ANALYSIS OF THE DRIVING ASSISTANT SYSTEMS AND THEIR IMPACT ON HUMAN BEHAVIOR AND MIND: PHILOSOPHY AND METHODOLOGY OF THE PLANNED RESEARCH

Ingrid Matoušková[1], Karel Pavlica[2]

[1] ŠKODA Auto University, Department of Human Resource Management, Na Karmeli 1457, 293 01 Mladá Boleslav, Czech Republic
[2] AMBIS vysoká škola, a. s. Lindnerova 575/1, 180 00 Praha, Libeň, Czech Republic

Abstract

The paper explains the research philosophy and methodology for the project "Synchronising Development of the Assistant Systems with the Capacities of the Human Mind." There exist two basic paradigms of conceptualizing the relationships between human beings and technologies. Within the prosthetic paradigm, technology is perceived and understood as a tool that increases and enlarges human abilities, skills, and range of action. Within the aesthetic paradigm, technology is perceived as an integral component of human beings and their world. In our view, it is necessary to refer to both of these paradigms in our research. With respect to this assumption, the following research questions have been proposed:

1. What is the optimum amount of assistant systems for drivers?
2. Which technologies and assistant systems actually help drivers, and which are useless and/or even harmful to them?
3. How do drivers adapt to driving assistant systems?

Planned empirical research on samples of both professional and "ordinary" drivers will seek to answer all of these research questions.

Keywords: Aesthetic Paradigm, Cyberpsychology, Drivers, Driving Assistant Systems, Pilot Study, Prosthetic Paradigm

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Introduction

The paper presents research philosophy and methodology for the partial research task "Synchronising Development of the Assistant Systems with the Capacities of a Human Mind." This research task represents one of ten tasks of a complex project entitled "Modern Technologies in the Area of Committing, Investigating, Proving and Preventing Criminality for the Purposes of Public Order and Safety in Road Transportation." The project is solved by a consortium of eight partners – Slovak Republic Ministry of Internal Affairs, Slovak Republic Police Constabulary, Police Constabulary SR Academy, Czech Republic Police, the University of Finance and Administration Prague, Iris Ident Slovakia, Czech Republic Probation and Mediation Service, ŠKODA Auto University. The project started in 2019. The Covid pandemic interrupted the work until the end of 2021, however. In other words, the solution of the project tasks restarted again in January 2022.

The research task "Synchronising Development of the Assistant Systems with the Capacities of a Human Mind" follows several interrelated partial objectives:

1. detailed analysis of the driving assistant systems used or planned for use in motor vehicles;
2. identification of the trends in the area of development and implementation of driving assistant systems;
3. analysis of the impact of these systems on the human mind and behaviour.

These goals were formulated with respect to two research expectations rooted in both everyday life experience and general psychological knowledge:

a) an ordinary driver is unable to effectively use all of the existing driving assistant systems;
b) frequent use of the driving assistant systems leads to atrophy and deterioration of the driver's skills and habits.

The first part of the paper describes the philosophy and methodology of the planned research. It explains the nature of prosthetic and aesthetic paradigms/approaches to technology–human interaction and relationships.

It presents results of recent studies focused on interaction between drivers and different driving assistant systems and argues for a need to integrate both of these paradigms in our research. Drivers of the cars equipped with the new digital technologies can be understood also as a specific kind of cyborgs. Therefore, cyberpsychology was identified as another useful philosophical reference for the planned research.

Explanation of the philosophy is followed by description of the research methodology. This paper is focused on the third partial objective of our project – analysis of the impact of the driving assistant systems on the human (drivers') mind and behaviour. As the main data collection technique, a questionnaire was chosen. This paper describes content and structure of the first version of the questionnaire (including its links to our research questions) constructed for the purposes of a pilot study. After a pilot study, a definite version of the questionnaire will be constructed, and data will be collected on the samples of professional as well as ordinary drivers. Questionnaire survey results will be validated by semi-structured interviews.

The second part of the paper describes the most interesting and important results of a pilot study and proposes next steps for our research.

The conclusion relates results of a pilot study to other studies focused on analysis of driving assistant systems and summarises key challenges and tasks for future research, development, and use of assistant systems.

Research Philosophy and Methodology

Ongoing continual implementation of the driving assistant systems into vehicles represents a specific case of human–technology interaction. Therefore, our research should refer to basic paradigms of a conceptualization of an interaction between human beings and technologies. There exist two basic approaches to the solution of this question – prosthetic and aesthetic paradigms (Corbett, 2009).

Within a prosthetic paradigm, technology is viewed as an extension of human capabilities, skills, and agency. For example, a microscope enables people to see objects that are too small for the unaided human eye to register. The prosthetic approach to driving assistant systems consequently leads to their understanding as the “tools” that are improving drivers' performance in different respects – i.e., safety, orientation in traffic, parking, using the phone.

Within an aesthetic paradigm, technology is seen as an integral part of human beings. Technologies are changing the ways people make sense of and perceive the world, so the human world is also changing – “once microscopic things became visible to scientists, the very way these things are represented and theorized by scientists also tends to change” (Corbett, 2009, p. 11). In this perception, people interiorize technologized ways of perceiving themselves and their world. The aesthetic approach to understanding technology often refers to the concept of the cyborg – technologies cannot be separated from the mind and body. The aesthetic understanding of the driving assistant systems views these technologies as integral components of the driver's mind and body. Through the use of these systems, drivers are developing new ways of both using and understanding/perceiving their “own” car as well as other “driving world” relevant realities.

Reference to the cyborg resonates with the new psychological discipline called cyberpsychology. Cyberpsychology is defined by its founder Suler (2016, p. 22) as “the study of cyber-psyche, the computer mind ‘out there’ created by the fusion of humans and machines.” Suler (2016) understands cyberspace as a psychological space that can be described by means of eight fundamental dimensions:

1. The identity dimension: Who am I?
2. The social dimension: Who are we?
3. The interactive dimension: How do I do this?
4. The text dimension: What's the word?
5. The sensory dimension: How am I aware?
6. The temporal dimension: What time is it?
7. The reality dimension: Is this for real?
8. The physical dimension: Is this tangible?

In respect to our research focus on the use of driving assistant systems in vehicles, in particular three fundamental dimensions of cyberspace should be considered (Suler, 2016):

- The sensory dimension and its concerns with questions like: How do we rely on different stimuli from cyberspace? What kind of stimulation do we prefer?
- The reality dimension and its concern with questions like: How do we differentiate between reality and fantasy in cyberspace? How do we react to real versus imaginary situations?
- The physical dimension and its concern with questions like: How does the use of digital tools and technologies affect our body? How do we use devices to interpret and react to our environment?

In our view, it is necessary to combine both paradigms (including the aesthetic paradigm's resonance with cyberpsychology) in our research. We should try to understand both how driving assistant systems influence skills, capabilities, and reactions of the drivers (prosthetic approach) and how they are integrated

into the ways drivers understand and “operate” with different “driving world” relevant realities that surround them – cars, traffic, drivers, and other participants in everyday traffic, etc. – (aesthetic approach).

Recent studies of human perception and use of (digital) technologies and/or driving assistant systems led to several interesting findings.

Vejačka (2016) studied which factors have a positive influence on people's adoption of new digital tools and technologies (eGovernment in particular). He came to the conclusion that significant influence on the adoption of new technologies have perceived usefulness, perceived security, amount of information, and perceived quality.

A study conducted by Mlekus *et al.* (2020) identified quality of output, novelty, dependability, and perspicuity as significant general predictors of technology acceptance. Authors of the study came to the conclusion that future users' opinions should be involved in the technology design process. An analogical “bottom-up” approach was recommended earlier also by Crabu and Magaudda (2018).

A psychological study conducted by Ho-Chang *et al.* (2020) suggests that an individual's cognitive style influences perception of the usefulness and ease of new (digital) technologies. People with introversion, thinking, and judging cognitive styles tend to perceive higher ease of use of new technologies than those with extroversion, feeling, and perceiving cognitive styles (this typology was proposed by C. G. Jung originally).

There exists a series of studies focused on accommodation of the driving assistant systems to human bodies/abilities.

A study focused on vibration warnings to drivers via Bluetooth earphones or smart wristbands demonstrated that vibrations on the upper jaw have the shortest simple reaction time and choice reaction time (Zheng *et al.*, 2021). Vibration warnings on the driver's upper jaw are more effective than those on the wrist and shin.

Another interesting study assessed the effects of different warning messages on the driver's ability to avoid a potential safety hazard (Wu and Boyle, 2020). Authors came to the conclusion that it is useful to combine speech-based cues (i.e., Brake now, Danger, Vehicle on your left) with non-speech-based cues (beep). This finding indicates the need to attract the driver's attention via combined stimulation of different receptors.

Bernhard and Hecht (2020) conducted a study investigating the effects of different positions of side-mounted rear-view cameras on distance estimation of drivers. On one hand, they found out that lower camera position led to distance overestimation and higher position to underestimation. However, the effect of camera position disappeared when the vehicle's back was visible. This indicates that information mediated by the camera (and possibly by other assistant systems) should be integrated with unmediated direct perception of the “real” world objects (physical points of reference).

A very interesting trend in the design of the interactions between assistant systems and drivers represents focus on gestures. Graichen *et al.* (2019) found out that gesture-based interaction with the systems and tools used in cars helps to reduce drivers' visual distraction, which has a highly negative impact on the driver.

A different series of studies is focused on adaptation of drivers to different assistant systems. As very important factors in this respect there were identified understanding and trusting these systems. Tenhunfeld *et al.* (2019) found out that using partially automated parking with little knowledge of its working can lead to mistakes and a high degree of initial distrust. Authors recommend short tutorials and brief explanations of the working of these systems.

Lee *et al.* (2019) found out that the level of trust in automated vehicles depends strongly on a similarity between the driver's and the vehicle's driving style. This indicates that drivers feel a need to perceive automated cars and possibly other assistant systems as safe and predictable.

Evidence for a need to make driving assistant systems understandable to drivers was brought by a study by Muslim and Itoh (2020). These authors illustrate that taking into account human skills and abilities while designing driver support systems alone is not sufficient. To maximize safety and system usability, it is also important to ensure appropriate drivers' understanding and acceptance of the system.

A study by Miller and Boyle (2018) indicates that the use of assistant systems (lane keeping system in their case) without understanding and active involvement of the drivers in the process of car control can easily lead to skill atrophy. In other words, besides training and understanding, drivers should not trust assistant systems blindly.

In summary, all the studies mentioned above suggest that:

1. Driving assistant systems should be designed in accordance with human skills and abilities.
2. There is still a lot of room left for improvement of interactions between drivers and assistant systems.
3. Information mediated by driving systems should be multichannel.
4. Drivers must understand the nature and principles of assistant systems working – they need training.
5. Driving assistant systems must be trusted by drivers.
6. Drivers must actively participate in the control of semi-automated and fully automated vehicles.

Methodology of the Research

As it was stated in the introduction, the research task "Synchronising Development of the Assistant Systems with the Capacities of a Human Mind" follows several interrelated partial objectives:

1. detailed analysis of the driving assistant systems used or planned for use in motor vehicles;
2. identification of the trends in the area of development and implementation of driving assistant systems;
3. analysis of the impact of these systems on the human mind and behaviour.

These goals were formulated with respect to two research expectations rooted in both everyday life experience and general psychological knowledge:

a) an ordinary driver is unable to effectively use all existing driving assistant systems;
b) frequent use of the driving assistant systems leads to atrophy and deterioration of the driver's skills and habits. As we can see above, the second expectation was recently confirmed by Miller and Boyle (2018).

Whereas the first two objectives can be reached via "desk research," the third goal requires an empirical study conducted on drivers. Our team decided to use a questionnaire and interviews for this purpose. In reference to the objectives, philosophical background of our project, as well as to the results of the studies mentioned above, the planned empirical research will try to answer three research questions:

1. What is an optimum amount of the assistant systems in vehicles?
2. Which technologies and assistant systems help drivers, and which are useless and/or even harmful for them?
3. How do drivers adapt to driving assistant systems?

The questionnaire will be constructed in two steps. First, a pilot version of the questionnaire will be proposed. After a pilot study conducted on samples of both professional and ordinary drivers (see Head 3 Results of a Pilot Study), a definite version of the questionnaire will be constructed and used. Questionnaire survey results will be validated by means of semi-structured interviews with selected drivers.

The pilot version of the questionnaire contained 13 items. The first five items were focused on the following topics: whether the respondent is a professional/ordinary driver, respondent's driving experience, explanation of the assistant systems to the respondent upon receipt of a (new) vehicle, which assistant systems respondents use regularly and why, respondent's ability to park a vehicle into a row of cars without an assistant system. The rest of the items focused on: respondents' identification of dispensable, indispensable assistant systems and dangerous assistant systems, respondents' use of the phone during driving, and assessment of the impact of assistant systems on road transport safety. On items 6, 7, and 8, respondents were offered lists of assistant systems (ŠKODA Storyboard, 2020) with a task to select those which are dispensable, indispensable, and dangerous.

Results of a Pilot Study

The pilot version of the questionnaire was used on a sample of 200 professional drivers (drivers of the Integrated Rescue System from the Czech Republic – 100 – and the Slovak Republic – 100) and 200 students of the combined form of study (Ambis, a.s. and the University of Finance and Administration). Respondents were addressed via e-mail. There were 255 completed questionnaires returned (50% completed by professional drivers and 50% by students).

The majority of the respondents (60%) reported 10 years or longer experience with (active) driving.

Disappointing results were brought by reactions to the statement: "I was introduced to the assistant systems upon receipt of the vehicle." 50% of respondents answered "no," 5% "partially," and 45% "yes." Such an approach represents a potential danger and decreases the effectiveness of the assistant systems.

The most frequently used assistant system was "parking assistant" (75% of respondents). 25% of respondents mentioned "cruise." 5% of respondents answered that they use nothing.

The questionnaire also contained items focused on the identification of dispensable, indispensable, and dangerous assistant systems. As dispensable systems, the most frequently identified was the "lane assistant" (25% of respondents). The reasons were – it doesn't work reliably; it sometimes reads the road wrongly; it tends to fight with you for the steering wheel; it tends to prevent me from avoiding an oncoming truck when I need – it is dangerous. In correspondence with this finding, 15% of respondents identified the "lane assistant" as a dangerous system on a separate questionnaire item focused on dangerous systems (10% of respondents identified touch systems – displays in particular – as dangerous).

As the most indispensable assistant systems, respondents identified the "blind spot detector" (20% of respondents) and ABS, ESP (10% of respondents).

In contradiction to general uncritical expectations, only 15% of the respondents believed driving assistant systems are increasing the safety of road traffic (25% of respondents answered "no" and 60% "don't know"). Among the critical comments on the address of assistant systems, the following appeared: they make drivers less alert; they distract attention from driving; people tend to rely on them too much, but systems are still systems that should but don't have to react properly.

As most of the respondents were reluctant to answer open questions, it will be necessary to validate the results of the definite version of the questionnaire via semi-structured interviews. It seems useful to integrate into these interviews also the critical incidents technique, which can help both to identify the kinds and to understand the nature of the dangerous situations following from the use of assistant systems.

Conclusion

The results of our pilot study correspond to the results of other studies focused on the analysis of driving assistant systems and their impact on human behaviour and thought in several respects. It was found that touch-based manipulation with systems and displays is dangerous. A promising alternative can be identified in the development of gesture- and voice-based forms of interaction. It seems clear that more attention must be paid to drivers' introduction to and training with assistant systems. Also, the improvement and/or removal of dangerous systems (i.e., “lane assistant”) is important. Last but not least, new ways of drivers' active involvement in the control of “high-tech” vehicles need to be developed and designed.

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Contact information
Ingrid Matoušková: Ingrid.matouskova@savs.cz, https://orcid.org/0000-0001-7444-5502
Karel Pavlica: karel.pavlica@ambis.cz, https://orcid.org/0000-0002-0341-8504