HUMAN – MACHINE INTERFACE RESEARCH FOR TRAFFIC EFECTIVITY AND SAFETY

Karel Schmeidler[1]

Human factors and cognitive engineering competencies exist in Europe but are scattered. For addressing this fragmentation of research capacities, HUMANIST gathers the most relevant European research institutes involved in Road Safety and Transport to contribute to the eSafety initiative and to improve road safety by promoting human centred design for IVIS and ADAS.

Keywords: Human-machine interface, ITS, traffic safety, IVIS, ADAS

1 Introduction: HUMANIST Project

An objective of this project is to build a top European workplace that will gather and integrate the outcomes of research of leading European transport institutions, and act as an intermediary in mutual information sharing and reducing the so-called knowledge gaps among individual countries in the whole area of the interaction of the user (driver) and technology, communication assistance systems in particular.

2 HUMANIST Noe Scientific Scope:

HUMANIST is a Network of Excellence gathering the main research institutions from 15 European countries. The partners involved in this network are working in the area of new technologies in Transport: with a specific concern on human centered design, to ensure matching between provided systems and services, and users needs and requirements, in addition to concern with road safety improvement.

The goal of HUMANIST is to create a European Virtual Centre of Excellence on HUMAN centred design for Information Society Technologies applied to Road Transport (IVIS and ADAS), with a coherent joint program of activities, gathering research, integrating and spreading activities. Research work is carried out in scientific task groups:

- Identification of the driver needs in relation to ITS
- Evaluation of ITS potential benefits
- Joint-cognitive models of Driver-Vehicle-Environment for User-Centered Design
- Impact analysis of ITS on driving behaviour
- Development of innovative methodologies to evaluate ITS safety and usability
- Drivers´ education and training for ITS use
- Use of ITS to train and to educate drivers

[1] Doc. Ing.arch. PhDr. Karel Schmeidler, CSc. is head of urban and transport sociology at CDV in Brno, Vinohrady 10, 639 00 Brno, Czech Republic, Tel.: 00420 724 027 356, E-mail: karel.schmeidler@cdv.cz

Integrating Activities permit to manage and to consolidate the NoE structure by promoting the mobility of researchers, by optimising the pool of existing experimental infrastructures, by setting up electronic tools (common database, web-conference, e-learning) for knowledge sharing.

Pic. 1: *Identification of the driver needs in relation to ITS*

This integration will allow increasing Societal Benefits of ITS implementation, to harmonise ITS approaches among State Members, to react quickly to any new technological developments and to face international challenges by producing state of the art research, identifying knowledge gaps, avoiding redundancy of research activities.

Spreading Activities allow to spread widely the knowledge from HUMANIST, by organising debates with RTD projects on eSafety and relevant stakeholders, by promoting harmonisation with standardisation and pre-normative bodies, by setting up training programmes, and by promoting and disseminating research results to a wide audience.1

Mobility program HUMANIST Centre of Excellence enables close co-operation among European research institutions, which is especially important for young researchers – PhD students and post-docs. This program gives opportunity to share expensive and unique infrastructure of collaborating institutions, usually not available at home.

Task force division:

Task Force 1: Mobility improvement

Task Force 2: Research infrastructure sharing and development

Task Force 3: Electronic means for knowledge sharing by the network

Task Force 4: Transfer of knowledge

Task Force 5: Training programs

Task Force 6: Diffusion of knowledge

Task Force 7: Management of the NoE

Task Force 8: Internal review, assessment and monitoring of self-sustainability

But the greatest benefit of the program is creation of the opportunity to be involved in important international projects and gain the unique professional experience in very quick and efficient way. They can present, share and defend their ideas, thesis, hypotheses and methodological approaches with international scientific community, professors and PhD students from other countries, with different scientific approaches and cultural background. They can learn the scientific procedures on site and get so

[1] eIMPACT Project This project focuses on socio-economic analysis of the effect of using intelligent transport systems in vehicles on accident rate. The Transport Research Centre has a task to collect relevant data from the areas in which accident rate could be reduced by introducing intelligent transport systems, such as accidents under bad visibility conditions, under the condition of aggravated road surface, or accidents resulting from failure to keep a safe distance between vehicles.

much unique information, which is not available in single institution or university at home. The latest experiences show many advantages compared to the other PhD students without this unique experience and give proof of scientific maturity of HUMANIST youth.

Pic. 2: *Impact analysis of ITS on driving behaviour*

3 Cooperation with partners

HUMANIST Network of Excellence has good web page. The Project as whole is divided to the work tasks that are also called work packages (Different work packages deal with specific research). There are about 8 work packages that focus on the scientific research. The research deals with HMI - human machine interface, it means human/machine relation. The project deals with IVIS and ADAS, which are information systems (IS) in cars. The difference between IVIS and ADAS is that ADAS can intervene while IVIS are mostly information systems.

For example one of the work packages we participate in deals with psychological research. The focus is in which way those IVIS/ADAS systems effect on drivers. Besides the positive effects (as increasing of safety) those can also have negative effects (decreasing safety). As for example, the drivers can have a feeling that they are out of the danger when they have some sophisticated safety system in their car and drive too fast. Thus, we collaborate with partners on simulators researches. Every partner has some special field in which he is strong, by which he contributes to the project. As for example: Swedish simulators are more sophisticated then ours. France has a good statistical software engine. France and Austria have good evaluation software and evaluation methodologies. So the cooperation works the way that each of the partners provides the knowledge or technological equipment they have.

Pic. 3: *Evaluation of ITS potential benefits*

Transport Research Centrum participates on various work packages. As an example, we work with identification of drivers' needs of ITS instruments, evaluation of those ITS advantages or from the psychological field developing the cognitive models. Another project is about ITS impact on the drivers' behaviour. We also participate on one work package that develops new methodologies for evaluation of ISC instruments. It is very important, because there are appearing many of those on the market and within the EU whole legislation referring to those means is going to change. It means to work on those tasks with ten years lead.

There are regular summit meetings, usually twice a year. Those are very important as for the discussion and explanation. As example: now we work on the naturalistic study (as it is impossible to make everything on the simulators) with Factum form Austria, Chemnitz University from Germany. Our research question is in which way those instruments have impact to the drivers. We provide a car to this research, Factum from Austria provides an evaluation method, and Chemnitz provides software. So this is mostly cooperation in the frame of central Europe. Both Chemnitz and Vienna are close to the Czech Republic, which enables close cooperation.

All the members of the consortium are research partners. But the network is broadening, because we need for example technical equipment, so companies producing simulators also participate. They provide us with simulators and we give them knowledge about how to produce the simulators in order to match the requirements.

We make simulators in cooperation with JKZ and JRM Olomouc, who produces them. They receive ideas for innovation of simulators, in order to make them usable both for teaching and tests in the research. Also, we cooperate with ECOM Slavkov on information systems in cars. We make something similar to black box. Within EU, there are speculations about putting those to all cars, to record for disquisition of accidents, feedback on the driver, who knows that he is in some way recorded. Even the biggest Czech car manufacturer Skoda participates on this research.

And of course, through HUMANIST there are proposals for FP7, there are 8-9 new projects, which emerge from HUMANIST.

4 New ideas and approaches in EU funded research

There are 8-9 new projects that emerge from HUMANIST. The more you know about something, the more you find out that you don't know so much and what you would need to find out. For example, ITS for specific groups of population. For example elderly pensioners have problems related to the decline of visual and hearing abilities, or different countries have different needs related to different cultural background.

5 Being involved in EU projects means a rich network

Getting new partners means getting new information, access to databases and technological equipment and most of all to people who you can address. The projects are broadening, if we weren't participating on HUMANIST we wouldn't apply for new projects.

6 A team to address specific R&D problems

It depends on the agreement from both sides and the knowledge. For example, there are starting new project from HUMANIST. We have now COST Action 352 (Cooperation in Scientific and Technologic Research), also European project. When we found out that some of the areas in HUMANIST are not worked through, we applied for COST. The funding of COST is a bit different; the national governments are co financing the project. So now we work on COST 352, which has developed from HUMANIST. We

used the partners from HUMANIST. We know the people; we know their competences so we addressed some of them.

7 Knowledge transfer between organisation and companies in the region

It exists in some extent. I have already mentioned some examples. I think the transfer will be more intensive in the future. HUMANIST has been more academically oriented in the beginning, however it is getting more and more into the practice.

8 Result - Intelligent cars of the future

Traffic on roads thickens, pressure on drivers increases, and accidents remain a burning issue. Will state-of-the-art technology, the so-called 'intelligent transport systems', enhance road safety?

Intelligent cars of the future, the development of which is supported by the European Commission, look quite normal at first sight. However, under their hood equipment is hidden, capable of many things: Preventing impacts, keeping the car within the lane, controlling the car distance in a queue, or preparing for an impact, and then calling help. If they became a regular part of car equipment the number of road accidents casualties could drop to one half according to the Commission. Traffic congestions would be limited, which would also result in reducing the quantity of combustion products in the air, and the fuel consumption would go down; total savings have been calculated at up to 22 billion EUR a year.

Pic. 4: *Drivers´ education and training for ITS use*

9 Example of intelligent transport systems in vehicles

Even today can we see sophisticated driver assistance systems ADAS (Advanced Driver Assistance Systems), which form a technological part of vehicles, as well as additional information systems IVIS (In-vehicle Information Systems). The use of mobile computer and communication devices in vehicles, such as mobile telephones and portable digital assistance devices, rapidly increases.

The Volvo Company, for example, have introduced an active safety system in the model S80; it is capable of taking over control over the brake system if the driver does not start to brake already in the initial phase of the danger of a collision. Systems have been developed which draw drivers' attention to the danger of micro-sleep, fatigue, or stress, which could result in the car's leaving the lane; if the driver does not respond immediately, the system will be able to direct the vehicle back.

GM are developing a cruise control responding already from the zero speed; it means that the car will be able to stop and move again along with a queue.

Mercedes of S and CL classes for example offer a hard-disk navigation system or intelligent system of light control with automatic evaluation and switching in five programs. There is a new product by the Japanese Company Sharp - the LCD display in the dashboard, the construction of which enables sending different images, the visibility of which depends on the visual angle; while the driver is watching the navigation system, the passenger may watch a film from the DVD player. New vehicles are produced with

the ESP stabilization system the light or acoustic warning signal of which draws the driver's attention to the fact that the vehicle is just balancing the skid, which would have occurred without the ESP engagement. Systems are produced that provide warning in foggy conditions or before an obstacle; in the last few years the dynamic navigation receiving signals on traffic congestions has resolved the problem of lost signal for example when driving through tunnels.

The system supplied to Citroën C6 also considers enhanced safety of pedestrians involved in a collision with a car. Acceleration sensors and an optical fibre sensor are built in the bumpers, which - together with an acceleration meter - supplies data to a control unit that evaluates the current collision. If it comes in contact with a pedestrian, the sensor bends and interrupts the light flow, and within a few milliseconds the control unit gives out an instruction for lifting the rear part of the hood above the motor, which reduces the risk of a contact with hard parts of the motor space.

It means that some systems of active safety do exist, but they are separate. The future lies in full integration of these vehicle intelligent systems.

10 Are Only positive aspects considered?

Do the new systems comply with varied needs of drivers - whether they are professionals, elderly, beginners, or handicapped ones? In Europe there are still relatively few scientifically acquired findings available that would capture this issue in all its aspects, including the need of education and training in using intelligent transport systems (ITS), their influence on mental burden and attention, or acceptance of these systems in relation to different socio-culture characteristics in general.

Some systems should facilitate drivers' tasks and enhance travelling safety for example by a better access to navigation information, which enables the reduction of the level of attention which has to be given to orientation when driving. The dissemination of traffic or meteorological information in real time makes it possible to predict certain critical situations and avoid them. Adaptive drive controls (for example cruise control) reduce drivers' stress and mental burden, while maintaining a safe distance from the vehicle ahead. Special active support systems balancing some delayed reactions and non-clarities in decision-making in unforeseen situations are suitable for example for senior drivers.

The majority of road accidents, around 90 - 95%, are caused by human failure. The data acquired indicate that the primary causes of at least one quarter of all accidents are inattention: distraction, "looking, but not seeing", and falling asleep behind the wheel. Traffic and safety measures, which are already commonplace today, such as safety belts or air-bags, contributed to the reduction of accidents in the last decades, but have reached their limits. How big a potential for further enhancement of road safety will be brought about by new, advanced assistance systems? No matter how perfect they all look from the technical point of view, humanities specialists ask up to what extent they are acceptable for the drivers and how they could change their behaviour and attitude when driving.

A broad range of advanced assistance systems are supposed to enhance the driver's perception of danger and partly automate the driver's tasks. This includes warning with regard to the speed, keeping the vehicle safely within a lane, detection of a blind stop, automated monitoring of the vehicle surroundings, pedestrian detection, vision improvement, and monitoring the driver's conditions and functions. In essence they improve or enhance perception and driver's cognitive functions. The practical impact on road traffic safety, however, will depend on their interaction with the driver. For example for effective support of the driver and avoiding a frontal collision it is most important that the warning signal or feedback intuitively require a correct and timely reaction - collision-avoiding manoeuvre.

New technologies assume a new concept of driver-vehicle interaction in more sensory modalities - visual, tactile, and auditory. The introduction of new safety systems can bring about enormous changes in

drivers' behaviour. Behavioural adaptation may significantly influence (as compared to the expectations) a topical safety benefit of the measures introduced both in positive and in negative sense.

Pic. 5: *Development of innovative methodologies to evaluate ITS safety and usability*

11 Predicting risks

The ADAS safety benefits may be significantly reduced or completely eliminated by an unexpected behavioural response of a driver with regard to technology, for example by excessive reliance on modern vehicle systems and shifting the safety limits. Safety potential of the appliances may remain unused - if, for example, their warning is perceived by the drivers as unpleasant or bothering; in this case they can simply give them up. Therefore an important objective of the Human Machine Interface research is also to discover possible unpleasant behaviour of the system.

The IVIS and mobile devices can induce the danger of working overload, particularly with regard to information, lack of attention, and diverted attention from the actual driving. If we take into consideration critical safety impacts of mobile telephones, the safety-related questions are also raised by the introduction of supplementing information functions, such as e-mail, access to the Internet, navigational assistance, or road and traffic information.

Contradicting information from different systems or conflicts between these independent systems themselves can distract attention, cause overloading, or drivers' confusion or irritation; it means that they can cause problems, which do not pose a threat in case of an isolated system. It is therefore necessary to introduce a complex of information functions in the vehicles. For the future a uniform adaptive integrated interface is necessary connecting different systems in one functional whole, which solves conflicts between individual functions and takes advantage of their aggregated effect.

The goal of transport experts focusing on humanities is to collect knowledge and get involved in the development of methods and technologies for safe and effective integration of the fixed ADAS and IVIS systems as well as portable devices and systems in the context of the vehicle control. On the basis of the findings acquired a general adaptive integrated driver-vehicle interface will be developed, which will be characterized by:

Multi-modal devices divided into various systems, for example displaying the information in the driver's field of vision, voice inputs and outputs, seat vibrations, equipment for touch inputs, or directional acoustic outputs.

Centralized intelligence for solving conflicts between the systems, for example by means of sorting the information on the basis of priorities and scheduling.

Smooth integration of mobile equipment in a uniform HMI.

Adaptability of the integrated HMI to the topical condition of the driver or driving context.

Pic. 6: *Multi-modal device*

12 Conclusion

In this way it will be possible to take advantage of new technology to the maximum benefit in the sphere of safety and at the same time to minimise information over-burden and inattentiveness caused by vehicle's information systems and mobile equipment. The goal is to improve mobility and comfort, but without any concessions in the area of safety.

Before the mass introduction of modern assistance systems, however, it will be necessary to solve a number of technical, psychological, legal, and organizational issues. Example of some: Who will bear a responsibility in case of an accident? Will it be the driver, as it is today, or the manufacturer of the systems, or the manufacturer of the car?

Reference Literature

1. BERNHARD, M., SCHMEIDLER, K. et. al. The Influence of In-Vehicle Information Systems on Driver Behaviour and Road Safety: COST Action 352. 1st ed. Brno: Ing. Zdeněk Novotný, 2009. 89 p. ISBN 978-80-7355-083-7.
2. BERNHARD, Michael, SCHMEIDLER, Karel. Human Machine Interface Research and ITS Development: Badanie interfejsu czlowiek-maszyna i rozwój ITS. Transport problems (Problemy transportu), 2007, vol. 2, no. 2, p. 8.
3. GELOVÁ E., HANZLÍKOVÁ I. ITS and Czech Circumstances. In Intelligent Transport Systems: Design and Safety, Praha, Volume 9. 2006
4. MACKŮ, I. Acceptance of telematics by Czech and British truck drivers. Different Drivers: Similar Needs? 2nd HUMANIST conference on driver needs. Turku (Finsko), 28 - 29. 9. 2006.
5. MACKŮ, I. Acceptance of telematics by Czech and British truck drivers. In ITS World Congress Proceedings, Londýn (Velká Británie), 8.10. - 12.10. 2006 [CD-ROM]. Londýn (Velká Británie) : ERTICO-ITS Europe, 2006.
6. MACKŮ, I. Evaluation of different ergonomic factors in cabin of drivers in public transport. HFES Europe Chapter Conference. Sheffield (Velká Britán
7. MACKŮ, I. Pedagogical aspects of simulator training process. In Proceedings of the Conference on European guidelines for the application of new technolgogies for driver training and education. Madrid, April 25-26, 2006. In Proceedings of the Conference on European Guidelines for the

application of new technologies for driver training and education., Madrid, 25-26/4/2006. Madrid: UPM Spain, 2006, s. 60.

8. PÍPA, Martin, PLÍHAL, Jiří. BLACKBOX - projekt vědy a výzkumu Ministerstva dopravy ČR. Soudní inženýrství, 2006, roč. 17, č. 5, s. 256-259. ISSN 1211-443X. (BLACKBOX - R&D project of MoT CR)
9. PÍPA, Martin. Intelligent Car Initaitive. ITS@revue [on-line]. 2006. Dostupné z WWW: http://www.cdv.cz/itsrevue/. ISSN 1213-4287.
10. PÍPA, Martin. Intelligent Car Initiative [on-line]. Dostupné z WWW: <http://www.cdv.cz>.
11. PÍPA, Martin. Intelligent Car Initiative. ITS@revue, 2006, roč. 6, č. 10, s. 5-6. ISSN 1213-4430.
12. SCHMEIDLER, K. Issues related to ITS safety and public authorities. In European conference on Human Centered Design for Intelligent Transport Systems: Stakeholders Forum: European Statement of Principles, Issuess and Perspectives, Lyon (Francie), 2. - 4. April 2008 [CD-ROM]. Lyon Bron (Francie): INRETS, 2008.
13. SCHMEIDLER, K. ITS for Sustainable Urban Transport. COST Action 352 Conference: The Influence of In-vehicle Systems on Driver´s Behaviour and Road Safety. Bundesanstalt fuer Strassenwesen, Bergisch Gladbach (Německo), February 10th 2009.
14. SCHMEIDLER, K. Roles, Effects and Acceptance of Advanced Assistance and Information Systems in Czech Republic in Safety Promotion and Injury Prevention. 8th World Conference on Injury Prevention and Safety Promotion. ICC Durban (Jižní Afrika), 3. 4. 2006.
15. SCHMEIDLER, K. The added value of the Network of Excellence for its members. In European Conference on Human Centered Design for Intelligent Transport Systems: HUMANIST publications, Scientific Advisory Board, Lyon (Francie), 2. - 4. April 2008 [CD-ROM]. Lyon, Bron (Francie): INRETS, 2008.
16. SCHMEIDLER, K. The role of Transport Research Centre in HUMANIST Programme. In On Safe Roads in the XXI. Century : 4th Conference, Budapest, Congress Park Hotel Flamenco (Maďarsko), 25. -27. October, 2006. Budapest (Maďarsko) : ERTICO, PIARC, 2006, p. 52.
17. SCHMEIDLER, K. Vývoj v oblasti ITS z hlediska HMI v silniční dopravě. In BRNOSAFETY: Mezinárodní konference o bezpečnosti silničního provozu, BVV - Central European Exhibition Centre Brno, 4.-5. 6. 2009. Brno: BVV - Veletrhy Brno, a.s., Výstaviště 1, June 2009, s. 5.
18. SCHMEIDLER, K., REHNOVÁ, V., WEINBERGER, J. a kol. Vliv moderních informačních systémů v automobilu na bezpečnost silničního provozu : Průběžná zpráva. Brno: Centrum dopravního výzkumu, 2005. 35 s. Zadavatel: MŠMT. (The impact of modern information systems on traffic safety)
19. SCHMEIDLER, Karel, VAŠEK, Jiří. Inteligentní dopravní systémy: design a bezpečnost. Silniční obzor, 2006, roč. 67, č. 6, s.173-174. (Intelligent Transport Systém: Design and Safety)
20. SCHMEIDLER, Karel, VAŠEK, Jiří. Pražský seminář o ITS a bezpečnosti zaštítilo konsorcium Humanist. Dopravní noviny, 2006, roč.15, č. 23, s. 18 (The Prague´s seminar on ITS and safety was supported by HUMANISt Consortium)
21. SCHMEIDLER, Karel, ZEHNALOVÁ, Veronika. Seminář HUMANIST: Centre of Excellence. Kriminalistika, 2006, roč. XX, č. 4, s. 57-59.
22. SCHMEIDLER, Karel. Inteligentní auta budoucnosti: Inteligentní dopravní systémy. Mistr, 2006, roč. 3, č. 9, s. 44-47. (Intelligent cars of future: intelligent transport systems).
23. SCHMEIDLER, Karel. Inteligentní auta budoucnosti. Psychologie Dnes, 2006, roč. 12, č. 9, s. 23-25. ISSN 1212-9607. (Intelligent cars of future)

24. SCHMEIDLER, Karel. Podíl lidského faktoru na bezpečnosti a nehodovosti dopravy: The Share of Human Factor in the Safety and in Accident Rate in Transport. Horizonty dopravy, 2006, roč. 14, č. 3, s. 15-20. ISSN 1210-0978.
25. ZEHNALOVÁ, Veronika. Seminář Humanist. ITS revue [on-line]. 2006. Dostupné z WWW: <http://www.cdv.cz/itsrevue/index.php?its=uvod/seminar-humanist>. ISSN 1213-4430.

Opponent: Prof. Dr. Ralf Risser, FACTUM OHG, Vienna, Austria, Danhausergasse 6/4
A-1040 Wien, Tel: 43 1 5041546 14, Fax: 43 1 5041548, e-mail: ralf.risser@factum.at