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Impact of speed management systems on driver behavior

Deliverable D.3

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INTRODUCTION

Maladjusted speed has been frequently acknowledged as one of the main factors contributing to risks for road traffic safety. To reduce speed, decades of infrastructural and police enforcement measures have passed. With ongoing developments in technology, intelligent in-car systems provide possible opportunities for assistance of longitudinal control of motorised road users in the future.

Intelligent Speed Management Systems (ISM-Systems) are designed to help the driver in choosing the appropriate speed. When speaking about ISM-Systems, it is necessary to distinguish between the numerous variants of these systems that have different functions and different effects on driver behaviour and road safety. Bauer & Seeck (2004)[1] developed a classification scheme for ISM-Systems where these systems are classified according to each of the following categories:

- *Kind (level) of feedback:* informative; warning (Speed Alert); assisting (Active Gas Pedal); intervening (ISA: 'Intelligent Speed Adaptation')
- *Possibility to overrule the function:* overrideable; non-overrideable (controlling)
- *Voluntariness of installation:* voluntary; mandatory
- *Voluntariness of use:* voluntary; mandatory
- *Kind of referenced speed limit:* legal speed limit; recommended 'safe speed'
- *Kind of referenced legal speed limits:* static; variable; dynamic.

It has to be noted that in this classification, the term 'ISA' is used for actively intervening ISM-Systems only, because only in this case, speed is 'adapted' by the system. In the case of a warning ISM-System, the system only recommends a certain speed but the choice of speed is left to the driver.

Although ACC ('Adaptive Cruise Control') is not counted among ISM-Systems originally, it is mentioned here because it also affects driving speed by maintaining the car at a predefined minimal distance from the car that is followed.

As all these systems may not only affect driving speed, it is also very important to have knowledge of the possible *side-effects* of these systems on driver behaviour before they are ready for implementation.

THE BRNO WORKSHOP

The aims of the HUMANIST Task Force D Work Package 3 was 1) to collect information on the effects of intelligent speed management systems on driving behaviour and 2) to promote the exchange of knowledge within the network. This

[1] Bauer, A. & Seeck, A. (2004): Geschwindigkeitsmanagement mit Hilfe von Fahrerassistenzsystemen - Offene Forschungsfragen. 21. Internationale VDI/VW-Gemeinschaftstagung 'Integrierte Sicherheit und Fahrerassistenzsysteme' am 27.-29.10.2004 in Wolfsburg. VDI-Berichte 1864, 485-496.

was done by organising a workshop, which was held in Brno, Czech Republic, on January 28, 2005. Six presentations were given, which covered a broad range of aspects of several kinds of ISM-systems.

Christhard Gelau (*BASt*) presented a number of considerations from the French-German project SafeMap about the socio-economic feasibility of a digital map that is required for several intelligent in-car systems. Preliminary results of this project suggest beneficial effects of these systems in terms of accident cost reduction.

Ioanna Spyropoulou (NTUA) gave an overview of studies into ISM-systems (ISA and ACC) that were performed in the USA, Canada, Australia and Japan. Her overview showed that these studies use a variety of methodologies and address effects on a large number of issues.

Letty Aarts (SWOV) presented an overview of the behavioural effects analysed by two Dutch ISA studies. Besides the expected reductions in speed and speed variance, other results were: a tranquilizing effect on driver behaviour of ISA drivers within an ISA-area, increased frustration in other road users, and a decreased effectiveness of ISA in areas with other speed-reduction measures or dense traffic.

Christine Turetschek (FACTUM) discussed the results of the Swedish ISA-studies. She particularly considered the difference between the objective and subjective data and showed that drivers are often more positive about supposed changes in their behaviour compared to the objective measurable behaviour. She proposed education as a possible measure to make drivers more aware of their wrong self-awareness.

Magnus Hjälmdahl (VTI) presented the individual and 'long-term' effects identified by one of the Swedish ISA-studies. He showed that speed increases when drivers get used to the system. The decrease in speed variance may not be a positive development for slow drivers who may not dare to drive faster. Furthermore, drivers who liked speeding, showed a tendency to quit the ISA-project in an early stage. This may be a possible drawback for implementation for drivers who do not want the system.

Mikko Malmivuo (VTT) presented the results of a research project into speed recording systems in Finnish taxis as a preparation of long-term mandatory ISA. The system warned the taxi-driver when he was speeding, which was a problem in taxis in Finland. Generally, the use of the system decreased speed even more than the speed of ordinary cars.

CONCLUSIONS

The positive effects of intelligent speed management systems are indisputable the reduction in *speed* and *speed variance*. Because speed management systems are aimed at speed reduction, these effects are not surprising and only show that the systems work as expected.

To be certain that the systems are overall really beneficial for road safety, it may be far more important to study the side-effects and the issues that are important for implementation.

- First of all, we may consider the *costs* of implementation. Because these costs may be high, governments first must be convinced that the benefits are even higher by preventing road accidents. This is one major implementation barrier apart from possible legal problems arising from an external speed control.

- A second point may be the public support of intelligent in-car systems for the reduction of speed. The general acceptance of such systems can increase by providing good information and education or combining the benefits on safety with the increase of driver comfort. However, mandatory use may be a problem for a group of drivers that prefer to speed. Their lack of support may undermine implementation. Future research may focus on convincing this group of road users of the benefits of ISM-systems, for instance by showing that the system prevents them from receiving fines (if they had prior).

- But also in 'normal' users, in-car speed management systems may meet resistance or have negative effect on other parts of the driving task that have to be considered:

    - The system may elicit feelings of frustration because of (supposed) time loss. These feelings may result in aggressive driving behaviour or compensatory speeding outside the areas where the system is active.

    - Intelligent speed management systems may also result in decreased feelings of responsibility for choosing the right speed. This may for instance be a problem when the system does not function properly in combination with drivers who have delegated speed control fully to their car.

    - Another issue may be the unknown effects of something that is called 'behavioural adaptation'. When forced to drive a safe speed, drivers may be tempted to take more risks, for instance by starting secondary (entertaining) activities during driving to increase their arousal level. That such a development would not be beneficial for road safety may, among others, be illustrated by HUMANIST deliverable D.2.

- A last point may be the effects of ISM-systems in interaction with other traffic and other systems. These issues are not yet studied to a large extend, but are nevertheless extremely important in a traffic world with increasing numbers of road users and a prospective shift from traditional measures to intelligent in-car technology.

ANNEXES

Annex	Presenting partner at the workshop	Title
1	Christhard Gelau (BASt)	The projects SafeMAP I + II: “Socio-economic assessment of a digital map for road safety applications”
2	Ioanna Spyropoulou (NTUA)	Overview of International Studies on Intelligent Speed Management Systems
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5	Mikko Malmivuo	Intelligent Speed Adaptation (ISA) – recording ISA in Finland
6	Christine Turetschek (FACTUM)	Effects of ISA on driving behaviur **(FULL PAPER)**

Annex 1

Title of paper: The projects SAFEMAP I + II: “Socio-economic assessment of a digital map for road safety applications”

Author: Christhard Gelau

Partner: BASt

Overview:

SafeMap is a joint German-French project with partners from industry (car manufacturers, map providers) and research institutes which was launched within the DEUFRAKO initiative in January 2004. The main objective of this project is to assess the socio-economic feasibility of a dedicated digital map data base comprising safety related data. In this context also relevant technical specifications will be developed and the organisational as well as the legal requirements for creating and maintaining this database will be examined. A first milestone which was reached by the end of the first year which indicated promising effects on traffic safety for both Germany and France. This analysis will be detailed in the second year where in-vehicle applications will be evaluated with respect to their effects on driver behaviour and acceptance in field studies both in Germany and France.

Summary of methodology:

Year 1 (Germany only): The concept developed by the German partners focused on the detailed analysis of existing accident data and a comparison between typical circumstances that led to certain accidents and the current driving situation of the driver. The study started with a survey of the structure and availability of accident and road databases in Germany. Based on the results of the survey, two test areas were chosen, one representing the average, the other one the optimum in terms of data availability and completeness. In a next step, appropriate filter rules were developed for the in-vehicle application “accident blackspot warning”. Based on a detailed accident analysis the so-called accident-road-element matrix was proposed as an algorithm to determine the degree of compliance between the characteristics of the accidents on a certain road stretch and the current driving situation of a driver. By applying the accident-road-element matrix for a given situation it can be decided whether to give a warning to the driver or not.

Year 2: The in-vehicle applications “legal speed warning”, “curve speed warning”, “accident blackspot warning” will be evaluated with regard to their effects on driving behaviour by means of on-road-tests. Exact methodology was still to be defined at the time of the workshop. Results of these tests will be used as an input for a refined assessment of the effectiveness of SafeMap applications.

Summary of results:

Year 1: A preliminary use-of-potential analysis showed that a maximum 46 % of accidents outside built-up areas in Germany could potentially be addressed (not avoided!) with the application “accident blackspot warning”. This result has to be refined in the second project year by a scenario-based analysis which specifies all the assumptions made on acceptance, market penetration, actual use of the system etc.

Year 2: still open at the time of the workshop

Annex 2

Title of paper: Overview of International Studies on Intelligent Speed Management Systems

Author: Ioanna Spyropoulou

Partner: NTUA

Overview

This contribution gave a summary presentation of various studies which were performed in the USA, Australia and Japan on speed management and longitudinal control systems. In general, the systems that were evaluated were conventional speed management systems: manual speed alerting and conventional cruise control, and intelligent speed management systems: advanced curve warning, and variations of intelligent speed adaptation and adaptive cruise control systems.

Summary of methodology

From a methodological perspective system evaluation was performed under the aspects of usability, impact on driver behaviour, road safety, traffic conditions and environmental conditions. The systems were evaluated by using a wide range of different methodologies such as experiments with the use of driver simulators and instrumented vehicles both in test tracks and real traffic, and simulations using traffic models. Results were analysed from questionnaire surveys, measurement of specific quantities such as speed, headways, travel time etc., estimation of specific quantities from modelling etc.

Summary of results

Regardless of the different approached taken on the studies, the main result arising from all studies was that all intelligent speed management systems can have a positive impact in terms of safety but also with regard to environmental effects. But there were also indications that ACC systems induce behavioural adaptation in drivers in terms of changes in workload, hazard detection and driving performance. However, as beneficial effects were also found in all studies that investigated effects of ACC systems there seems to be a clear need for more research that helps to answer the question under which precise conditions phenomena of behavioural adaptation have to be expected.

Annex 3

Title of paper: Intelligent speed management studies in the Netherlands

Author: Letty Aarts

Partner: SWOV

Overview:

In the Netherlands, currently two studies have been performed in intelligent speed management systems. They all concern intelligent speed adaptation (ISA) systems.
1) In the first study, which was part of the European MASTER-project, the behavioural effects of a half-open ISA variant (counter-pressure of gas pedal) were tested. In particular it was tested what the effects would be on a) travel time, b) the time-gap in car following, c) give-way behaviour, d) driver workload and e) the general opinion about the system.

2) The second study was a free field study in the city of Tilburg, in the area called Campenhoef with 20 cars and one public transport bus equipped with a closed ISA system. Within the testing area, 120 volunteer car drivers and 20 bus drivers participated each for 8 weeks per car. The system worked in the area of Campenhoef and two provincial roads. This study aimed at finding out the effects of a) user interaction with the system (in particularly the use of the'emergency button' that could switch the system off, b) driving behaviour (including speeding and general driving behaviour such as overtaking) and c) the public support of ISA, which was measured in four groups that differed in the amount of information they had received about the system.

Summary of methodology:

Study 1: behavioural effects of an half-open ISA system were tested by means of an instrumented car. Twenty to 24 participants drove a preselected route on different road categories once with the system on and once with the system on, counterbalanced over participants. Their driving behaviour was measured during free driving and during car-following.

Study 2: free field study with 20 cars and one public transport bus with a closed ISA system that worked within a particular area. Participants were 120 volunteers that lived within the testing area and each participant drove in a ISA car for about 8 weeks. The bus was tested by 20 bus-drivers. Their behaviour and opinions about the system were measured by an on-board data logger and self-reports in a logbook. Traffic speed within the area was measured by counting-tubes on the road. Public support of ISA was measured by means of questionnaires that were send to a) participants of the study, b) inhabitants of the testing area, c) inhabitants of the city in which the system was tested and d) inhabitants of the province in which the system was tested.

Summary of results:

Both systems showed to result in a reduction of speed and speed variance but the systems appeared to be particularly effective in areas without other speed reducing measures (such as speed humps and cameras) and in situations in which drivers were not hindered by other traffic.

ISA-drivers furthermore reported a tranquilizing effect of ISA on their driving behaviour by reducing the number of overtaking actions. However, ISA seemed to elicit aggressive reactions in non-ISA drivers (only a problem when ISA is not fully implemented), and ISA-drivers also had the tendency to speed outside the area where the system was activated.

Summary evaluation

Study 1) Travel times increased slightly with 2.5%. The time-gap in car-following only increased in the interval below 50 km/h. No differences could be established in giving way behaviour between driving with and without ISA. There appeared to be more frustration during driving with ISA and drivers also reported a decrease in performance during driving with ISA.

Study 2) The 'emergency' button was particularly used for reasons of (supposed) malfunction or during shifts of car-users. In only one or two times, the button was used for reasons of frustration or irritation. Speed and speed variance were reduced, and ISA drivers reported a tranquilizing effect due to fewer overtaking manoeuvres and more distance keeping to other cars. They however had a tendency to speed more outside the ISA areas and also reported increased frustration in other road users.

Consequences

ISA has a positive effect on speed and speed variance, and also public support for ISA improves when drivers are well informed about the system. However, before ISA will be mandatory, the side-effects of the system have to be overcome before implementation will be successful.

Annex 4

Title of paper: In-vehicle speed adaptation – On the effectiveness of a voluntary system

Authors: Magnus Hjälmdahl

Partner: VTI

Overview:

The hypotheses tested in this project were derived from the experiences of earlier studies on the effects of the Active Accelerator Pedal (AAP) on driver behaviour and on theoretical considerations on possible effects of driver assistance systems on driver behaviour.

Hypothesis 1: *The speed level will decrease after long-term use of the AAP:*

This hypothesis is based on the experience of earlier trials of speed adaptation systems, described in chapter 1.4.2, which showed that the use of such systems leads to a general reduction in speed.

Hypothesis 2: *The variance of speed will decrease after long-term use of the AAP:*

This hypothesis is also based on earlier findings. Studies have shown that it is the highest speeds that are reduced the most, which would lead to a decreased variance in speed. In addition to the effect from the reduction of the highest speeds, there could be an increase of the lowest speeds due to drivers who, without the AAP, drive under the speed limit “to be on the safe side”. With the help of the AAP they can drive exactly at the speed limit.

Hypothesis 3: *There is a difference in chosen speed depending on your attitude to the AAP:*

Studies of test drivers’ attitudes that were carried out in earlier trials showed that drivers who often drove over the speed limit were more negative to speed reducing measures, including ISA.

Hypothesis 4: *Drivers will not lower their speed in low speed situations or in areas where they are not supported by the AAP to the same extent when driving with the AAP as when driving without the AAP:*

The hypothesis is based on the theoretical argument that drivers, who feel stressed and pressured for time because they cannot drive as fast as they want to, will try to “make up for it” by driving faster where the system does not interfere with their speed choice. Support for the hypothesis can also be found in the theories of behavioural adaptation and Wilde’s risk compensation theory which argues that road users will use up some of the margin afforded by safety improvements by, for example, driving faster.

Hypothesis 5: *The drivers of AAP-cars will be more inclined to follow traffic regulations:*

This hypothesis also stems from the "behavioural adaptation" theory and the positive change can be attributed to a slower and more relaxed driving pace. The AAP could however have the opposite effect if drivers try to compensate for lost time by, for instance, not stopping at stop signs or running red lights.

Hypothesis 6: *Behaviour towards other road users will improve after long-term use of the AAP (the drivers will be more willing to give priority to other vehicles and pedestrians):*

This hypothesis originates from the empirical findings that drivers entering an interactive situation at lower speeds are more willing to stop and give priority.

Hypothesis 7: *Drivers get used to the system "taking control" and thereby delegate responsibility for certain driving tasks:*

This hypothesis originates in the phenomenon of behavioural adaptation, which is defined as "those behaviours which may occur following the introduction of changes to the road-vehicle-user system and which were not intended by the initiators of the change". A driver supported by an intelligent accelerator pedal is able to devote more attention to the other driving tasks. On the other hand he might become over-reliant on the system. For example, the driver might consider that the system will always know what the speed limit is and will always issue a warning at inappropriate speeds.

Hypothesis 8: *The time gap to the vehicle in front will increase:*

This hypothesis also gets its origin from the "behavioural adaptation" theory but here the expected effect is positive from a traffic safety point of view. Earlier studies on the effects of speed adaptation systems have shown that there is an effect on car-following behaviour. The results are, however, not unanimous so there is a need to study the long-term effects.

Hypothesis 9: *Time consumption increases when driving with the AAP:*

If mean speeds are decreased, as it is hypothesized, it is reasonable to assume that the driving time increases.

Hypothesis 10: *Emission volumes decrease in vehicles equipped with the AAP:*

Lower speeds will bring smoother acceleration curves since the drivers will not speed up to the same extent, and lower speeds and smoother acceleration curves will bring a reduction in emissions.

Summary of methodology:

All the test drivers had the AAP installed in their own vehicles and they first drove with it for one month without it being activated, this to register data of their normal driving behaviour. They then drove for a period varying from five to eleven months with the system activated. Data was registered in the vehicles and collected from the test drivers throughout the project but it was analysed for three specific periods: the month before activating the system, the first month of use and the last month of use (after five to eleven months of using the system). These periods are referred to as Without AAP, Short term use and Long term use. Control measurements were also carried out in the field in Lund and in Helsingborg (a neighbouring city of similar size).

Summary of results:

The results showed that the AAP brought a significant reduction in both mean speed and speed variance, estimated to lead to a reduction in injury accidents of up to 25 % if all vehicles where equipped with the system. It was further found that drivers' behaviour towards other road users improved, they showed a more correct yielding behaviour and were more likely to give pedestrians the right of way at zebra crossings. Moreover, the time gap to the vehicle in front increased slightly with the system. However, there were also signs of negative behavioural modifications in the form of drivers' forgetting to adapt their speed to the speed limit when not supported by the system; this effect was not statistically significant though. These positive results augur well for in-vehicle speed adaptation, but this thesis found that the drivers in favour of the AAP were already without it driving at, or close to, the speed limit while those most negative to the system were the fastest drivers. It was further found that the speed-reducing effect of the AAP was lower for those who were negative to the system. The conclusion is that a voluntary system like the AAP will reduce inadvertent but not deliberate speeding. For such a system to reach its full potential, either peoples' intentions have to be changed or the system has to be more intrusive, i.e. a mandatory limiting system.

Consequences

Since the idea was first introduced in the early eighties Intelligent Speed Adaptation systems like the AAP have been considered as a possibility for future speed management and there have always been more problems than solutions, and more questions than answers. In addition there has also been strong opposition to the systems from vehicle manufacturers and implementation has never been anything more than futuristic ideas. In the last couple of years however, both technological development and research on ISA have changed the conditions radically and in Sweden there is now a program being developed by the SNRA on how to implement ISA, starting with the SNRA's own vehicles in 2004 (Vägverket, 2003d). It has not yet been decided what or which systems are to be used more than that they will be either advisory or advisory intervention systems. The general idea of the program is to let the market decide as much as possible what the system will look like. The findings of this thesis have shown that such an approach will not be very effective unless it is combined with other measures to increase drivers' intentions of keeping the speed limit. Such measures, for instance more enforcement and demands that the speed limits are followed when purchasing transportation services, are mentioned in SNRA's program. This research has shown that, if a demand for keeping the speed limit is created, an ISA system like the AAP is an efficient tool to increase safety on our roads.

Annex 5

Title of paper: Recording ISA, field trials in Finland

Authors: Juha Tapio & Harri Peltola

Partner: VTT Technical Research Centre of Finland

Overview:

A field trial with Recording ISA for assessing possible traffic safety effects and user acceptance was implemented in Finland.

Summary of methodology:

A small GPS based device, which recorded speed, time and coordinates of the measuring point was inserted in test vehicles. A total of 165 test drivers, employers and parents of young drivers were regularly sent information by e-mail on the speed observations and possible speeding in different speed limit areas. The objective of the feedback was to motivate drivers towards more moderate driving behaviour. Speeds measured during the feedback period were compared with speeds measured before the period. Comparisons to general speeds on automatic traffic measurement points and user acceptance survey were conducted as well.

Summary of results:

The main results of the trial suggested that Recording ISA has a positive impact on traffic safety. Especially the average speed of taxi drivers compared with the average speed of ordinary car and van drivers decreased on highways in 80 kph and 100 kph speed limit areas.

The companies and their drivers accepted the idea of using Recording ISA as a quality assurance system. “Big brother” fears were not observed, nor were conflicts between employers and employees.

In family use the Recording ISA that gave speed information to parents too was considered acceptable when young drivers used their parent’s car, but opposite was true if young drivers drove their own car.

To summarise, the Recording ISA has a positive impact on traffic safety. The impact is conditional on the willingness of the supervisor (e.g. employer, customer of the transport company, parents) to insist moderate driving behaviour.

Consequences

The Recording ISA is applicable as a quality assurance system in transport companies and their customers. Especially customers should insist transport companies to control speed of their trucks.

It could also be used as a quality control system in company cars.

Other applications could be controlling repeatedly speeding drivers after several speeding fines and guiding young drivers towards moderating their driving behaviour.

Annex 6

Title of paper: Effects of ISA on driving behaviour **(FULL Paper)**

Author: Christine Turetschek

Partner: FACTUM

Introduction

This summary refers to a large-scale study about ISA which took place in Sweden. One study reported here was carried out within the framework of the Swedish National Road Administration's large-scale trial with Intelligent Speed Adaptation (ISA). 284 vehicles in the city of Lund were equipped with an active accelerator pedal (AAP). The second study – actually the earlier one - was an observation of drivers with 2 months experience in Eslöv, combined with interviews, in 1997 with a follow up in 2000. In the large-scale study, different methods to find out which influence the use of an AAP (Active Accelerator Pedal) has on driving behaviour were used. Both, qualitative methods like interviews and surveys and objective methodes like analyses of accident rates, calculation of travel times, data logging and in-car observations took place. In the Eslöv-study, in-depth interviews were the main method, and these interviews were carried out at to occasions with exactly the same questions.

The study which took place in Lund was carried out to in order to answer the question, how the use of ISA will influence the behaviour of drivers and their interaction with other road users, especially vulnerable ones. The hypotheses predicted that the behaviour will improve. They also expressed the expectation that the headways to vehicles in front would increase. On the other hand there were also hypotheses that suggested that drivers would get used to the system and therefore delegate the responsibilty to ISA.

The follow up study of the Eslöv studie targeted more the attitudes of critical groups and of drivers, in order to clarify whether they would lead to acceptance problems for an implementation and if acceptanve parameters would change in connection with the use of the system. The focus was also more on finding out if the behaviour outside of the test area is influenced.

This abstract will not give an account of all results of these studies but should give an overview over the effects on attitudes and driving behaviour, and their changes, that have been found with the help of the above mentioned methods.

Influence on Speed-Behaviour

Table 1: Speed Behaviour

	Decreased viz. improved	Unchanged	Increased viz. deteriorated
General speed level in the test area *(objective)*		↕	
General speed level in the test area *(subjective)*			
Maximum speeds on the main street *(objective)*			
Speed behavior of test drivers in the test area *(objective)*			
Respecting of speed limits *(objective, subjective)*	=		
Speeds outside the test area (30, 50 ,70 km/h) (*subjective)*			
Speed adjustment before obstacles and at intersections *(objective)*			
"Pedal-to-the-metal" effect where pedestrians would cross the street *(objective,subjective)*	=		
Attention for speed limits outside the test area (*subjective)*			
Awareness of erroneous speed choices (*subjective)*			
Journey time *(objective)*		↕	↕
Journey time (*subjective)*			

=*means that objective data and the subjective estimation of the interviewed persons correspond*

↕ *Means that there is a difference between objective data and the subjective estimation of the interviewed persons*

As we know and as studies have indicated, speed plays an important role for traffic safety. The first necessity resulting from this is to keep the drivers' behaviour as near as possible to the regular speed limits, to start with. Table 1 showes that the use of ISA can influence behaviour in several ways. For instance, **maximum speeds** on

main streets decreased with about 2km/h. Next to the fact, that the speed behaviour in the test area improved, it also became easier for drivers to stick to the **legal speed limits** even outside of the ISA test area. According to measurements a positive behaviour transfer took place, as well.

The interesting thing is that test persons paid less attention to **speed limit signs** within the test area while more attention was paid to signs **outside the test area**. Obviously, problems of erroneous speed choice became more conscious, with the **Result that speeds outside** the test area decreased, as well.

Speed adjustment before obstacles and at intersections deteriorated. I.e., speed was reduced somewhat later then without ISA. But there was no "**pedal to the metal**"[2] effect at pedestrian crossings, which had been expected before the study.

Many test drivers reported, that they generally drove less quickly, which is in contrast to the objective data that showed no change in the **general speed** level.

An interesting point is that all drivers – independently of their attitude towards AAP - had the impression, that their journey time became longer although this could not be verified with objective data.

Interaction with pedestrians/cyclists or other road users in general

Table 2: Interaction

	Improved	Unchanged	Decreased
Interaction with pedestrians *(subjective)*			
Consideration of cyclists and pedestrians (*subjective and observation)*	=		
Giving priority to pedestrians at pedestrian crossings (*subjective and observation)*	=		

=*means that objective data and the subjective estimation of the interviewed persons correspond*

The drivers had the impression that their **interaction with pedestrians** and their **consideration of cyclists and pedestrians** had improved. The assumption of the test drivers that they did give more priority to pedestrians at pedestrian crossings was supported by an in car-observation. Negative types of interaction with pedestrians

[2] Pedal-to-the-metal effect: Refers to the hypothesis that people will drive with full gas all the time because speed is limited.

decreased, for instance giving priority only at a very late stage, that pedestrians had to force their priority, and that drivers force pedestrians to stop or that they endanger them.

Sticking to the rules

Table 3: Sticking to the rules

	Improved	Unchanged	Decreased
Observance of traffic rules in general (*subjective)*			
Distance at the car in front *(objective, subjective)*	=		
Red light violations *(objective)*			
Lane use, lane changes, number of overtakings			

=*means that objective data and the subjective estimation of the interviewed persons correspond*

The drivers experience that they consider **traffic rules** and traffic signs more with ISA. **Distance keeping** to the car ahead improved, both according to the subjective impression of the drivers and to in-car-observation results. However, the study could not show any systematic effects with respect to **red light violations** of ISA vehicles. Nor could any significant changes in **lane use and lane change** or in the **number of overtakings** be found.

Changes in attitudes

Table 4: Changes in attitudes

	+	=	-
Behaviour when using ISA (*subjective)*	More considerate		
Attitude changes *(objective, subjective)*	More positive =		
Behavior generalisation *(objective, subjective)*	Positive generalisation =		
Driving style (*subjective)*	More relaxed		

=*means that objective data and the subjective estimation of the interviewed persons correspond*

Test drivers think that they improved their behaviour when using ISA. Their attitudes became more positive, they developed a more relaxed driving style, they say (55% state that they have become safer and calmer, especially in the city.), and a positive behaviour generalisation was mentioned and could be observed.

What improvements of behaviour due to ISA are reported by the interviewed persons? 80% think that the changes in the driving style are still completely or partly (36%) there after a period of one year. However, some of them did not experience any changes. But nobody stated that his/her behaviour had deteriorated. Interviews one year later showed that about half of the respondents had developed a more positive attitude for different reasons: ISA was not as troublesome as they had thought. They did not know before how ISA was going to work, etc. Some became more doubtful, even if there was hardly any development towards the negative side (Risser, R.; 2002)).

Changes in behaviour

75% of the interviewees did not mention unexpected/unwanted behaviour changes, whereas 20% say that some adjustment and planning was needed. Additionally, almost all interviewed persons think that it is no problem to have no possibility to make up for lost time. According to the first statement, some people think that one just has to plan better and adjust behaviour, and some think that the possibility to make up for lost time in the city is non-existent or marginal, anyway. (Risser 2002)

The majority of the interviewed persons (60%) think that no new hazards due to the use of ISA have occurred, especially not if the application worked well. But one third think that some situations have become more difficult: For instance, there is a risk of being hit from behind, they fear; and overtaking has become harder, as one does not have the possibility to accelerate hard in critical situations. (Risser 2002).

Miscellaneous

Table 5: Speed Behaviour

	Improved	Unchanged	Decreased
Accidents *(objective)*			
Awareness of what is happening along the road side (*subjective)*			
Equipment experienced as being a support when driving (*subjective)*			
Feeling to be controlled and desire to switch off the system (*subjective)*			
Experience of effects of ISA in general (*subjective)*			
Safety effects of ISA: decrease of average speeds or improvement of rule awareness *(objective)*	⇕	⇕	⇕
Safety effects of ISA: deteriorated for some (18%) but ok for the majority *(subjective)*		Ok for the majority	18%

⇕ *Means that there is a difference between objective data and the subjective estimation of the interviewed persons*

No effects of ISA on **accidents** were found, neither positive nor negative. However, **safety effects of ISA** like decrease of average speeds or improvement of rule awareness could be observed. In contrary 59% of the interviewed persons think, that ISA also could have disadvantages in certain cases, or that there are clear situations where ISA has disadvantages for traffic safety (18%): At intersections, when overtaking, by disturbing other road users who want to carry on “undisturbed”, or when it does not really work well, technically speaking (Risser 2002).

At the same time, drivers experienced the use of ISA as a **support** for the driving task, and they mentioned **general** positive **effects** of ISA; some of them report even one year later that they have become more aware of traffic safety (more insight in the problems, one thinks more about speed, etc) (Risser 2002). However, the **feeling of being controlled** and the **wish to switch off the system** were not changedOne problem is that drivers with an initially negative attitude towards ISA feel more frustrated because they perceive themselves as being a hindrance for others. They experience more time pressure, more stress and less driving pleasure.

Conclusion

Summarisingly it can be said, that the use of ISA leads to positive effects with respect to the driving behaviour, and consequently to traffic safety. In some aspects there could be found differences between the objective data and the subjective view of interviewed persons. This is the case for instance with respect to the general speed level or also concerning the safety effects of ISA. If people think that they drove less fast when using ISA , and if this could not be varified with the objective data, this is a sign that people not always assess their own behaviour in a correct way. Following this thought people may tend to assess their own behaviour erroneously when using other IST applications. Erroneous assessment of one's own behaviour and its consequences could be tackled with psychological training (q.v. TF F). In this connection it would also be quite interesting to look at data at the individual level: Whether the persons who think that their behaviour has improved really have improved according to the behaviour observation. If this is not the case then there may exist even a more urgent need for training, and for making these people aware of the differences between their self-perception and their actual behaviour.

Additionally, there exist differences between individuals with an initially positive attitude and those who had a negative attitude towards AAP from the beginning. Drivers with a positive attitude atated that they experienced advantages connected to AAP: They braked less often (= smoother speed choice and accelerations) and they had to look at the speedometer less often.

Drivers with a negative attitude (especially young ones) exceeded the speed limit by using the ”kick down” function to a larger extent. This indicates that the use of AAP should be accompanied by communicative measures, as well. Training could be one of these measures.

Literature

Several publications of the ISA studies exist, among others, the effects of Large Scale use of active accelerator pedal in urban areas:

Kaufmann C. & Risser R. 2003, Die Effekte der Verwendung eines aktiven Gaspedals AAP in einem Feldversuch in Lund, Zeitschrift für Verkehrssicherheit ZVS, pp 184-190

Risser R., et. al. 2002, In-depth analyses of acceptance of a dynamic speed limiting function

Várhelyi A., Hydén Ch., Hjälmdahl M., Risser R. & Draskóczy M. 2002, The effects of Large Scale use of active accelerator pedal in urban areas, Paper for the 15th ICTCT workshop on Speed management strategies and implementation, Brno, Czech Republic, October 24th - 25th, Department of Technology and Society, Lund University, Box 118, 221 00 Lund, Sweden

Várhelyi A., Hjälmdahl M., Risser R., Draskóczy M., Hydén Ch., Taniguchi S., Almqvist S., Falk E. & Ashouri H. 2002, The effects of Large Scale use of active accelerator pedal in urban areas, ICTCT Extraordinary workshop on ISA – Intelligent Speed Adaptation in Nagoya, Japan, May 19th to 20th 2002, Department of Technology and Society, Lund University, Sweden