HUMANIST VCE mailing list (1100 names), a more focused dissemination was then made to European networks working in European Transport Research (ECTRI, FERSI, FEHRL & EURNEX) who disseminated the information to their member institutes and/or universities. The DECOMOBIL partners were also asked to disseminate the information to their respective networks. Annoucement of the happening has been made via social networks such as LinkedIn in various thematic groups such as Applied Cognitive Psychology, Certified Human Factors and Ergonomics Professionals, Cooperative Systems, Decade of Action for Road Safety, Driver Distraction, Ergonomics, ERTICO - ITS Europe, EURO Working Group on Transportation, European Transport Research, FP7 Information and Communication Technologies (ICT), HFES Europe Chapter, Horizon 2020, Framework Programme for Research and Innovation, Human Factors, Human Factors and Ergonomics Society (HFES), Human Factors professionals, iMobility Forum, International Ergonomics Association (IEA), ITS - (Intelligent Transport Systems), Road Safety International and SAFERIDER.

Finally, a announcement was also made on the project website (http://decomobil.humanist-vce.eu) and in the project newsletter 8 published in July 2014.

2. Research issues on Human centred design for safety critical transport systems

The title of the DECOMOBIL final workshop was initially defined as "Sustainable mobility within a resilient road transport system". However, it was decided to reflect in the workshop the conceptual and methodological evolution of the corresponding Task Force from the HUMANIST VCE. Therefore, it was decided to:

- focus on the concept of Resilience Engineering, which is a new approach to safety management in highly complex systems;
- get knowledge and experience from other transport modes, particularly aviation and space, in which automation processes are accompanied by an increase in safety and security;

- highlight the increasing complexity of the road transport system and the related safety issues in the way to automation; and
- highlight the increasing importance of human-centred design in this era of increasing complexity of technology-based systems.

The road transport system is a very dynamic and complex system involving human-machine interaction and human-machine cooperation (in-vehicle assistive technologies), together with numerous social interactions in the traffic. Furthermore, the road transport system is totally open, in opposition to other modes of transport (railway, maritime, aviation) in which highly trained and competent professionals drive or pilot different vehicles. Within the road transport system, there are an enormous variety of road users (drivers, riders and pedestrians; novice, experienced, young, old and mobility-impaired; professionals, etc.) evolving on the road environment.

Such variety, just covered by traffic laws and the corresponding supervision, as well as the diversity of behaviours in the road environment lead to an increased dynamics and complexity of the road transport system. Being safety a main concern in the frame of a sustainable mobility, a new approach based in a human-centred design integrating the users, technology and organization seemed to be the way to achieve a sustainable mobility within a resilient transport system.

Therefore, it was decided to bring to the workshop this new approach, highlighting the contribution from other highly complex transport systems and the last developments in the frame of driving with an intelligent co-pilot, as well as an understanding of accidents causation and the importance of ITS to prevent from human transient factors and other risks.

Then, the contribution of Resilience Engineering to the sustainability of the road transport system was stressed as a framework for the enhancement of overall system safety and efficiency, taking into account the challenges faced by transport stakeholders.
Thus, under the title of "Human Centred Design for Safety Critical Transport Systems", the workshop was completed with:

- an approach related to the safety of vulnerable road users and its potential link to automation, as well as the future research priorities in the field;
- an analysis of safety vs. ecomobility highlighting research priorities;

Finally, Myriam Coulon-Cantuer, the EC Project Officer, presented the view of the EC on the future research challenges for ICT and transport.

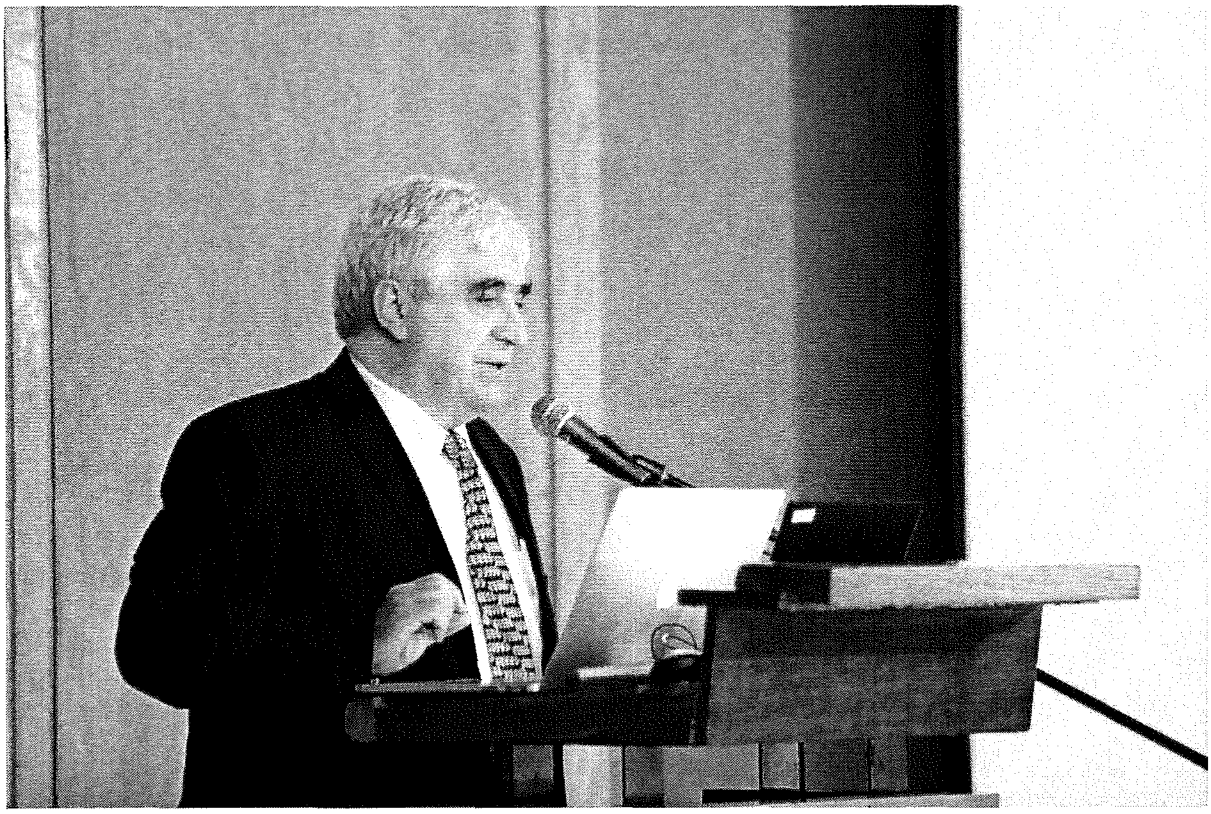
3. Presentations

3.1 Welcome and presentation of the main objectives of the DECOMOBIL project

Anabela Simoes, Professor, CIGEST **& Annie Pauzié, Research Director,** Ifsttar

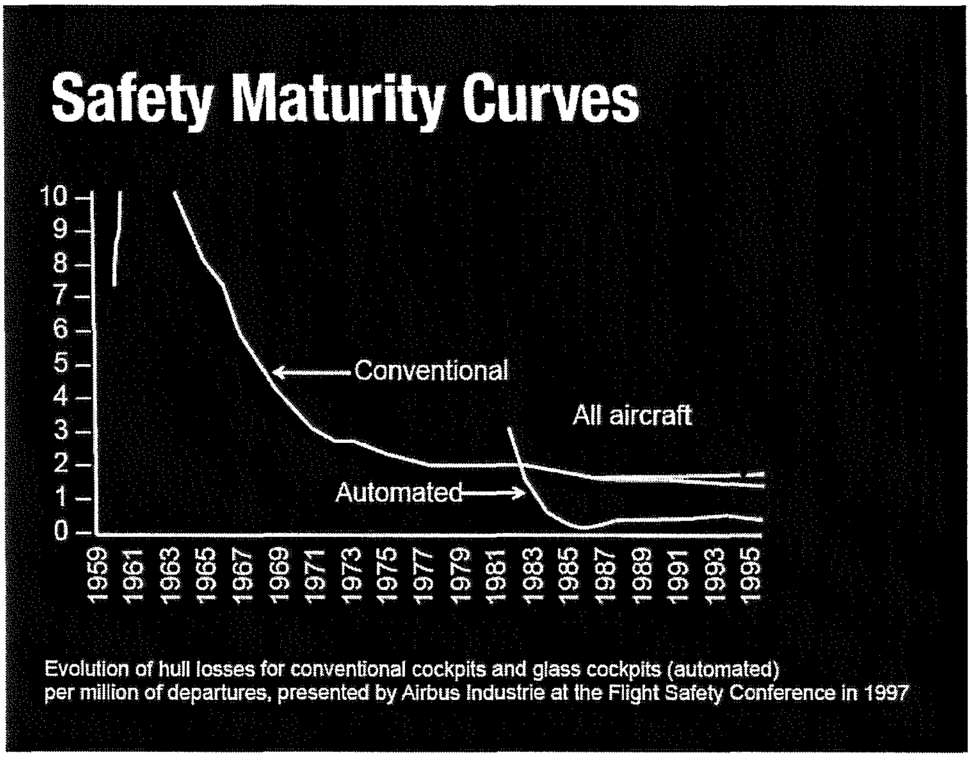
After welcoming the participants to the University of ISG/Business & Ecnomics School, in Lisbon, the main purposes of the DECOMOBIL project have been presented to the audience.

3.2 Transport Safety: A matter of Technology, Organisation and People

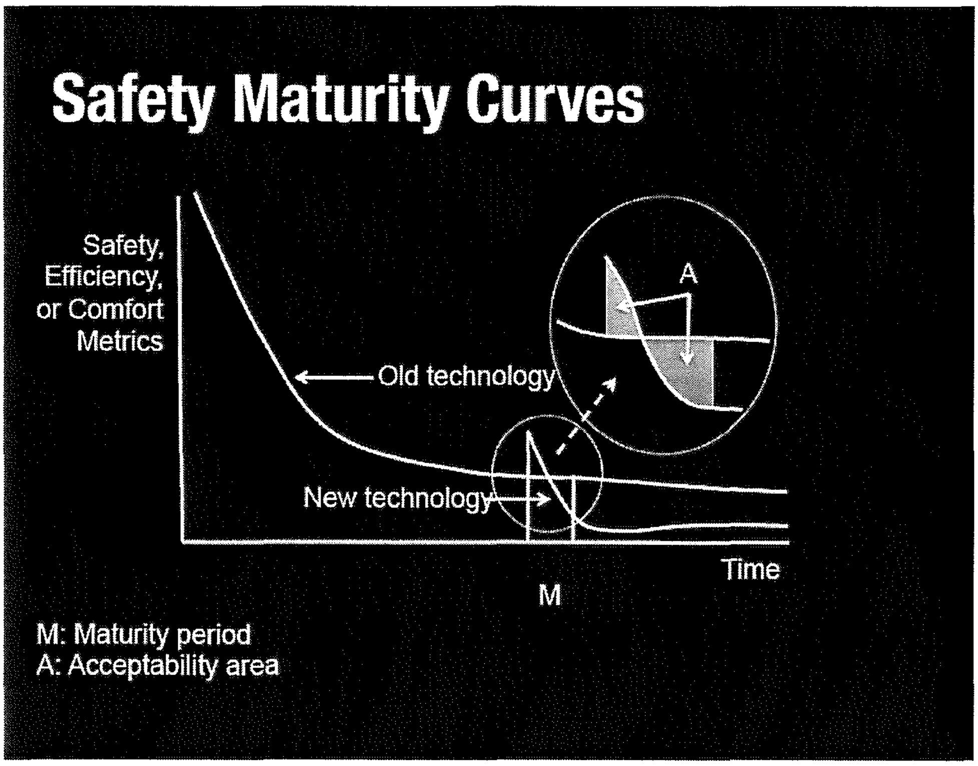


Dr. Guy Boy, University Professor, Director, Human-Centered Design institute, Florida Institute of technology; IPA Chief Scientist, Human-Centered Design, NASA Kennedy Space Center, Fellow of the Air and Space Academy, USA.

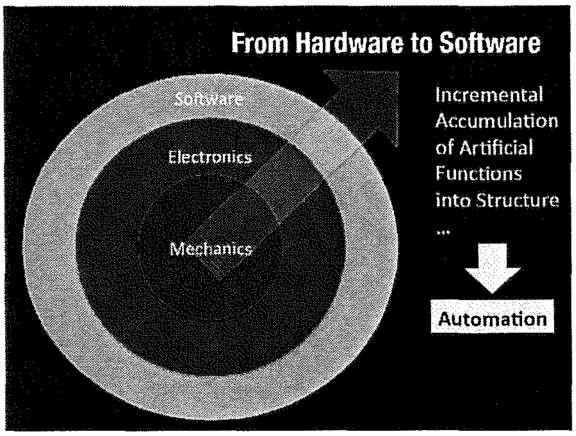
Full video and slides of the presentation available at http://decomobil.humanist-vce.eu/Downloads.html



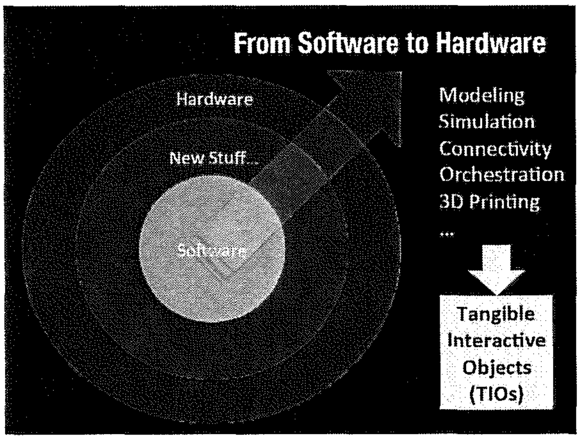
Safety in aircraft: critical figures of accidents while switching from conventional to automated aircraft before reaching a level of technology and human maturity related to the automation: an example to consider while on the process to develop automation in road transport.



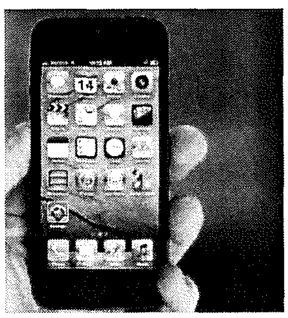
Previous process of automation was from Hardware to Software, corresponding to the accumulation of artificial functions to mechanical structure:

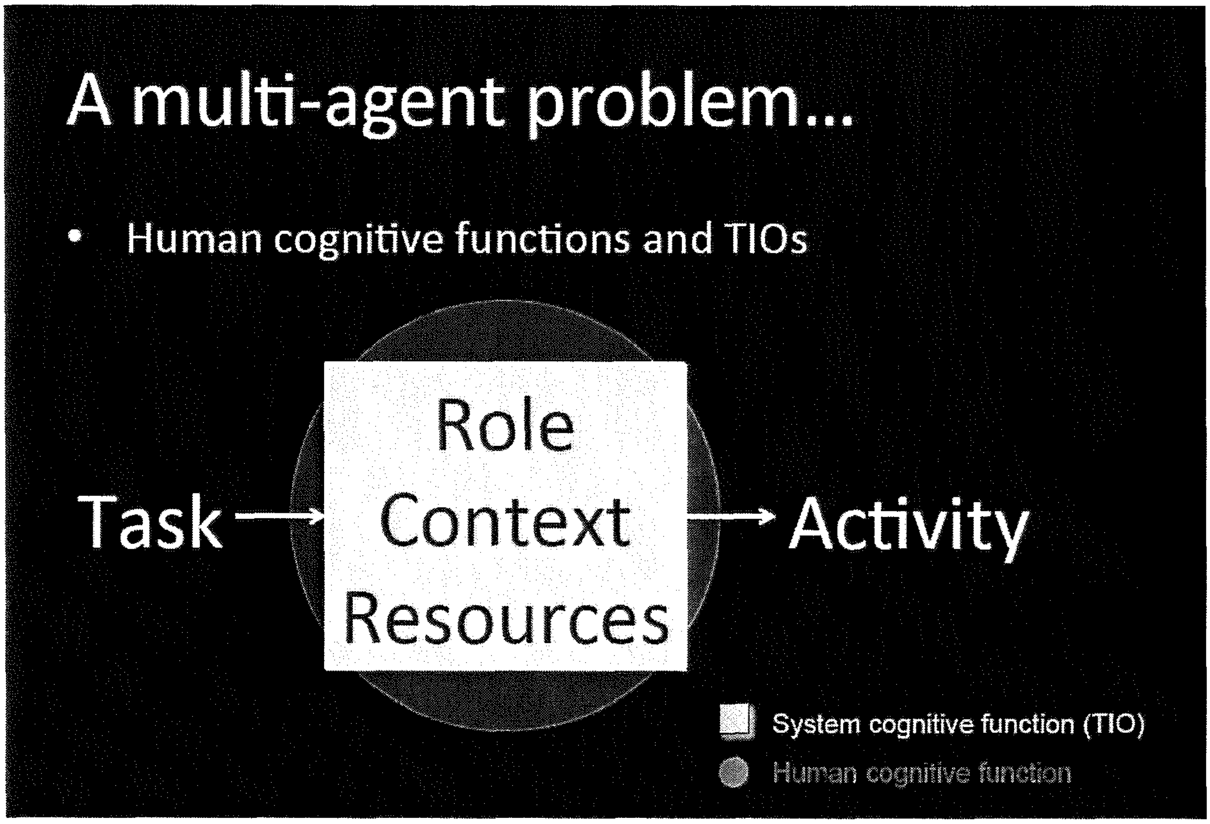


Nowadays and in the future, modeling, simulation, connectivity support the process of developing Tangible Interactive Objects (TIO) and going then from software to hardware.

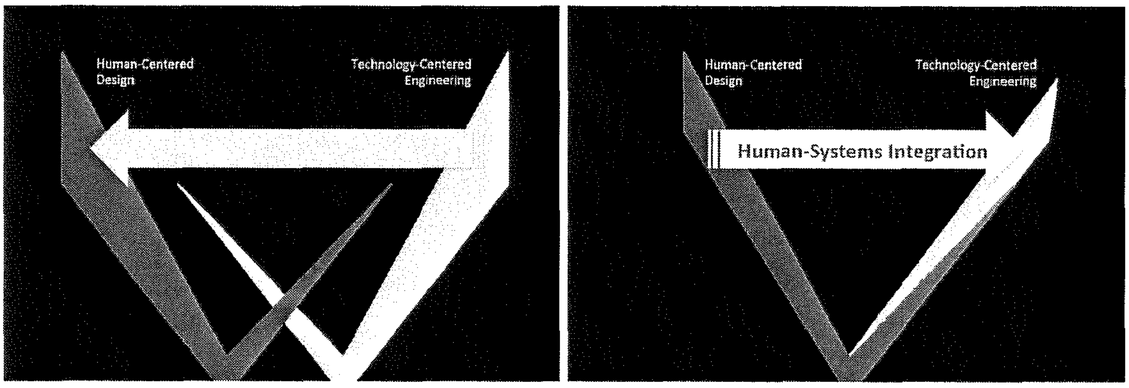


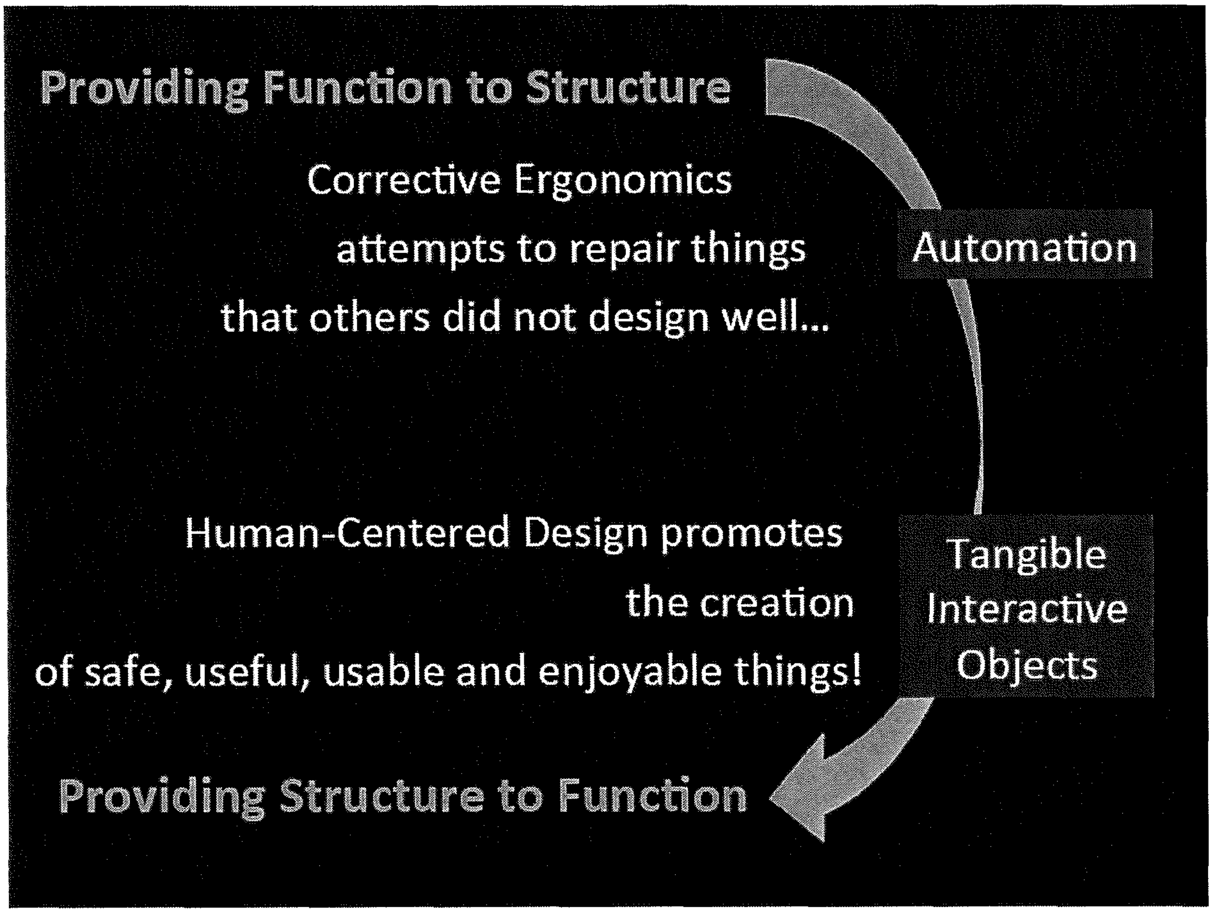
The smartphone: an example of Tangible Interactive Objects.



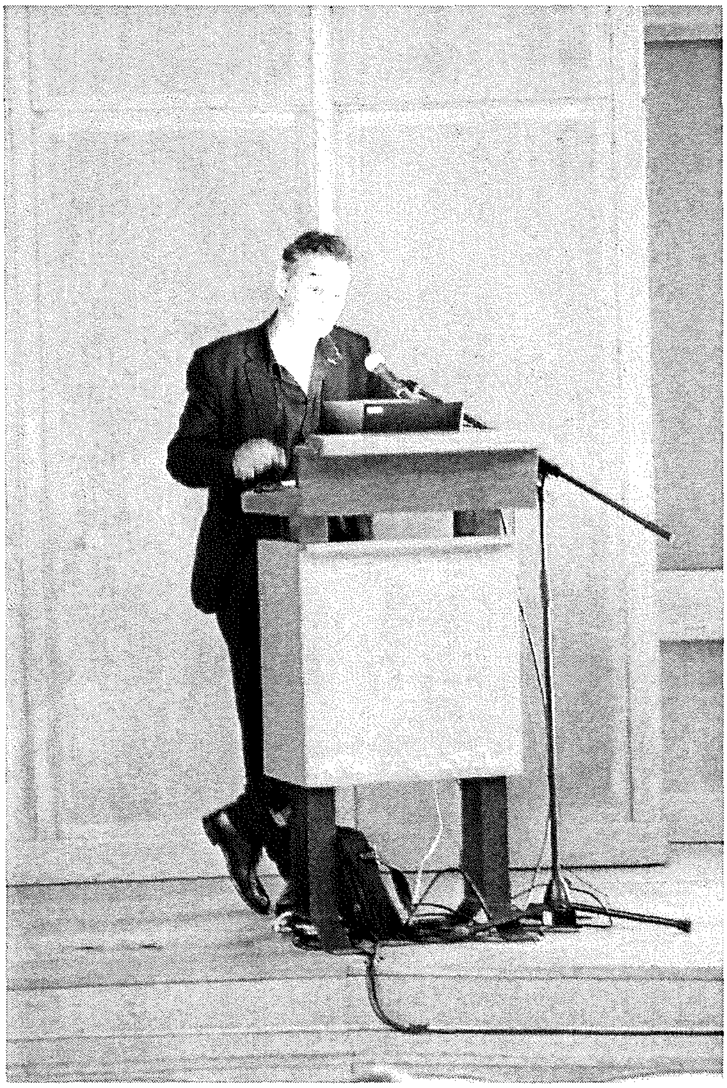


The V-Model becomes more complex and required Human-Systems integration:




Providing Function to Structure
Corrective Ergonomics
attempts to repair things
that others did not design well...
Automation
Human-Centered Design promotes
the creation
of safe, useful, usable and enjoyable things!
Tangible
Interactive
Objects
Providing Structure to Function

3.3 The Pervasive Copilot: How ITS could support a Shared Situation Awareness between road users ?



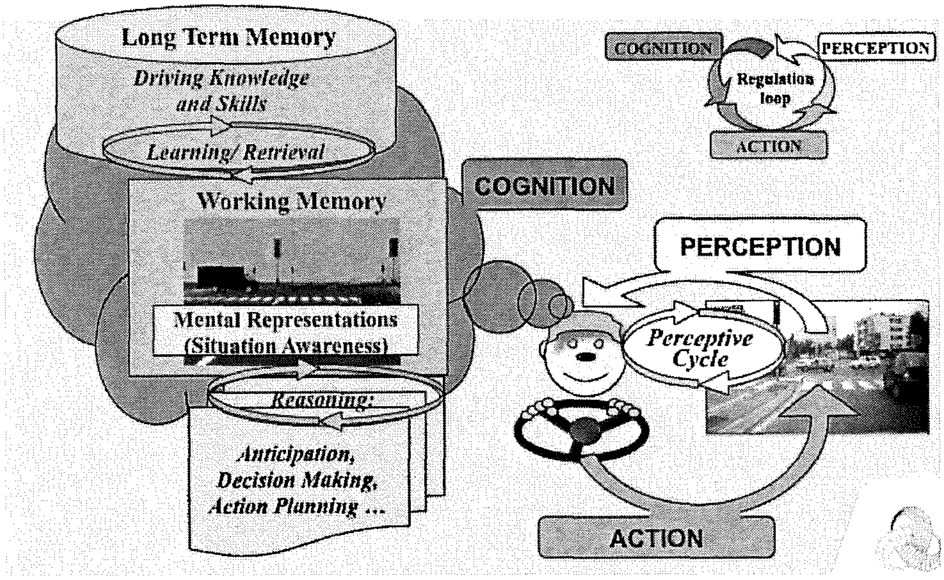
Dr. Thierry Bellet, Researcher, Ifsttar-LESCOT (Ergonomics and Cognitive Science Laboratory), France.

Full video and slides of the presentation available at http://decomobil.humanist-vce.eu/Downloads.html

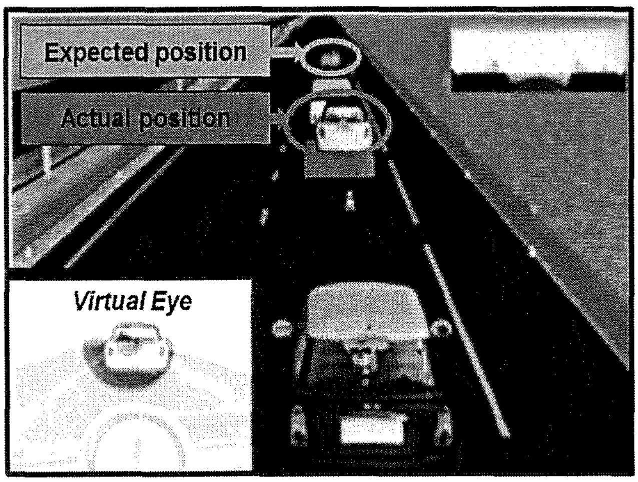
1) The Situational Awareness issue
2) How driving aids can support Drivers' Situational Awareness?
3) How future ITS based on *Pervasive Technologies* could support a *"Shared Situation Awareness"* between road users ?

⇒ ***The "Pervasive Copilot"***

Situation awareness: a central process to drive a car:

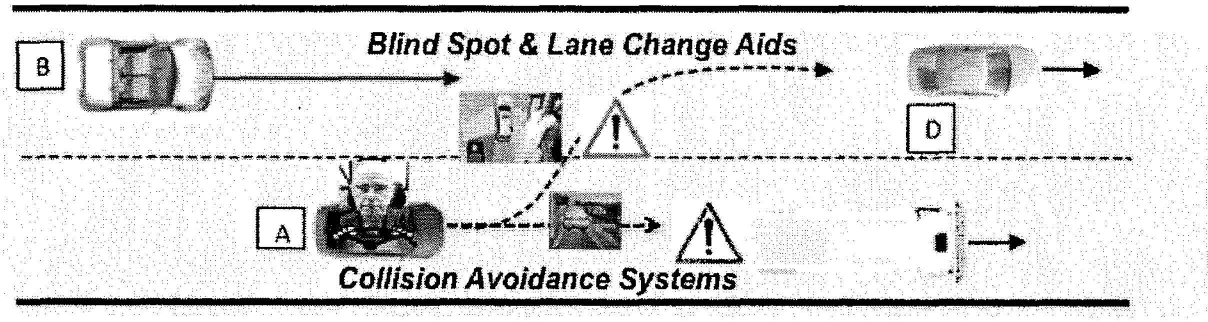


Example of erroneous situation awareness due to a misperception (visual distraction)



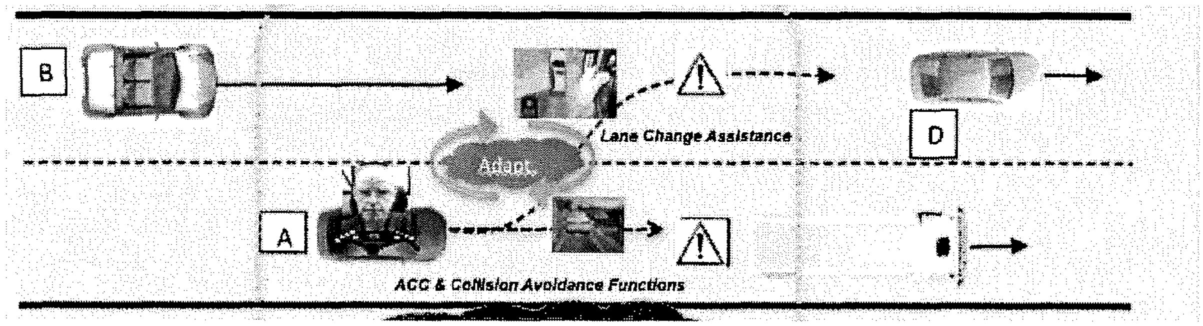
How to support Driver' Situation Awareness during driving ?

- Individual driving aids:



- Benefits :
  - ✓ Can support and increase Situation Awareness
  - ✓ Can avoid (e.g. warn the driver) local risks
- Limits :
  - ✓ A set of Individual Systems => "local SA support"
  - ✓ Individually designed and can be in conflict
  - ✓ Not always adapted to specific needs of the driver
  - ✓ Towards the Adaptive and Integrative Copilot

- the "Integrative & Adaptative" co-pilot:



The "Adaptative Copilot":

- Based on Real-Time Analysis (Monitoring) of :
  - The *Driving Situation*
  - The *Driver's Behaviour*
- In order to <u>Automatically Assess</u> in real time if:
  - *It is or not necessary to assist the driver in the current situation ?*
  - *If Yes, Which kind of help is needed (Type & Mode of assistance)?*
- To Provide an assistance specifically adapted to <u>THIS</u> driver in <u>THIS</u> driving situation

Towards the "Pervasive Copilot"

The pervasive technologies approach:

- Pervasive Computing is a recent field of research (end of 90s) in Computer Sciences, Electronics & Telecommunication
- A "New Vision" on interactions between human beings and all electronic systems in the near future
- Based on "Ambient Intelligence" and "Communications" between interconnected devices (the *"Every-ware"* concept of Greenfield, 2006)
- Ambient intelligence refers to electronic environments that are _sensitive_ and _responsive_ to the presence of human (they are *"aware of us"* and they have to *"take care of us"*)

The pervasive technologies approach based upon Ambient Intelligence:

The pervasive computing want to propose Human-centred Systems that are (Aarts et al. 2001):

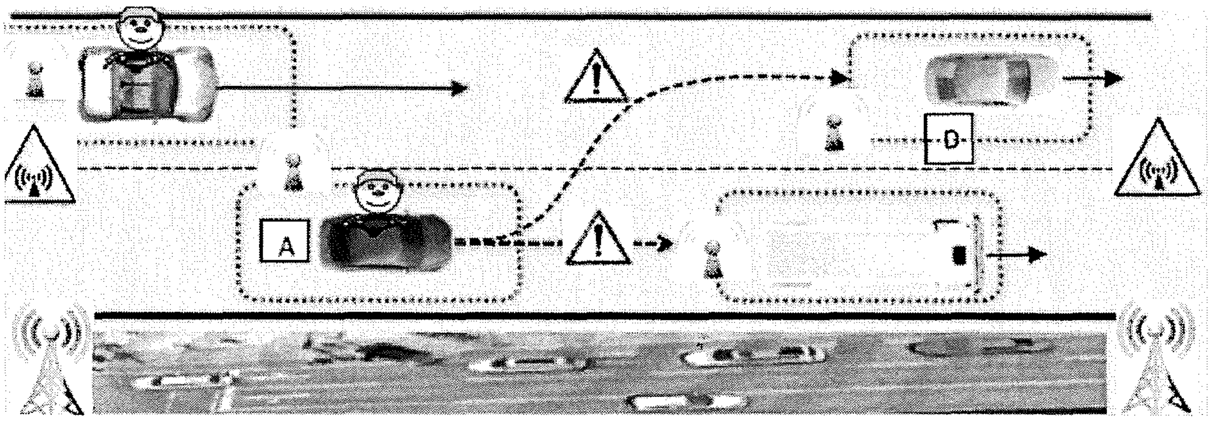
- Embedded and Interconnected: networked devices are integrated into the environment and communicate
- Context-Aware: Pervasive device can recognize the user and the situational context of device use
- Personalized: they can be tailored to users
- Adaptive: they can change their response accordingly user needs and context
- Cooperative and Anticipatory: they can anticipate user needs and collaborate without any explicit demand

The Problem of "Un-Shared Situation Awareness

The driver point of view

The motorcyclist point of view

Future challenge: The Pervasive COPILOT



ITS based on "Ambient Intelligence" Support Technologies

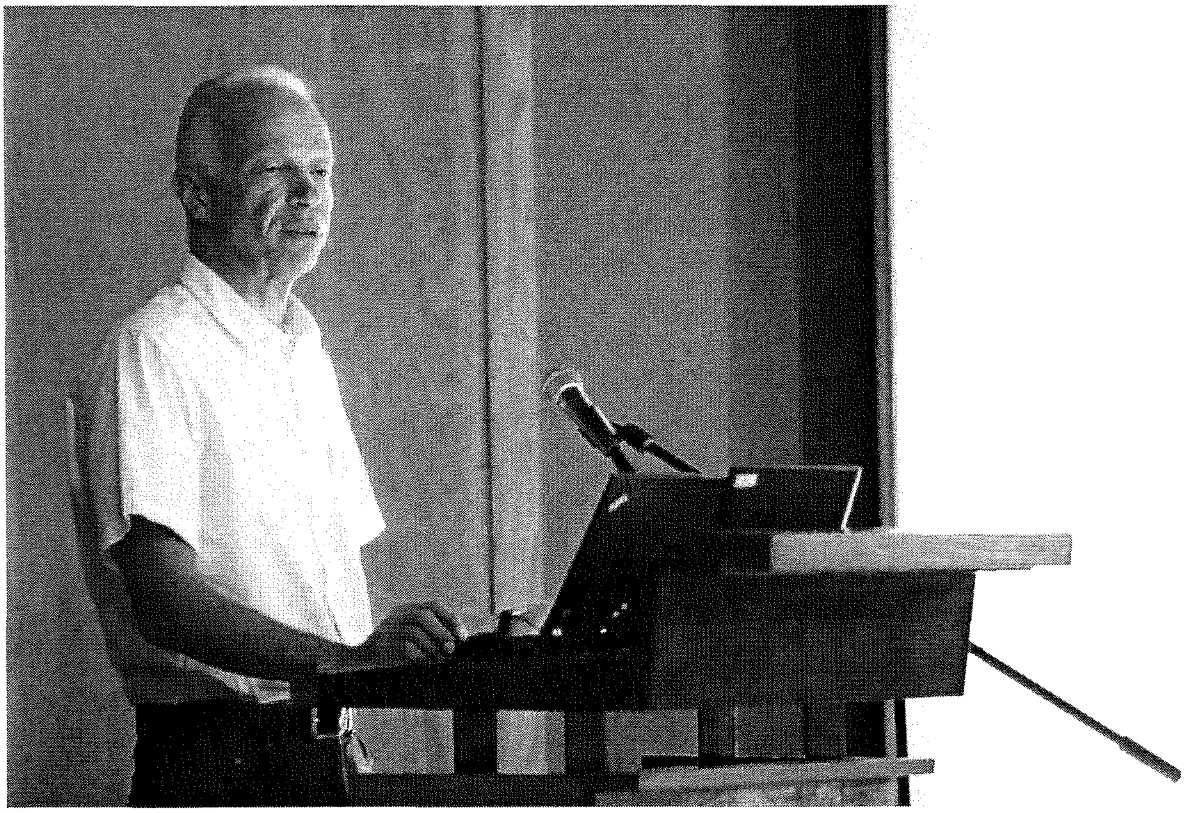
- ✓ *Embedded Sensors in Vehicles (V-V) & Telecommunications*
- ✓ *Interconnected Road Infrastructure (V-Infrastructure)*

⇒ Could be a Support for a "Shared Situation Awareness" (between road users) and "Global traffic Management" ITS

Conclusion

- Design a Pervasive Copilot seems to be complex task, however:
- Several support technologies already exist:
    - Embedded sensors (for both Car and Road Infrastructure)
    - Driving Aids (to be better integrated)
    - Traffic Controls Services, Organization and Supports for ITS
    - Interconnected Nomadic Devices
- Main missing components of the functional architecture:
    - The "Global Situation Awareness" approach
    - The "Centralized Manager" to monitor driving aids as an "Integrated Device"
    - Ambient Intelligence & Pervasive technologies adaptation to the specific constraints of car safety / ITS applications

3.4 Road traffic accident causation and ITS: how do we choose the most effective solutions?



Prof. Oliver Carsten , Institute for Transport Studies , University of Leeds, UK

Full video and slides of the presentation available at http://decomobil.humanist-vce.eu/Downloads.html

Typical alternatives are to:

1. Learn from accidents
2. Look at current technologies and see how they might assist road users

We can look at accidents and identify clusters. Thus Carsten and Draskóczy, 1995 drew on previous work (e.g. Hydén and Draskóczy, 1992) to identify the major safety problems in Europe as: single vehicle accidents on motorways

- rear-end collisions on motorways
- single vehicle accidents on rural roads
- head-on collisions on rural roads
- crossing collisions at rural intersections
- crossing collisions at urban intersections
- pedestrian and bicyclist accidents in urban areas

We can also observe the role of individual factors in traffic accidents:
- Young drivers are over-involved in loss of control crashes
- Elderly drivers are over-involved in intersection crashes

In-depth study aiming at looking at the causation of urban road accidents with particular emphasis on the role of human factors (Study cases: 1254 accidents in north Leeds in 1988, Total of 2454 immediate participants).

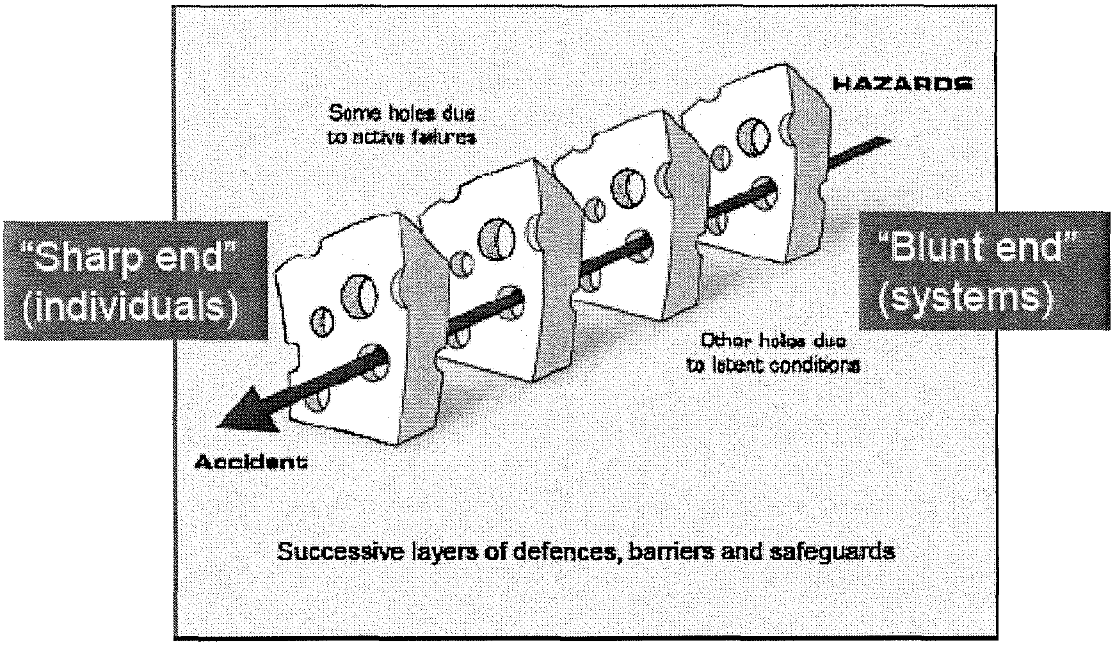
Contributing factors :
- Multi-level scheme from immediate road user errors at top to more remote causes at bottom
- Based on standard of a "reasonable road user"
- Assigned to each participant in a case conference
- A chain of contributory factors for a driver might be: "failure to yield - minor into major" caused by: "failed to look at all", caused by: "impairment – alcohol" and "fatigue"

At the main explanatory level, the most common explanations of driver and rider failures were:

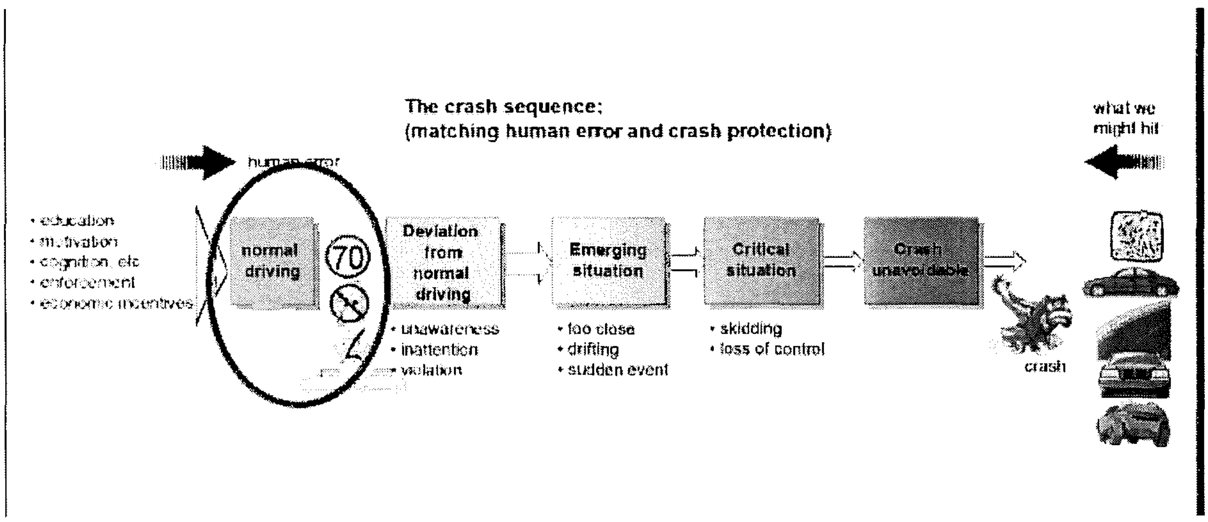
Perceptual error	16%
Unable to see	12%
Cognitive (judgement) error	12%
Lack of skills	3%
Attitude problem	2%

At the second level, which examined behaviours that increased the risk of an accident, there were some interesting differences by age and sex:
- "Driving too fast for the situation" was more commonly coded for younger drivers and much more so for males (but only coded for 5% of drivers and riders)
- "Following too close" was less common for older drivers (40+)

Human make errors; systems reduce errors and protect against the consequences of error: the latest version of the Swiss cheese model (Reason, 2008)



The crash sequence: matching human error and crash protection (Tingvall, 2006)



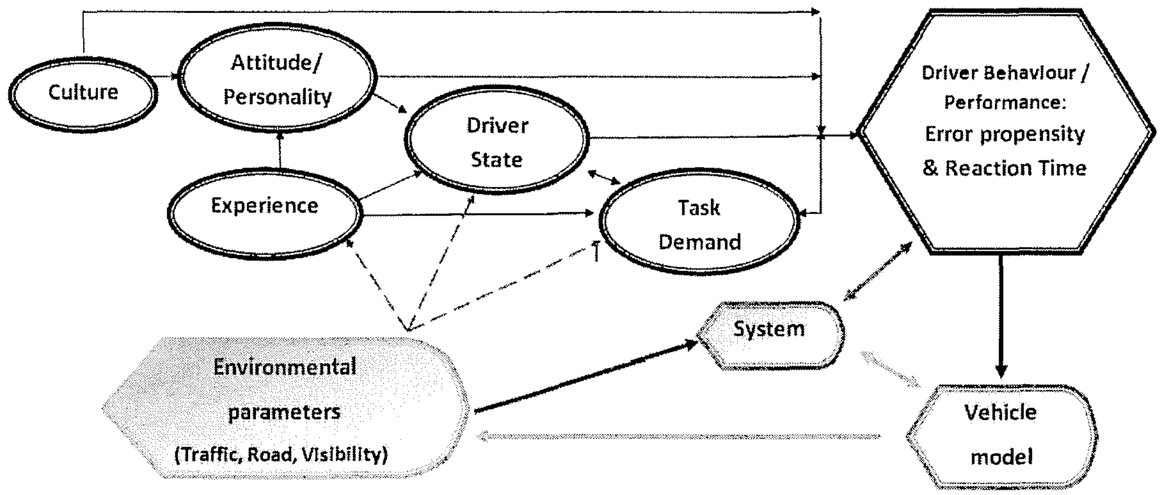
So maybe we can infer that...

- Systems that increase driver compliance (e.g. Intelligent Speed Adaptation (ISA0, alcolocks, etc.) will have wider impacts than systems that focus on particular errors (e.g. FCW, LDW)
  - – EuroFOT estimates that FCW reduces injury accidents by approx. 4% on motorways
  - – ISA-UK predicts up to 29% reduction in injury accidents with ISA

• Where a crash is imminent, automated intervention such as AEB can contribute (= a final system defence with the possibility of human error being eliminated)

• We perhaps need to go back to first principles and create systems that really support the driver

ITERATE based on Carsten (2007): the goal is to keep risk of violation and error low and maintain safety margins.



Conclusions

- Systems that prevent deviation from normal (rule-compliant) driving will tend to be more effective than systems that support drivers nearer to a crash event
- There is a role for systems that take over from the driver when a crash is imminent
- For driver support, we need to focus on driver state and managing task demand to prevent overload and underload
- We need to be wary of technology for technology's sake

3.5 Vulnerable road Users safety and potential link to automation and future research priorities in the field

Stella Nikolaou, Researcher, CERTH/HIT, Greece

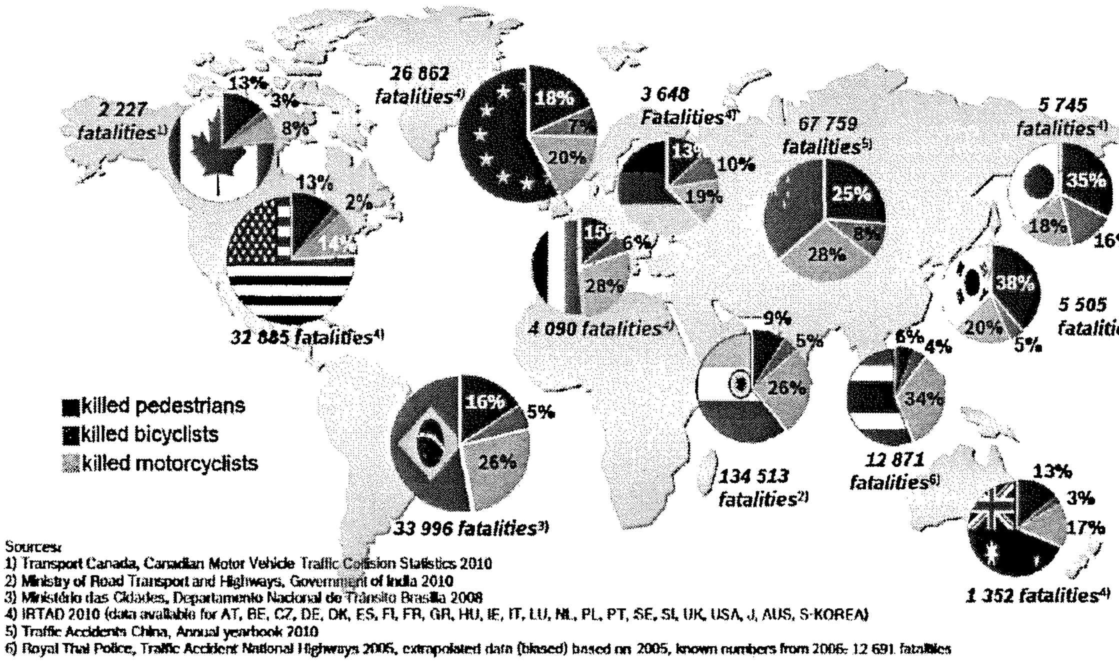
Full video and slides of the presentation available at http://decomobil.humanist-vce.eu/Downloads.html

Vulnerable Road Users: the need

- In Europe, 42% of the overall accident fatalities involve VRU (ERSO, 2010).
- 45% of all seriously injured persons are vulnerable road users. Within urban areas the vulnerable road users make up 67% of the seriously injured (European Commission, 2013).
- Although the total number of fatalities and severe injuries due to traffic accidents is decreasing, the number of VRU that are killed and wounded in traffic tends to decrease in a much slower pace (ERTRAC, 2011).

- Vulnerable road users are benefiting less from improved road safety (IRTAD, 2014).

Vulnerable road users fatalities in 2010:



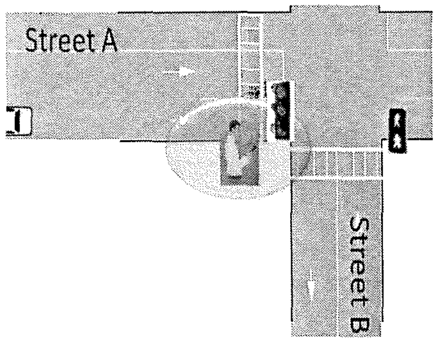
Illust

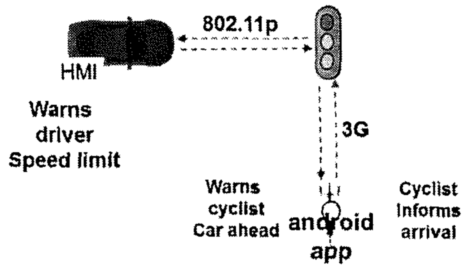
VRU iMobility Working group main obectives:

- Analyse the know-how, background data and current market & near-market solutions/ trends
- Analyse the most significant studies, researches, projects and field studies involving new concepts on VRU safety
- Identify research gaps and priorities for future research initiatives
- Promote the identified solutions, and contribute to the objectives and targets related to VRU safety in the "Horizon 2020" work-programmes
- Support European research initiatives in the field of VRU safety

VRUITS Main Objectives:

1. Assess societal impacts of selected ITS, and provide recommendations for policy and industry regarding ITS in order to improve the safety and mobility of VRUs;
2. Provide evidence-based recommended practices on how VRU can be integrated in Intelligent Transport Systems and on how HMI designs can be adapted to meet the needs of VRUs, and test these recommendations in field trials.





ITS applications selected for assessment:

1 **Blind Spot Detection**
2 **Intelligent Pedestrians Traffic Signal**
3 Intelligent Speed Adaptation
4 Red Light Camera
5 **Intersection Safety**
6 **Pedestrian Detection System + Emergency Braking**
7 Navigation System for non-motorised VRUs
8 **PTW Oncoming Vehicle Information System**
9 **VRU Beacon System**
10 Digital bicycle rearward looking assistant
11 Roadside Pedestrian Presence warning system
12 Urban Sensing System
13 Automatic Counting of Bicycles and Pedestrians
14 Night Vision and Warning
15 **Information on Vacancy on Bicycle Racks**
16 **Bicycle to Car Communication**
17 Rider Monitoring System
18 **Crossing Adaptive Lighting**
19 Infotainment
20 Real-time Information Systems for Public Transport
21 Pedestrian Road Weather Warning
22 Forward Obstacle Detection for Cyclists
23 **Green Wave for Cyclists**

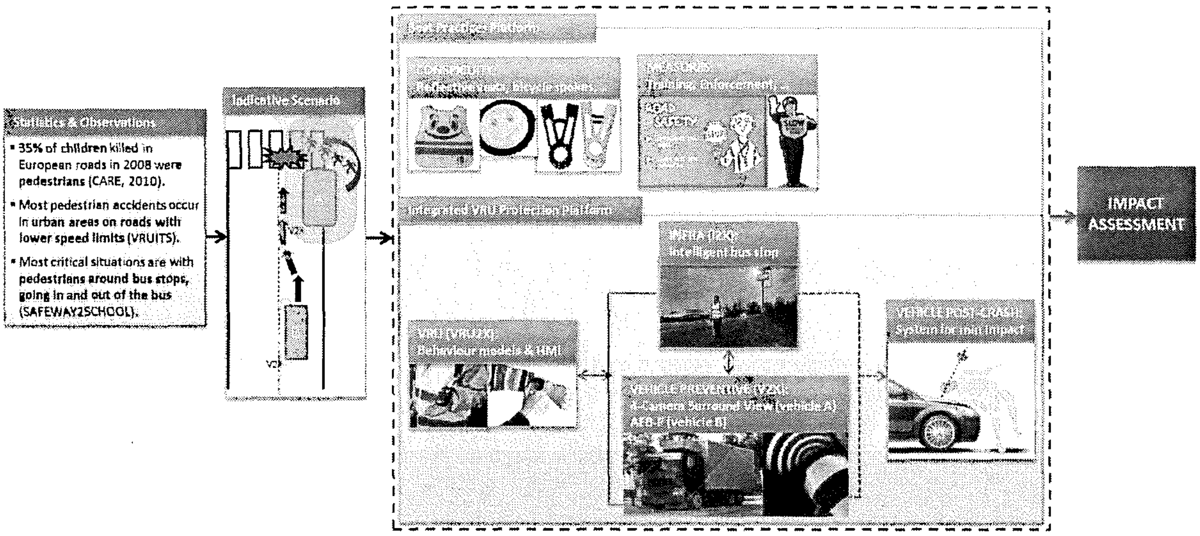
Integration of VRUs in cooperative traffic systems

1. Device, which is detected by interrogators in vehicles and/or infrastructure, sending none or limited data
    a) "tag"-like device
    b) Smartphone (use of Bluetooth or WiFi signals)
        - Problem: no standardised wireless protocol available, providing low latency and reliable location detection in dense dynamic environments

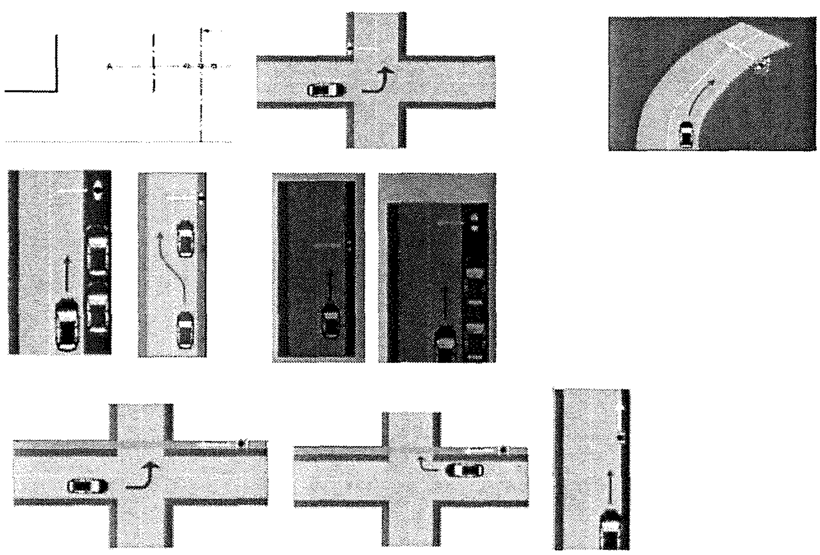
2. Device, supporting standardised cooperative applications
    a) Uni-directional (only transmission of messages)
    b) Bi-directional, allowing warning of VRUs
        - Requires, a/o

- Miniaturisation and power optimisation
- on-device intelligence and in-vehicle fusion with other sensors
- New HMI concepts for warning VRUs
- Integration in C-ITS standards

Cooperative VRU Protection Concept



EuroNCAP 2018: Scenarios comprehend pedestrians in intersections, in a curve road, in good and bad visibility conditions, as well as cyclists.



VRU WG Research Priorities (2013-2014) – Mapping to H2020 Transport WP 2013-14

- In-depth accident analysis for VRU's (Reflected in MG3.4)
- Large-Scale Field Operational Tests on Vulnerable Road Users (Not reflected in the 2014-2015 WP – Consideration for 2016-2017 WP?)
- Cooperative Systems for PTWs safety enhancement (Reflected in MG3.4)
- ICT-based advanced in-vehicle and infrastructure-based technologies and smart applications to protect VRU's (Reflected in MG3.4)
- Advanced ITS technologies for the enhancement of children safety in road transport (Reflected in MG3.4)
- Methodologies for assessment of Intelligent Transport Systems on Vulnerable Road Users safety (Reflected in MG3.4)
- Sustainable riders' training aiming at safe and cost efficient behaviour (not directly addressed in MG3.4)
- Interaction of future automated vehicles with compatible vehicles and Vulnerable Road Users (Issue for MG3.6!)

VRU WG - Recommendations & Priorities 2015-16

- Large-Scale Field Operational Tests for Vulnerable Road Users
- Specificities of PTW's on application and services and their interaction with other road users
- Integrated safety for children, elderly and persons with reduced mobility as pedestrians, cyclists and Ebike users.
- Interaction of VRU's with automated and non-automated vehicles (promoted in cooperation with the Human Factors Subgroup of the Automation WG)

Research & Innovation (R&I) WG - Research Priorities 2015-16 – Road Safety Objective

Establish the scientific basis for realizing Vision Zero in the EU before 2050, taking into account all phases from normal, assisted or automated driving to post-crash safety.

Objective

Establish the scientific basis for realizing Vision Zero in the EU before 2050, taking into account all phases from normal, assisted or automated driving to post-crash safety.

Priorities

Safety of the Vulnerable Road User (VRU)

- Need for incident, near-miss and pre-crash data related to Vulnerable Road Users (incl. single accidents).
- Development of advanced in-car systems (also specific solutions for trucks and buses) to avoid or mitigate conflicts with VRUs.
- Specificities of PTW's on application and services and their interaction with other road users.

- Integrated safety for children, elderly and persons with reduced mobility as pedestrians, cyclists and ebike users.
- Interaction of VRU's with automated and non-automated vehicles with various uptake rates

Large-Scale Field Operational Tests for VRUs

- Investigation and refocus of FOT methodologies, equipment and systems used in the automotive FOTs and their adaptation to VRU-specific applicability
- Adaptation and design of proper data handling procedures and data analysis, matching the needs of VRU accident causation
- Naturalistic riding conditions cast an additional requirement on ITS for VRU development and availability due to issues such as cost, space, powering and HMI element and safe use

Vehicle technology for 2-wheeler safety (PTW, bicycles, pedelecs)

- Active safety systems for two-wheelers to avoid or mitigate collisions. Systems can be cooperative (e.g. ITS systems) or non-cooperative.
- Passive safety systems to make a crash as forgiving as possible. Stand-alone and combined in-vehicle systems and personal equipment (e.g. garment and helmet).
- Visual (e.g. lighting) and/or digital (e.g. cooperative systems) conspicuity enhancement should improve visibility and detectability of vehicles and anticipate potential critical or hazardous situations.
- Adaptive HMI and decision support systems to properly communicate prioritised information from all ARAS and OBIS and other ITS systems to the VRU.
- Safety solutions dedicated to particular user categories such as elderly riders, impaired persons (e.g. mobility scooters), novice and returning riders.

Automation WG – Human Factors SG, Investigating road user behaviour in the context of automation heterogeneity across the vehicle fleet

Background

- For the next fifty years the road vehicle fleet will comprise of vehicles with different automation.
- Vehicle drivers/riders, pedestrians and cyclists may modify their behaviour based on their perception and understanding of the automated/manual driving behaviour of vehicles they encounter.
- May be associated with negative safety outcomes and potential disruption of transport systems

Objectives

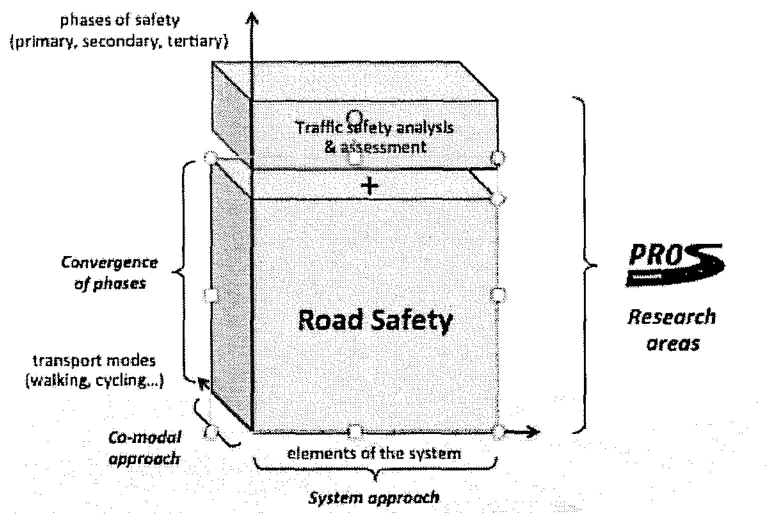
- Investigate road user (pedestrians, cyclists and drivers) behaviour in the context of a vehicle fleet with heterogeneous levels of vehicle automation.

- Investigate how to improve the ways in which automated vehicles can communicate their intentions to other road users so that manoeuvres are in line with human drivers' expectations (and conduct evaluation studies of proposed techniques).
- Investigate opportunities for misuse/abuse of automated vehicles that may result in unanticipated adverse consequences.

Outcomes

- Produce guidance on optimisation of road transport systems with changing heterogeneous levels of automation over time based on an understanding of road user behaviour in this context and effective, intuitive communication of automated vehicle intention.
- Development of strategies to prevent misuse/abuse of automated road transport systems by other road users.

The PROS approach project



Priorities in Road Safety Research – Human

- Behaviour in traffic – Making us safer road users
- Improving protection in crashes – Counteracting our fragility

Priorities in Road Safety Research – Vehicle

- Technological leadership in safe future vehicles – From assisted to automated driving
- Technological leadership in safe future vehicles – Improving protection in crashes

- Vehicle technology for two-wheeler safety

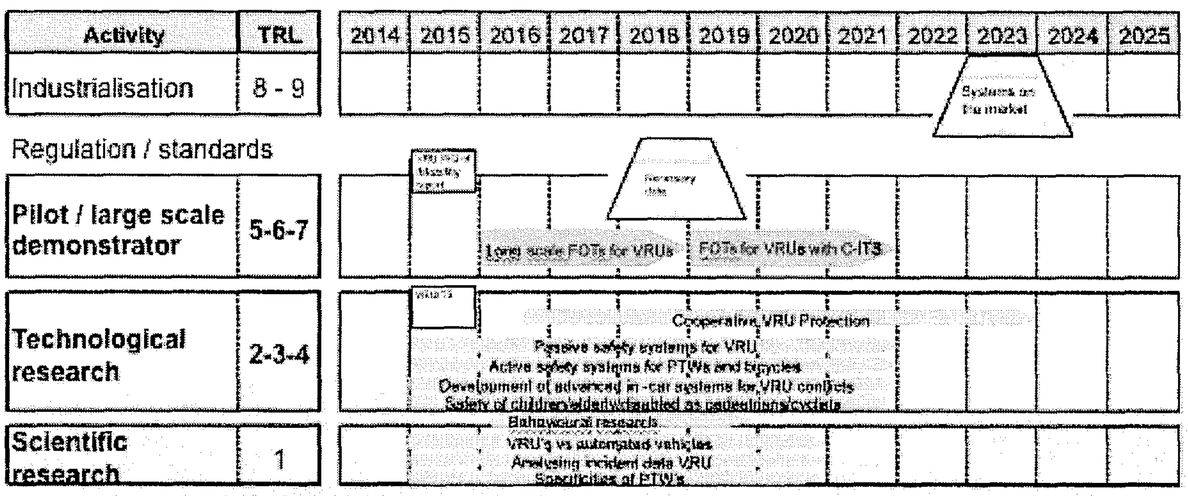
Priorities in Road Safety Research – Infrastructure & Traffic System

- Safe roads design – Making them self-explaining, forgiving and interactive to the benefit of all road users
- Advanced road maintenance concepts for safety
- Innovation in ITS infrastructure for safety – Making use of the connected world
- Traffic management for road safety

Priorities in Road Safety Research – Traffic Safety Analysis & Assessment

- Understanding what is happening on the road and linking it to measures
- Evaluating systems

VRU safety - Roadmap



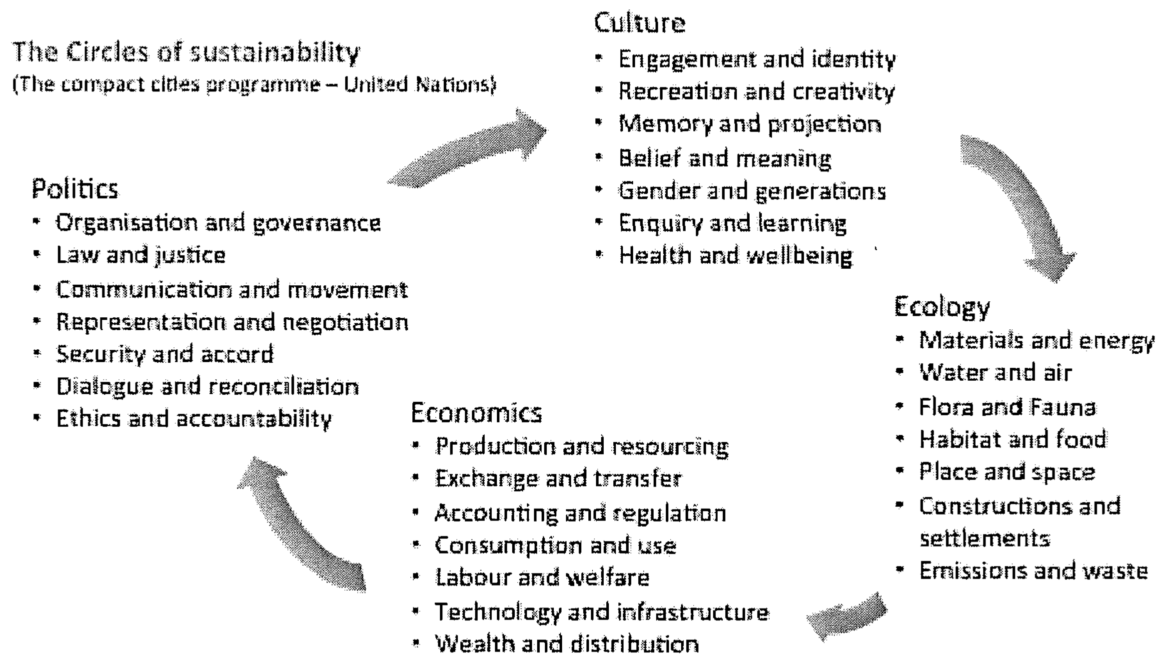
3.6 The contribution of resilience to sustainable transport systems

Pedro-Ferreira, Researcher, ISG/DREAMS

Full video and slides of the presentation available at http://decomobil.humanist-vce.eu/Downloads.html

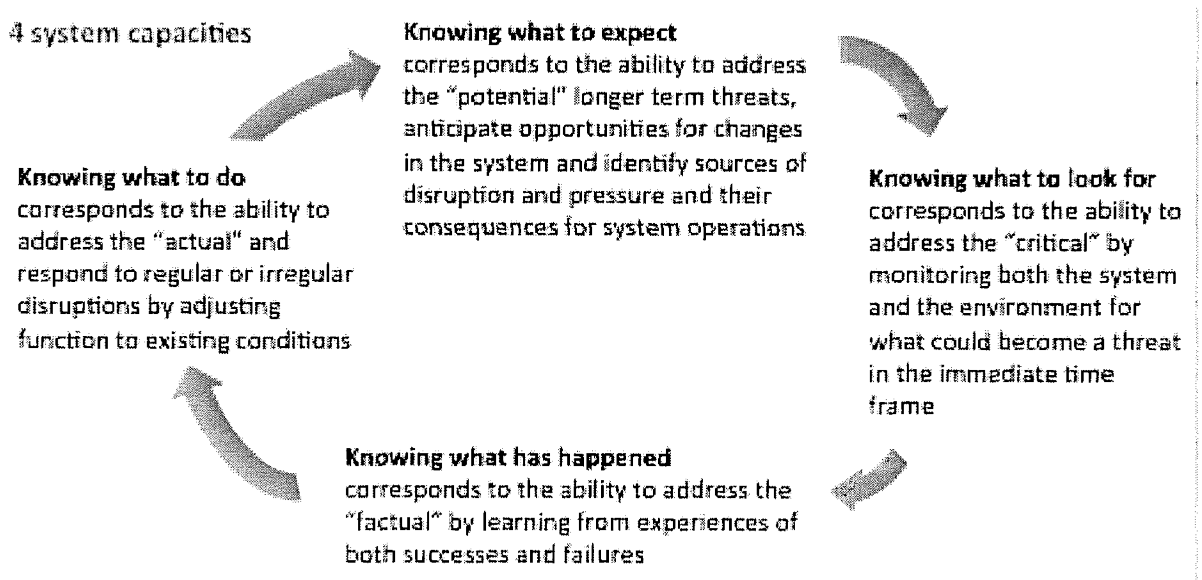
1. Sustainability

Development that meets the needs of the present without compromising the ability of future generations to meet their own needs (Brundtland Commission, 1987). *Report of the World Commission on Environment and Development.* United Nations).



2. Resilience engineering

The intrinsic ability of a system to adjust its functioning prior to, during or following changes and disturbances, so that it can sustain required operations under both expected and unexpected conditions (Hollnagel, E.: "Prologue: the scope of resilience engineering". Hollnagel et al. (eds.): "Resilience engineering in practice - A guidebook". Ashgate, 2011).



3. The challenges

Sustainability challenges are particularly prominent in transport systems, not just as a consequence of increasing energy prices, but also due to their critical economic and social function, as well as their yet considerable reliance on public funding:

- Growth of either passenger numbers or freight loads
- Numerous stakeholders (i.e. Maintenance and other service providers) that generate strong operational interdependencies
- Demands for higher energy efficiency in view of reductions in terms of environmental impacts and costs
- Demands for enhanced safety, security and overall service quality
- Demands for higher inter-modality and accessibility
- Demands for increased flexibility in transport services (costumer focused)
- Demands for higher economical and ecological sustainability (reduced reliance on public funding, reduce environmental impacts, among others)
- Transport operators and infrastructure managers must undertake a wide range of different courses of action within various management aspects (safety, security, finance, reliability, customer satisfaction, quality., business continuity...)
- Beyond the challenges that such actions pose in themselves, the coordination and integration between such a diversity of needs is rapidly becoming a critical issue for every transport stakeholder
- These management aspects can often become contradictory (i.e. the need to prevent access to restricted areas by fencing versus the need to ensure access to emergency response crews and maintenance...)

4. Resilience towards sustainability

Financial robustness and economic growth (i.e. revenues, market shares...) as means to ensure the survival and continuity of business and operations are called into question, as large scale and complex systems become increasingly vulnerable in the face of managerial and operational control challenges

↓

The waste of resources as a result of both **poor efficiency and failures** tends to increase alongside with systems scale (and complexity), which can compromise sustainability

Integrated approaches:

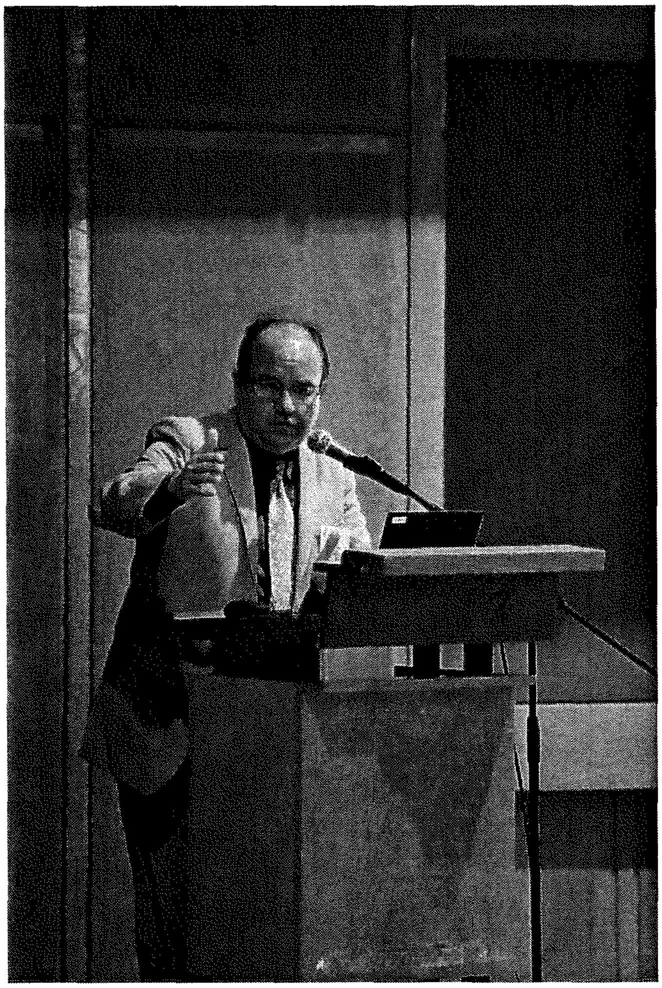
- The critical role of system interdependencies and the need for an integrated management of numerous aspects (safety, security, quality...)
- The need to take into account high variability and uncertainty factors
- Sustainability relies on a continuous ability to provide transport services whilst adapting to ever changing resource limitations and operational environments (i.e. economical and social, weather and climate...)
- Resilience engineering is based on adaptability capacities and on continuously balancing safety principles against efficiency ones (the ETTO principle)

5. Resilience towards sustainability

- Resilience engineering offers an adequate framework for the development of more sustainable transport systems
- Through an understanding of the variability of system interactions and the overall dynamics of its interdependencies, valuable answers to research questions earlier raised may be produced
- A response to current challenges and demands, transport stakeholders must be capable of seizing every opportunity to innovate and enhance efficiency, whilst ensuring high safety and quality standards
- Beyond minimising the consumption of financial, human, material and energy resources, efficiency gains must consist on generating the ability to flexibly allocate available resources, in order to continuously adjust to fast pace changing operational environments.

- A shift in social and economic paradigms must be undertaken
- Whatever that may come to be, it currently requires a new approach to understanding complexity and high dynamics, and to accepting their inherent uncertainty and underspecified nature

3.7 Safety vs Ecomobility, Setting priorities right



Dr. Evangelos Bekiaris, HUMANIST Virtual Center of Excellence Chairman

Full video and slides of the presentation available at http://decomobil.humanist-vce.eu/Downloads.html

Is research a matter of fashion and trend?

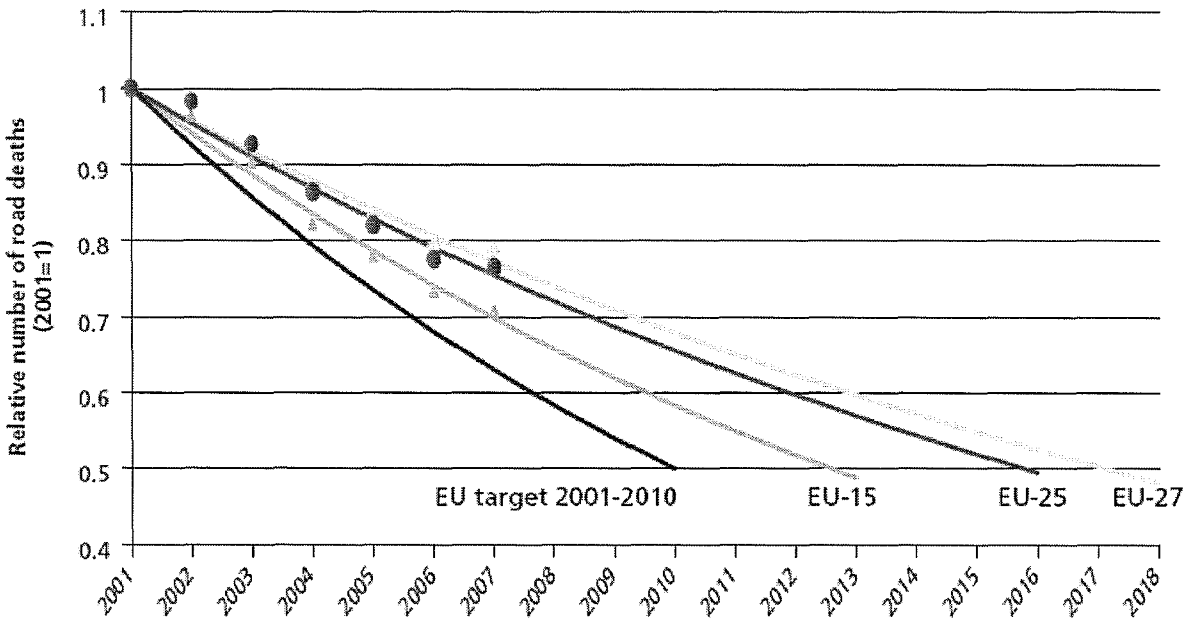
- Within FP6 the new concept of **"Zero Vision"** was introduced as the ultimate goal of the Transportation System; ***meaning zero deaths on the road.***
- Within FP7, the same term of **"Zero Vision"** is to be found in relevant Calls and EC official documents; ***meaning zero pollution from Transport.***
- Change of Policy Priorities meant a dramatic shift of Transport Research funds from Road Safety to Environmental Protection issues.

... as if the lose of life matters less...

...as if we had reached our initial goals...

...as if traffic safety and environmental protection can be decoupled...

The European Union's yearly reduction in road deaths from 2010 to 2010 was no more than 4.2% on average. To reach the set goal we should have had an annual reduction of 7.4%.



The challenges at a European level

- Continuous reduction of traffic accident fatalities, as well as focus on injuries reduction. The annual cost due to road accidents is 180 bn€. A reduction of 20% is possible.
- Only in one year, in EU-27, more than 1.000 children are killed in traffic accidents. The reduction of children-victims in accidents (ages 0-15) of up to 60% is targeted by the EU for 2020.
- The accidents with motorcyclists victims constitute the 16% of the total in EU-25, while they constitute only 2% of the circulation. Thus, a motorcyclist has 13 times greater risk to be killed on the road than a car passenger.
- The risk of death of pedestrians is 9 times greater than the one of private vehicles passengers; whereas the risk of death of bicyclists is 7 times greater.
- 60% of the EU residents live in urban areas and although the mean speeds are low, about 2/3 of the road fatalities take place there. Thus, emphasis should be given in traffic safety within the cities and rural agglomerations.
- The differences between traffic safety level among EU countries can vary up to 500%! Transfer of best practices among countries, as well as the adoption of common policies and standards is thus highly recommended.

Traffic Safety: Putting the legos in place

- Traffic safety risk emanates from the cooperation of three main factors: driver-vehicle-traffic environment.
- Measures in order to support/improve any of these factors, may have negative side-effects to the others.
- According to the risk homeostasis theory (Wilde 2001), the enhancement of safety level of a vehicle leads sometimes drivers to change their driving profile, undertaking more risky maneuvers, in order to keep their conceived level of risk constant.
- Thus, optimal measures to improve to all three contributors or build upon the strengths and interactions between each combined environment.
- ***Any change in the type of vehicles and infrastructure due to environmental reasons will also impact traffic safety and vice versa.***

The two pillars of Road Safety and Infrastructure:

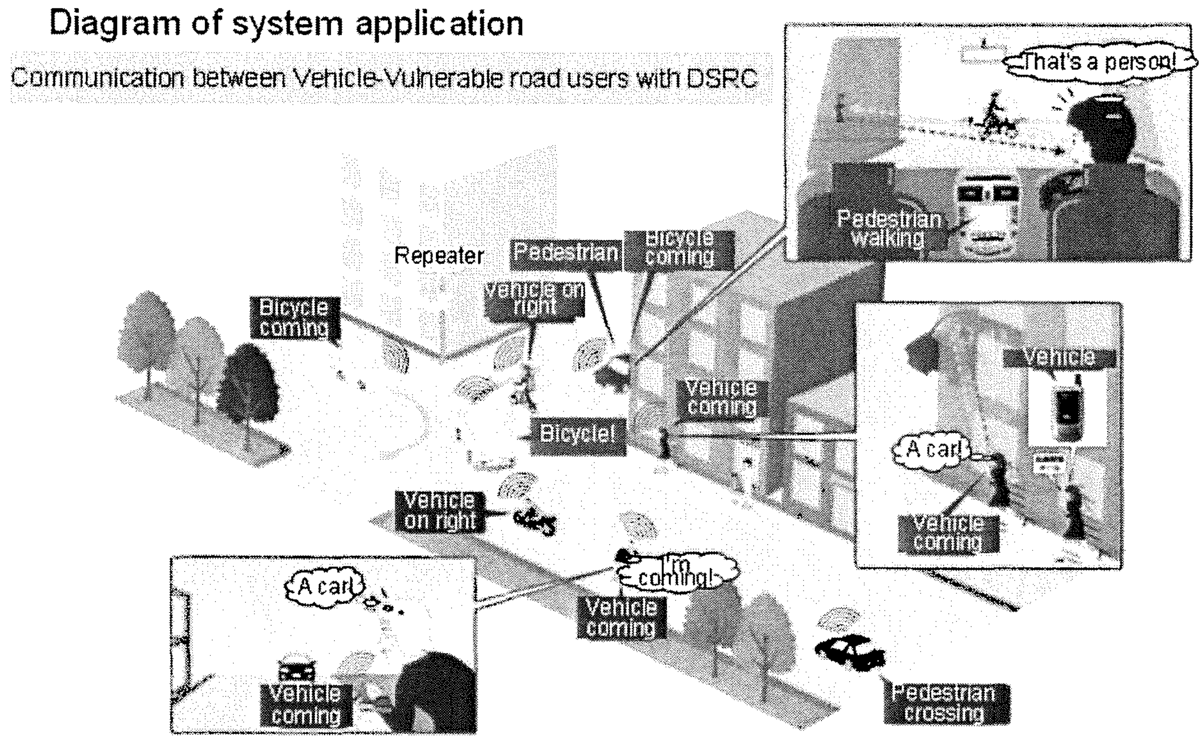
I. Forgiving Roads

A forgiving road is defined as a road that is designed and built in such a way as to interfere with or block the development of driving errors and to avoid or mitigate negative consequences of driving errors, allowing the driver to regain control and either stop or return to the travel lane without injury or damage.

II. Self-explanatory Roads

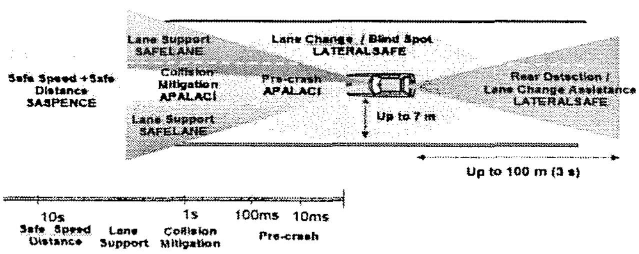
Self-explanatory road is defined as one that is designed and constructed to evoke correct expectations from road users and elicit proper driving behaviour, thereby reducing the probability of driver errors and enhancing driving comfort.

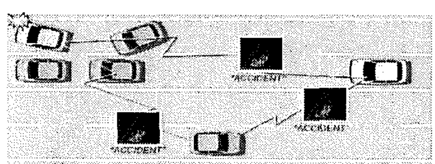
We are living in a cooperative world so also traffic environment is cooperative: C2X and other 3G/4G communication are part of the solution. Integration of communication is very challenging into integrated and safet schemes.

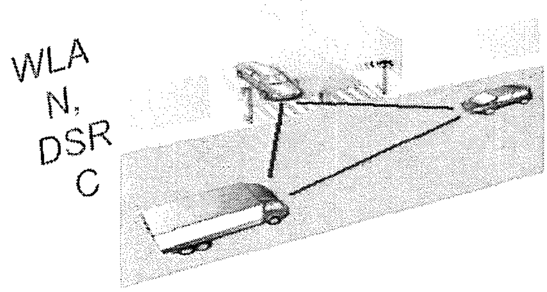


Examples of Cooperative Systems :

- Speed adaptation (V2I and I2Vcommunication)
- Reversible lanes due to traffic flow (V2I and I2V)
- Local danger / hazard warning (V2V)
- Post crash warning (V2V)
- Cooperative intersection collision warning (V2V and V2I)

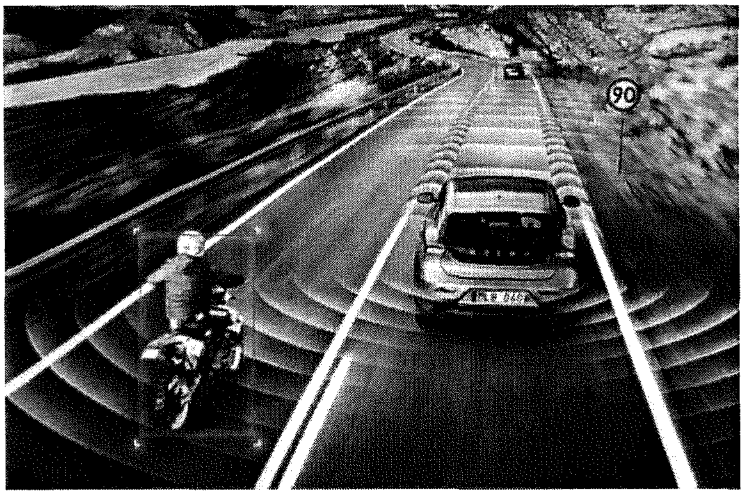




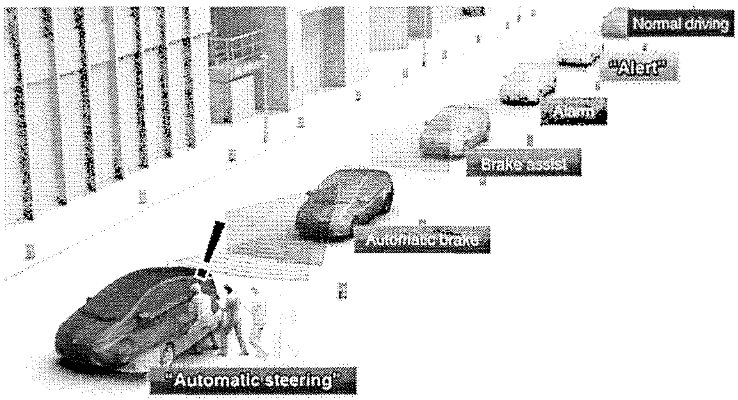


VRU Safety: Towards Integrated Safety

Although ADAS systems exist since long, the integrated safety is just beginning.



Sensors and integrated functions are needed
to manage complex situations



Integrated safety is part of steps
towards automated driving

Cooperative Systems – Potential Impacts

- Dynamic speed adaptation shows most potential (-7%) to decrease fatalities.
- The cooperative intersection collision warning and local danger warning comes next (-4%).
- The potential of injury prevention is higher for cooperative inter-section collision (-7%) followed by dynamic speed adaptation (-5%).

- The reversible lane system decreases the fatalities and injuries on the sections equipped. However, a very small part of the motorway and urban network are suitable for the system.
- The SAFESPOT impact analysis study showed considerable safety effects resulting in 7.1 % less fatalities for the V2V case, and 8.9 % for the V2I case, assuming a 100 % penetration rate of cooperative systems into the vehicle fleet (Schindhelm, 2010).

But the traffic environment is becoming ...automated!

Automation: Pros & Cons

<u>Advantages</u>

- Reduces manual workload and fatigue*
- Relief from small errors*
- Economical utilization of machines
- Precision in the handling of routine tasks*
- Increased productivity*

<u>Disadvantages</u>

- Automation- induced failures
- False alarms
- Boredom*
- Increase in mental workload due to additional monitoring of systems*
- Over-reliance, complacency; willing to accept results without scrutinizing them first*
- Silent failures
- Reduced alertness of operator, by offering a false sense of security*

* Human related

NEW TYPES OF ACCIDENTS!

Road Automation & Safety: Considerations

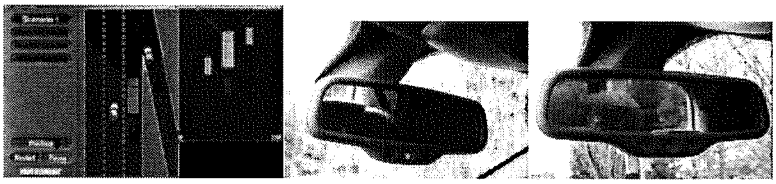
- Human-centered definitions of levels of automation
- Definition of hand-off processes between driver and system and how to test them
- Vehicles with different levels of automation ⇨ Challenges in HMI design
- Secondary tasks and influences on cockpit design
- Can disengaged driver be brought back to attention, and how soon?
- Matching driver mental model to actual system concept of operations

- What level and kind of driver status display is needed?
- Is an external display of automated status needed for other drivers?
- Long-term unintended consequences of increased reliance on automation?
- How to reconcile individual driver desire for convenience with need for safety?

Some ideas...

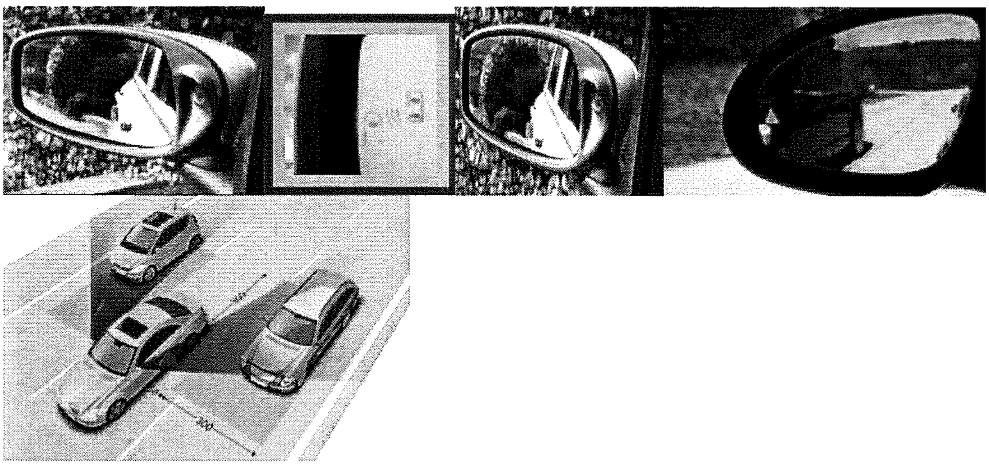
Haptic Warnings (Virtual Rumble Strips)

- Vehicle lateral and rear monitoring system (LRM)

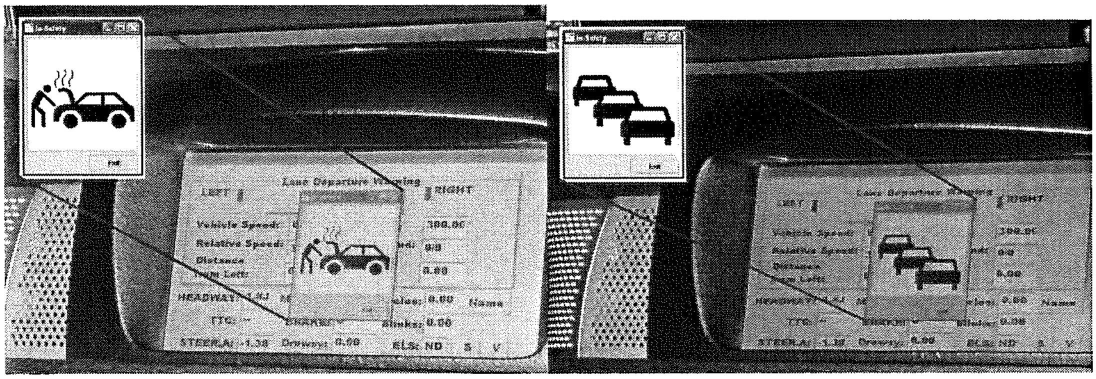


- Lane Departure Warning / Lane keeping Systems (LDWS)

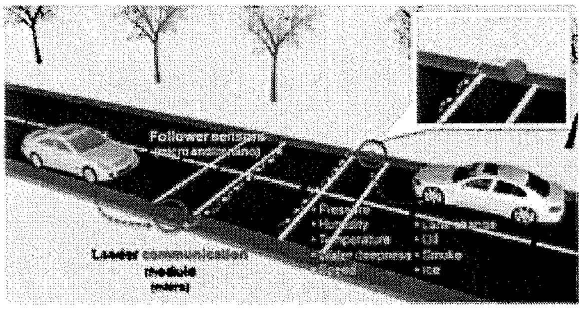
- Collision Avoidance Systems (CAS), for the lateral area, including lane change support systems.



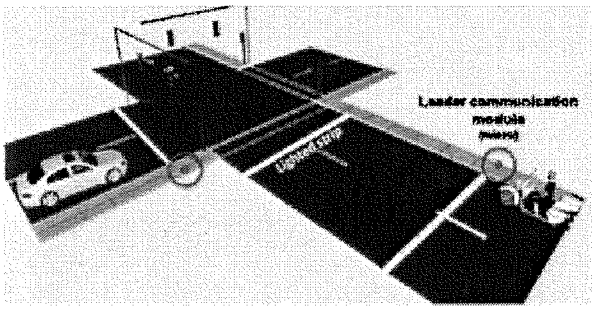
In vehicle personalized priority information...



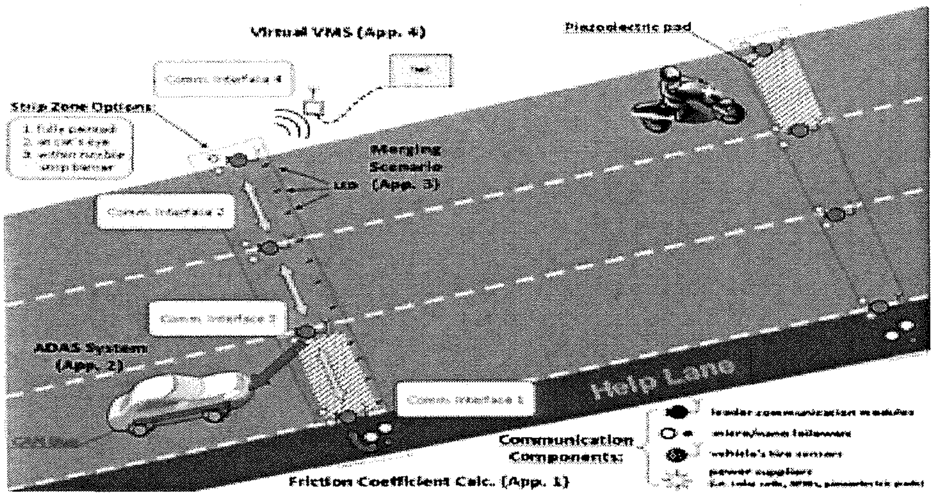
Smart Strip Concept



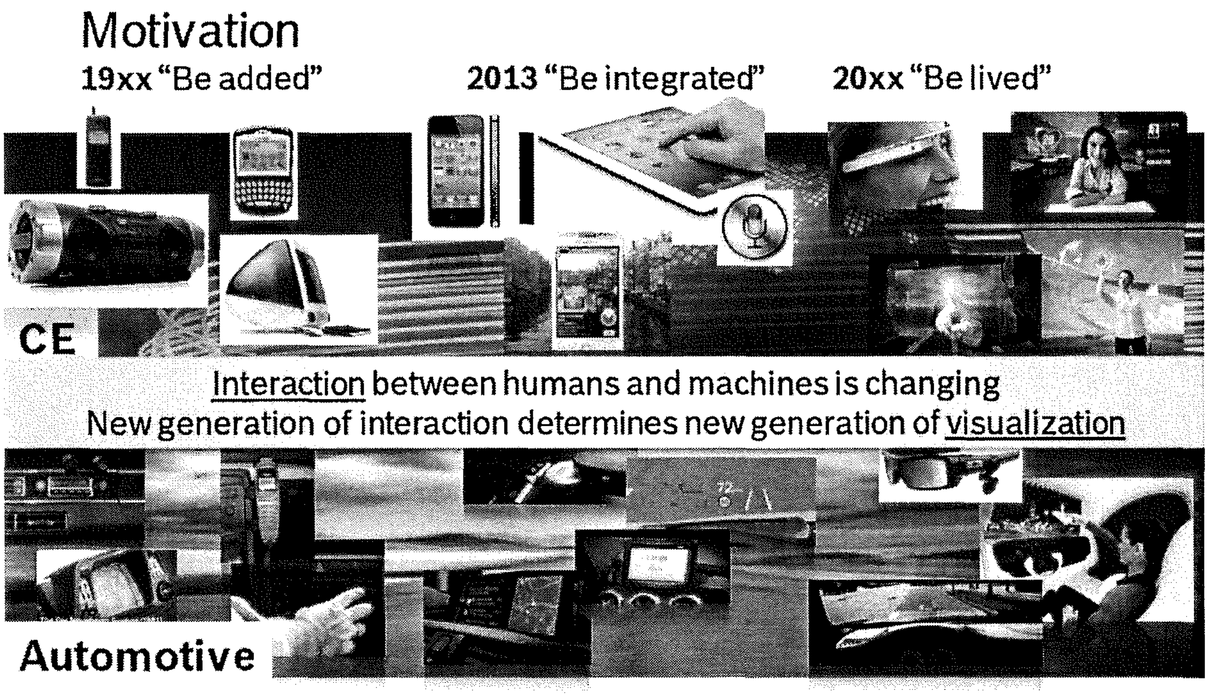
Smart Strip miniaturized multi-sensorial platform at a highway or rural environment



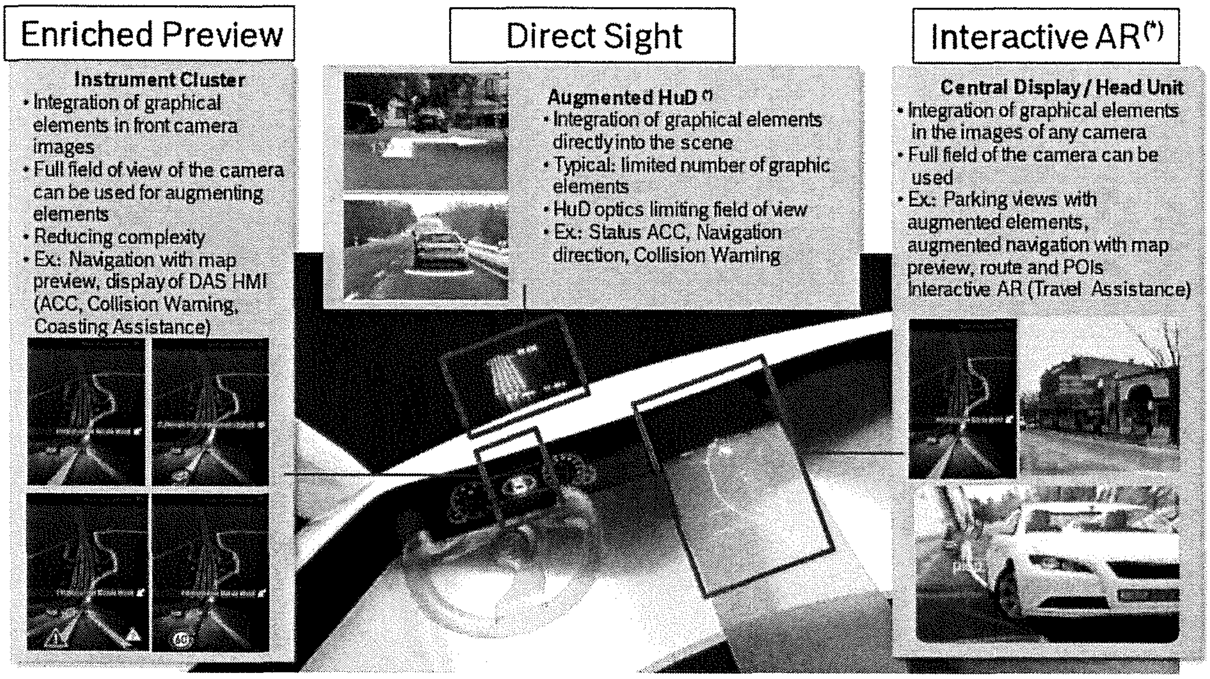
Smart Strip miniaturized multi-sensorial platform at an intersection/ merging application.



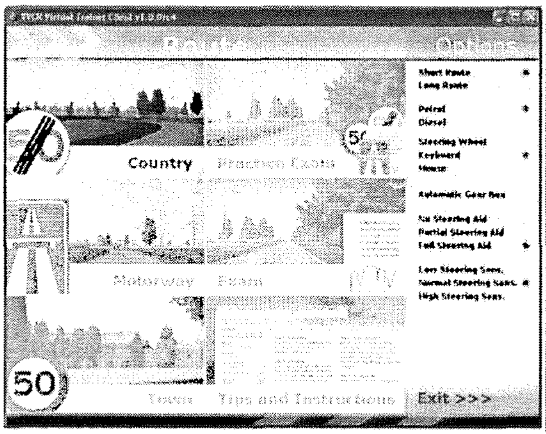
Augmented Reality

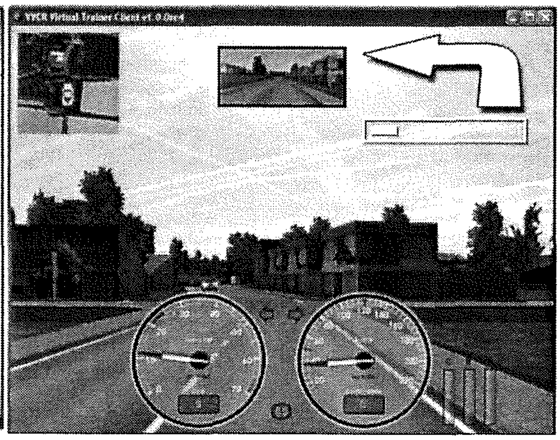


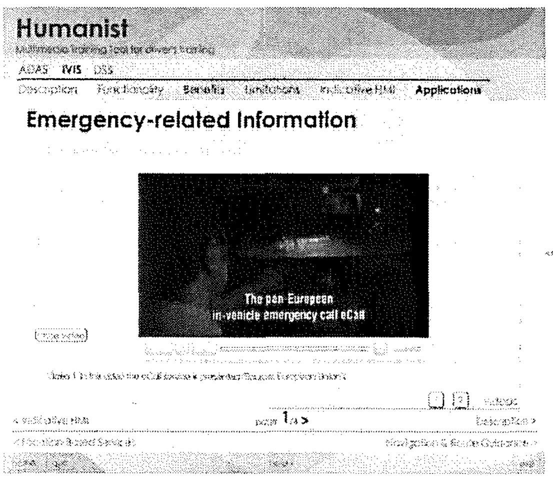
Augmented Reality in the Driver Cockpit

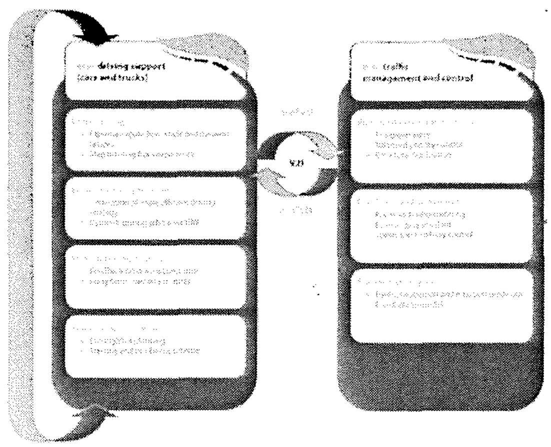


All stakeholders training









Vehicles are changing too: Are electric powered vehicles more dangerous than conventional ones?

- NHTSA Technical Report: *Incidence of Pedestrian and Bicyclist Crashes by Hybrid Electric Passenger Vehicles* (09-2009).

The study found that pedestrian and bicyclist crashes involving both HEVs and ICE vehicles commonly occurred on roadways, in zones with low speed limits, during daytime and in clear weather, with higher incidence rates for HEVs when compared to ICE vehicles.

- Dutch research has shown that quieter trams and the use of mp3 players both lead to a slight increase in road accidents (Stoop, 2008).

Are HEV Too Quiet to Be Safe for Pedestrians?

- In 11/2008, the American Society of Automotive Engineers created a special committee to examine whether hybrid cars should be made more audible for the sake of pedestrians, particularly the blind ones.
- Blindfolded subjects, who listened to recordings of cars approaching at 5 mph, could locate the hum of a Honda Accord 36 feet away and a Prius, running in electric mode, 11 feet away, without any traffic noise or other distractions (L. D. Rosenblum, 2009).

When added some realistic background noise to the recordings, Prius was mostly undetected; the Accord was detected 22 feet away.

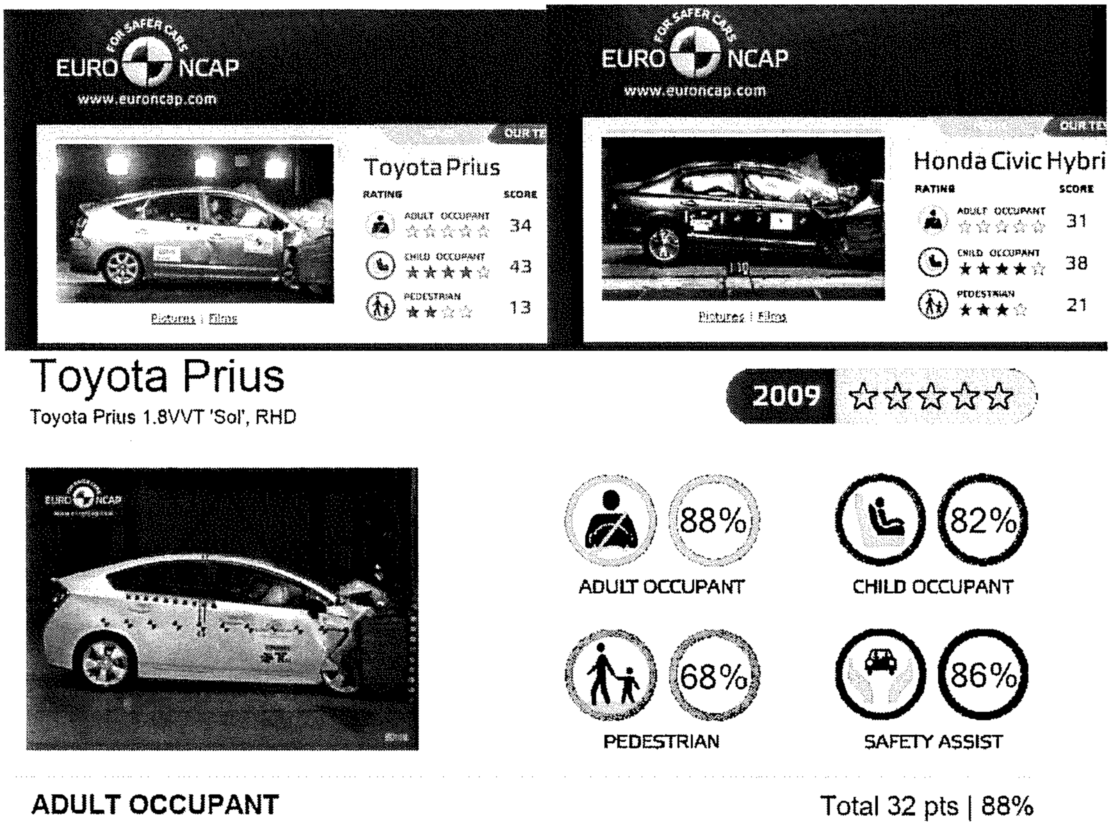
Adding sound to HEV

Sound producing devices is a viable option for increasing the auditory warning time of an electric motor powered vehicle. The engine noise was the preferred sound as an auditory warning for the vehicle (Goodes et al, 2009).

Lotus Engineering has developed a system to synthesize external sound from electric and hybrid vehicles.

Adding sounds to vehicles might seem counterintuitive, particularly since there are also concerns about noise pollution, especially in urban environments

Crash test performance of HEV



Crash Compatibility of HEV

- Electric cars are small and rigid.
- Hybrid cars are carrying two rigid parts at the front: the combustion and the electric engine.
- Hybrid cars are about 300kg heavier than an average 11ookg passenger car.

Potential dangers related to electricity as source of energy:

- Full Electric Vehicle running out of battery (On 21/12/2009, in one day, the German organisation ADAC received 28,654 emergency calls. 90% of those calls were battery breakdowns or empty batteries) in:
    - Interurban roads where continuous long trips
    - Tunnels
    - Ring-roads

Related research on battery recharge

- Project: *Magnetic slots car*: This research is about transferring power from the road, but taking the motor itself outside of the vehicle and using a linear motor.
- Project: *Korean OLEV*: Cars with no batteries use power from inductive lines.

Volvo considerations:

- In normal driving an advanced monitoring system is required to regulate cooling so that each battery cell maintains optimum operation and if overheating does occur to shut down the battery to prevent fire risks.
- Determination of technical upgrades that will be required to safety features like chassis architecture, Dynamic Stability and Traction Control systems to cope with the extra weight of battery packs in electric vehicles and the optimum location for those packs.
- Development of avoidance systems such as Collision Warning with Full Auto Brake and/or City Safety so they can be powered by electric vehicles regardless of the condition of the batteries (for example so their performance does not deteriorate if the batteries are low on power).

- In the event of a crash, protecting the batteries and isolating them from the passenger crumple zones so occupants are protected should the heavy batteries move, shutting off the batteries after the collision to prevent the risk of a short circuit and venting any gas that may leak from a shattered battery.
- A security cut-out (like a home circuit-breaker) that shuts down and isolates the batteries in a collision if the current travels in the wrong direction (such as when two wires are crushed together in an impact).

And vice versa...safety gaps may doom the environment...

- Large quantities of *dangerous goods (DG)* are daily being transported in an uncontrolled environment (transportation network)
- DG represent about 5% of all goods transported on roads – more than half of this share being attributable to flammable liquids.
- Accident consequences of simple collisions can lead to further undesirable scenarios like:
    - Fires (jet fire, pool fire, flash fire)
    - Explosions (Boiling Liquid Expanding Vapour Explosion – BLEVE, Vapour Cloud Explosion – VCE)
    - Gas Cloud Formation (toxic release)

- Risk for the driver, the surrounding population, the other road users and the infrastructure
-

DG transport – Beyond accidents

- Environmental damage due to traffic pollution in queues, noise pollution and wasted energy (fuel) during queuing.
- As a result of accidents, traffic jams but also road works and other unexpected events but also due to the different national regulations and individual infrastructure policies (i.e. DG vehicles are not allowed in Gotthard tunnel), truck drivers are often forced to follow secondary roads and alternative routes.
- The actual accident risk and impact when using secondary roads or other alternative ways is not calculated.
- No particular guidance on the safest alternative when drivers need to re-route.
- The business chain is not notified about routes and incidents; so, unable to react when needed.
- Big delays in infrastructures – no passage priority (creating more delays...).
- No automatic check of vehicles, cargo and driver (more delays, frequently reason for non-passage)

Technological Responses to Priorities

- Routing: use of a multiparametric decision support system to obtain optimum routes (also in case of re-routing)
  - *Weighted Criteria: Safety (Individual/Societal), Security, Cost, Environmental Damage*
  - *Taking into account local rules & restrictions, traffic and environmental data, vehicle and cargo status*
- Monitoring: use of advanced telematics to monitor dangerous goods movements.
- Logistics Chain Notification: notify all involved actors of the Logistics Chain what they should be aware of in case of an incident – fast reaction and guidance
- Enforcement/emergency through telematic solution.
- Automatic (pre-trip) Passage Priority to reduce delays *(critical also for Vulnerable Goods transport).*

Towards a real safe and environmental friendly driving environment....

3.8 View of the EC on the future research challenges for ICT and transport

Myriam Coulon-Cantuer, European Commission, DG CONNECT, Smart Cities and Sustainability

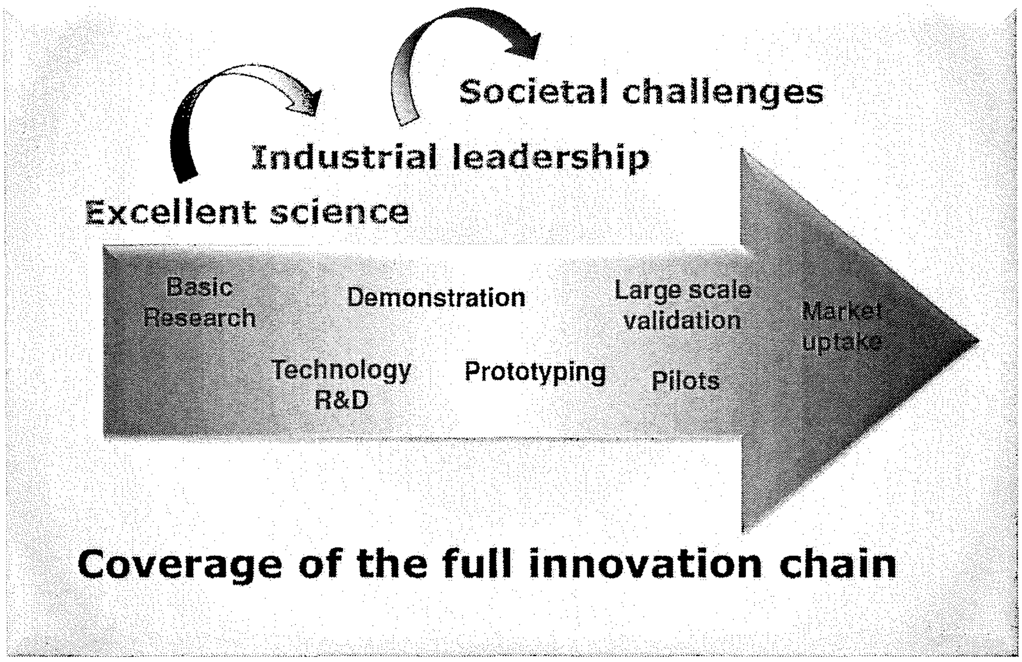
Full video and slides of the presentation available at http://decomobil.humanist-vce.eu/Downloads.html

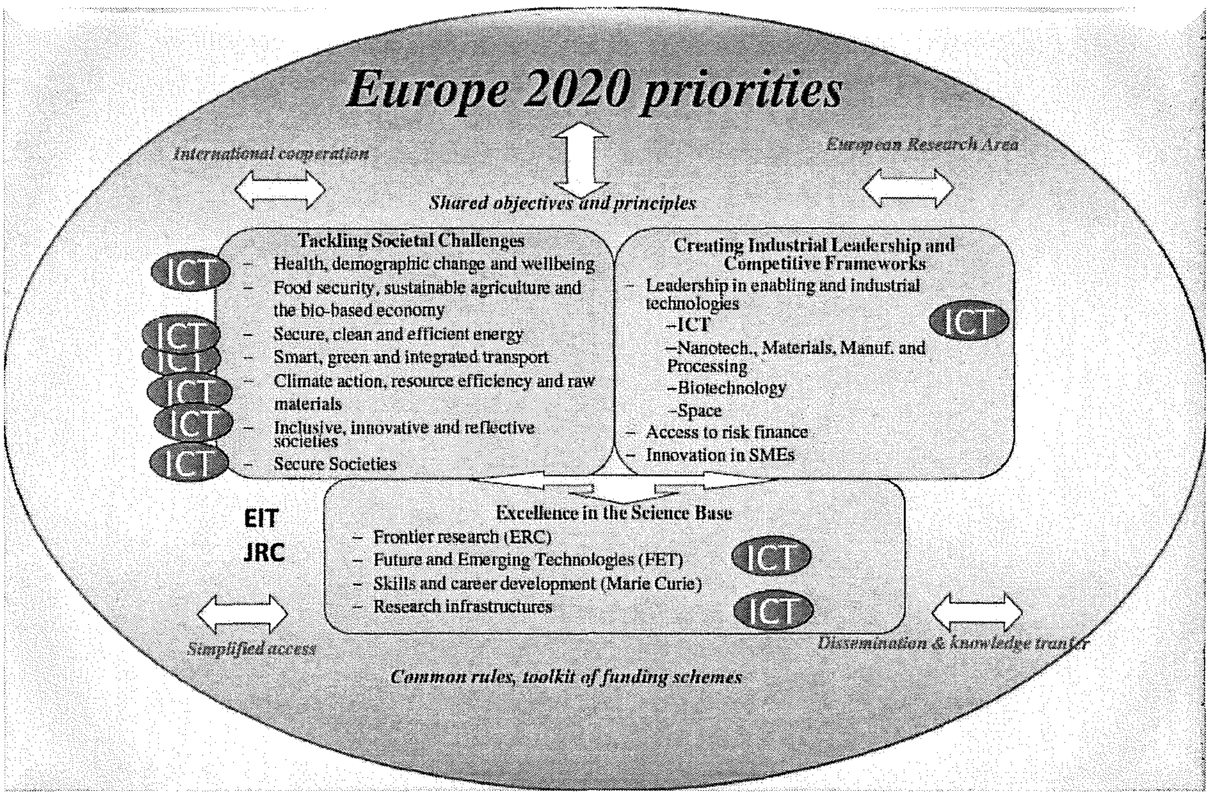
Addressing the challenges with H2020

- Workprogramme 2014-2015
    - Smart Cities
    - Cooperative ITS
    - Connected Automation
    - Electromobility
- Preparing the Workprogramme 2016-2017

Europe's transport sector: targets 2020-2050

- Safety (- 50% by 2020. Zero fatalities by2050)
- Energy Efficiency & Emissions (- 80 to 95% by 2050)
- Accessibility for everyone
- Congestion (- 2% GDP)
- Balance between transport modes


Societal challenges
Industrial leadership
Excellent science
Basic Research
Demonstration
Large scale validation
Market uptake
Technology R&D
Prototyping
Pilots
Coverage of the full innovation chain


Europe 2020 priorities
International cooperation
European Research Area
Shared objectives and principles
Tackling Societal Challenges
- Health, demographic change and wellbeing
- Food security, sustainable agriculture and the bio-based economy
- Secure, clean and efficient energy
- Smart, green and integrated transport
- Climate action, resource efficiency and raw materials
- Inclusive, innovative and reflective societies
- Secure Societies
Creating Industrial Leadership and Competitive Frameworks
- Leadership in enabling and industrial technologies
-ICT
-Nanotech., Materials, Manuf. and Processing
-Biotechnology
-Space
- Access to risk finance
- Innovation in SMEs
ICT
EIT
JRC
Excellence in the Science Base
- Frontier research (ERC)
- Future and Emerging Technologies (FET)
- Skills and career development (Marie Curie)
- Research infrastructures
Simplified access
Dissemination & knowledge transfer
Common rules, toolkit of funding schemes

Opportunities in WP2014/2015 under CNECT-H5 responsability

Societal Challenge 3: Secure, clean and efficient energy : Smart Cities and Communities (Integration of energy, transport and ICT)
Societal challenge 4: Smart, green and integrated transport

- Cooperative ITS
- Connected Automation
- Electromobility

Smart Cities

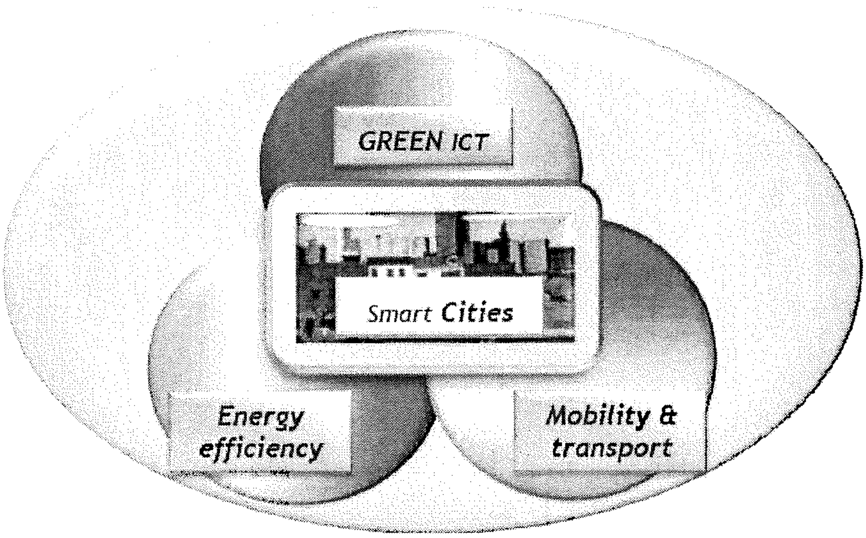
Smart Cities : The urban mobility challenges

- Growing population
- Congestion
- Safety
- Noise and air pollution
- Low levels of energy efficiency
- Lack of balance between transportation modes
- Accessibility problems

Moving toward smart cities : Smart Cities « philosophy »

- Tackle common challenges & bottlenecks
- Develop innovative & replicable solutions
- Bundle demand from cities and regions
- Attract and involve business and banks

→ **Create markets!**



Moving toward smart cities : European Innovation Partnership (EIP) on Smart Cities and Communities

- Objective : Accelerate development and deployment of integrated energy, transport and ICT solutions at local level to serve EU climate/energy targets
- Ultimate aim : Transform a number of European cities
- How?
    - Providing funding for selected large-scale demonstration projects under H2020 focus area "Smart Cities"
    - Focused horizontal activities (capturing lessons learned, identifying needs for regulation & standards, harmonising approaches to data collection, formatting and measurement, etc.)
- Constituency building : High Level Group, Sherpa Group, Stakeholders Platform

Moving toward smart cities : Horizon 2020, Work Programme 2014-2015

SCC-01-2015 (EUR 106.18 million) Forthcoming
Solutions integrating energy, transport, ICT sectors through lighthouse projects

- large scale demonstration of replicable SCC concepts in a city context where existing technologies or very near to market technologies will be integrated in an innovative way

Sustainable urban mobility: through the integration of energy/ fuelling infrastructure with vehicle fleets powered by alternative energy carriers for public and private transport, including logistics and freight-distribution.

- Implications on energy management, and impact on the electricity grid, must be assessed.

Cooperative ITS

Moving towards full connectivity in transportation Cooperative Mobility ... an attractive option contributing to safer, cleaner, and more efficient and sustainable traffic solutions ...

Why Cooperate Mobility?

- Improving safety and energy efficiency
- Making transport more intelligent
- Optimising existing transport system
- Increasing interoperability between modes
- New applications and services

Horizon 2020, Work Programme 2014-2015 : Objective MG.3.5-2014 « Cooperative ITS for safe, congested-free and sustainable mobility »

Research and innovation actions:

- Open in-vehicle platform architecture for real-time

ITS services & mechanisms to provide:

- positioning technologies

- dynamic maps for transport applications
- innovative solutions, also for heavy goods vehicles

Coordination and Support Actions
- standardisation
- awareness and campaigning

Connected Automation

Moving towards Automated driving : Automated driving has great potential to improve significantly safety and energy efficiency
What does Automation in road transport stand for?

- Different terminology used: autonomous, automated, driverless, semi autonomous, fully autonomous ...
- We do not target research to build another Google car or a Mars rover – this technology exists
- The automated vehicle conceived within a cooperative systems environment:
    - Equipped with sensors and functions to travel around with minimum or no effort by the driver
    - Communicate and coordinate with other vehicles, the roadside infrastructure, and the transport cloud
    - New services enabled by connected automated car

Horizon 2020, Work Programme 2014-2015 : Objective MG. 3.6-2015 « Safe and connected automation in road transport »

- R&I activities must support gradual progress towards full automation:
    - Dedicated supporting technologies for individual pre-emption or compensation of human errors, or even taking over the vehicle control in case of imminent collisio (ADAS to support drivers; driver condition & warn, control or correct behavior; HMI aspects)
    - Novel transport, service & mobility concepts enabled by automated driving and connectivity, including for road freight
- Coordination and Support Actions:
    - Dissemination and take-up of results, including the development consensus building on business models to progress towards ful automation
    - Liability & standardization policy & regulatory framework recommendations

Electromobility

Moving towards electromobility
What means ICT for EVs ? Electro-mobility is one of the largest opportunities to radically change the transport system & make a quantum leap into the next generation of sustainable mobility
ICT within the EV

- Efficient components & systems
- Active & Passive Safety
- Strategic technologies (batteries & e-motors)

Connectivity (V2X)

- Integration into smart infrastructures (grid, cities)
- Efficient routing
- Safety
- Services

Horizon 2020, Work Programme 2014-2015 : Objective GV.8-2015 "Electric vehicles' enhanced performance and integration into the transport system and the grid"

- EV concepts featuring a complete revision of the electric and electronic architecture for improved efficiency, functionality and modularity.
- Novel BMS (designs with improved thermal management, power density and life time, safety and reliability; Improved modelling and simulation tools for BMS improvement; Standards.
- Test methodologies and procedures to evaluate the functional safety, reliability and lifetime of battery systems.
- In-vehicle integration of the overall cycle of EV energy management into a comprehensive EV battery and ICT-based re-charging system management
    - providing ergonomic and seamless user support.
    - build upon existing technology standards

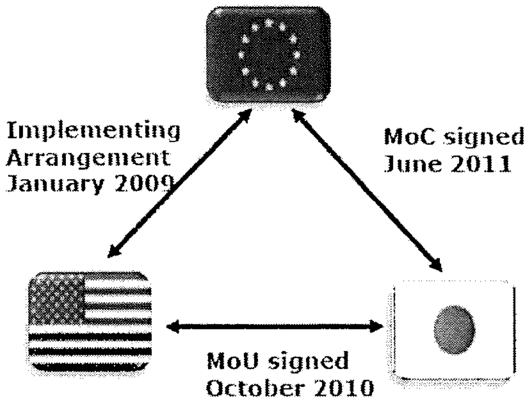
Horizon 2020, Work Programme 2014-2015 : ICT cross-cutting activities

- Internet of Things and platforms for Connected Smart Objects (51 M€)
- Human-centric Digital Age (7 M€)
- Cyber-security, Trustworthy ICT (38 M€)
- Trans-national co-operation among National Contact Points (4 M€)

Workprogramme 2016-2017 in preparation...

With input from...

- SRA and position papers from stakeholders
- iMobility Forum
- Smart Cities European Innovation Partnership (SCC EIP)
- Technology Platforms, Joint Technology Initiatives (JTIs), Public Private Partnerships (PPP), Joint Programming Initiatives (JPI)...
- Research projects, relevant CSAs...
- International Cooperation
- others


Implementing
Arrangement
January 2009
MoC signed
June 2011
MoU signed
October 2010

4. Round table

Panel of speakers from left to right: **Guy Boy, Oliver Carsten, Stella Nikolaou, Angelos bekiaris, Pedro Ferreira, Thierry Bellet** *(The previewed roundtable was finally chaired by Pedro Ferreira instead of Prof. Guy Boy, due to last minutes constraints).*

Following the above-referred presentations, it was intended to give rise to discussions among presenters and the audience. Debate was initiated around the notion that technology does not provide in itself the means for heightened systems safety and efficiency. While the idea that it has such potential often prevails, the experience of aeronautics and space industries provides many examples that the continuous adding of more layers of technology has more than anything else contributed for the shift of systems control towards higher and more complex levels. Discussion was led by issues and challenges regarding the implementation of a more adequate approach and how the necessary changes in practices, processes and structures could be brought about. Following a few questions raised by the chairman, the discussion started focusing mainly on:

1. The road transport system and its complexity highlighting the great variability of road users and their behaviour; Road users under major concern (VRU) were specially addressed, particularly in what regards ITS relevant functions;
2. Inputs from aviation and space onto the road transport system, particularly in what concerns the undertaken automation of driving; the novel conceptual approach to HCD was raised as an important framework for the research on automated driving;

3. The Resilience Engineering approach and its view towards a tolerant transport environment instead of basing safety and accident prevention in what already happened; a better understanding of the system components (people, organisation and technology) on their reciprocal influences could represent an interesting contribution to the approach;
4. ITS and their different functions, focusing at technologies developed to act as a co-pilot and their potential contribution to improve safety; pros and cons of some in-vehicle technologies were also raised;

Following an interesting discussion, the round table was closed.

5. Conclusion and future priorities

From left to right: **Lucile Mendoza, Annie Pauzié, Anabela Simoes.**

The DECOMOBIL final workshop through presentations and discussions highlighted the increasing complexity of the road transport system and the related safety, security and sustainability concerns in an era dominated by a fast technologic development. The Human Centred Design approach directed to the set composed by technology, organization and people, represents a theoretical and conceptual framework for further research fitting the present H2020 challenges in the field of mobility and the European targets in the transport sector for 2020-2050.

The following research priorities were identified in the frame of the DECOMOBIL road map stressing the importance of electromobility. However, some additional and specific research needs raised from the final workshop, being some of them very close to the ones defined in the project:

- A safe and sustainable mobility of people and goods addressing environmental, economic and efficiency issues
- A full automated road transport infrastructure allowing for communication, localization and control (Cooperative ITS)
- Study of the automated driving addressing specific conditions and transition behaviour
- Safety and security issues in the field of transport (different modes)
- Variability of road users and safety issues, addressing particularly VRU

ANNEX 1

List of participants

List of participants

Name			Affiliation	Country
1	STEVENS	Alan	TRL	Royaume-Uni
2	ZÁMEČNÍK	Petr	Transport research centre	République Tchèque
3	SERRANHEIRA	Florentino	ENSP/UNL	Portugal
4	NASCIMENTO	Rafael	Universidade do Minho	Portugal
5	DELAHAYE	Marcel	I-MASC University of Basel	Suisse
6	MAGER	Ralph	I-MASC University of Basel	Suisse
7	LORENZO	Henrique	University of Vigo	Espagne
	RIVEIRO	Belen	University of Vigo	Espagne
8	ARIAS SÁNCHEZ	Pedro	University of Vigo/Inst. Ingenieria	Espagne
9	COULON CANTUER	Myriam	E.C. - DG CONNECT H5	Belgique
10	WRATHALL	Christopher	Project Reviewer	Royaume-Uni
11	COSTA	Ernesto	Project Reviewer	Portugal
12	CARREIRO	Fernando	MARESTRADA, SA	Portugal
13	ALVES	Jorge	PLANESTRADA, SA	Portugal
14	CARVALHO	Carla	PLANESTRADA, SA	Portugal
15	APARÍCIO	Pedro	Safemode	Portugal
16	VIEIRA	Joana	Centro de Computação Gráfica	Portugal
17	NETO	Catarina	ULHT	Portugal
18	NIKOLAOU	Stella	CERTH	Grèce
19	SAJJAD	Salma	Pakistan Girl guides association	Pakistan
20	KHAWAJA	Asif	School of Motoring Lahore	Pakistan
21	REBELO	Francisco	Ergonomics Laboratory - Lisbon University	Portugal
22	ALMEIDA	Ana	Laboratório de Ergonomia FMH	Portugal
23	BOY	Guy	NASA Kennedy Space Center	États-Unis
24	CARSTEN	Oliver	Institute of Transport Study, University of Leeds	Royaume-Uni
25	MOREAU	Fabien	IFSTTAR	France
26	BELLET	Thierry	IFSTTAR	France
27	ATTOMA	Giuseppe	Attoma	France
28	AZOULAY	Yael	La Tortue	France
29	CORREIA	Ilda	individual	Portugal
30	MEIRELES	Patrícia	Mediaview	Portugal
31	RODRIGUES	Telma	Pengest- Planeamento e Engenharia, S.A.	Portugal
32	KREMS	Josef	TU Chemnitz	Allemagne
33	PACE	Jean-François	INTRAS - University of Valencia	Espagne
34	COTRIM	Teresa	Ergonomics Laboratory - Lisbon University	Portugal
35	HAUPT	Juliane	FACTUM OG	Autriche
36	CADARSO	Maria	M ITI	Portugal
37	MOUTA	Sandra	Associação CCG/ZGDV	Portugal

38	NORIEGA	Paulo	Universidade Lisboa	Portugal
39	CARVALHAIS	José	FMH, Universidade de Lisboa	Portugal
40	BEKIARIS	Evangelos	CERTH/HIT	Grèce
41	SHALA	Kumbim	EUROLAB	Albanie
42	SANCHEZ	Nuria	UPM	Espagne
43	PAUZIÉ	Annie	IFSTTAR	France
44	MENDOZA	Lucile	HUMANIST VCE	France
45	NAPOLETANO	linda	Deep blue	Italie
46	AKHAVAN	Mehri	KAVOSHBETON COMPANY	République Islamique d'Iran
47	JABERI	Reza	KAVOSHBETON COMPANY	République Islamique d'Iran
48	JABERI	Azadeh	KAVOSHBETON COMPANY	République Islamique d'Iran
49	SIMOES	Anabela	ADI ISG	Portugal
50	FERREIRA	Pedro	ADI ISG	Portugal
51	ROLA	Susana	ADI ISG	Portugal

ANNEX 2

Evaluation of the workshop

The following questionnaire was specially prepared to assess the participants' opinion about the workshop. It was distributed at the participants' registration and collected at the end of the day.

Questionnaire to Participants

Please assess questions 1 to 7 using the 5 levels scale; questions 9 and 10 answering just Yes or No; leave your general comment in question 11

Questionnaire								
Questions		1 Low	2	3	4	5 High	Y	N
1	Classify the level of your previous interest on the topic of the workshop							
2	How far did the workshop match your expectations?							
3	How far did the different presentations match the topic of the workshop?							
	Transport safety a matter of technology, organisation and people							
	The Pervasive Copilot: How ITS could support a shared Situation Awareness between road users?							
	Road traffic accident causation and ITS: how do we chose the most effective solutions?							
	VRU safety and potential link to automation and future research priorities in the field							
	The contribution of resilience to sustainable transport systems							
	Safety versus Ecomobility; setting priorities right							
	View of the EC on the future research challenges for ICT and transport							
4	How did you find the contribution of the different presentations to discussions?							
	Transport safety a matter of technology, organisation and people							
	The Pervasive Copilot: How ITS could support a shared Situation Awareness between road users?							
	Road traffic accident causation and ITS: how do we chose the most effective solutions?							
	VRU safety and potential link to automation and future research priorities in the field							
	The contribution of resilience to sustainable transport							

	systems							
	Safety versus Ecomobility; setting priorities right							
	View of the EC on the future research challenges for ICT and transport							
5	The interest of the round table							
6	Your level of participation in the round table							
7	How do you classify generically the organisation of the workshop?							
8	The time allocated to discussions was enough?							
9	Did you interact with presenters and put your questions?							
10	If you have any positive or negative comment, please leave it here							

The analysis of the participants' answers to the questionnaire showed that they were globally satisfied with the workshop (average 90% of satisfaction) and the round table was found interesting (88% of the answers). Anyway, the participants also found that the interaction with the round table lecturers was quite low. Therefore, in the future a thinking will be made in order to find in which way we could increase the interaction during future workshops and round tables.

Some comments have been made:

1. The focus of the workshop was not clear/was broad:

   Automation/resilience/safety/inclusion/sustainability.

   Some further introduction would have been useful maybe. Moderators should have provoked more audience questions and/or asked questions themselves.
2. As a reviewer, I found this worshop valuable for giving some insight into the activities of the project. Interesting and stimulating presentations + discussion