The European PROSPER-project: Final results of the trial on Intelligent Speed Adaptation (ISA) in Belgium

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Final results of the trial on Intelligent Speed Adaptation (ISA) in Belgium

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ABSTRACT

In October 2002 a first ISA-trial in Belgium was held in Ghent. Until January 2004, 34 cars and 3 buses were equipped with the "active accelerator pedal (AAP)". This means when the driver attempted to exceed the speed limit, a resistance in the accelerator was activated. If necessary, the driver could overrule the system. To study the effect of the ISA-system both surveys and analyses of driving data were held.

Data logging shows a clear effect of the ISA-system on speeding behaviour. Speeding reduces significantly. There is however still a large remaining percentage of distance speeding, especially in low speed zones. Differences between drivers are large. For some drivers speeding increases despite activation of the system. For less frequent speeders average driving speed almost always increases and for more frequent speeders average tends to decrease. Less frequent speeders tend to accelerate faster towards the speed limit and drive exactly at the speed limit in stead of safely below, which causes average speeds to go up.

KEYWORDS

Intelligent Speed Adaptation (ISA), speed-warning devices, acceptance, driving-behaviour, basic attitudes,

TRIAL-SETTING

In total, 37 vehicles participated in the ISA-trial. Twenty vehicles were owned by private test-drivers, 17 vehicles were owned by companies: six cars of the City of Ghent (one of the Social Services), five vehicles of the Ghent University, three buses of the regional public transport company, two vehicles of the Province of East-Flanders and one of Volvocars Ghent.

To recruit private test-drivers, advertisements were published in different media. Possible candidates could respond by letter to receive an application form. Hundred and eight drivers were retained as potential candidates. The drivers were selected from those 108 applicants based on technical feasibility of installation of the system inside the car, gender and age. It was difficult to have equal age and gender groups because a low number of women had respond. Twenty candidates were selected as test-drivers: 11 male and 9 female drivers.
Also not every selected driver was the only driver of the vehicle. The total number of voluntary drivers was 28, spread over the 20 private cars.

Companies selected their cars themselves, only based on the given criteria of technical feasibility of installation. The gender and age of these test-drivers were not known in advance. By these selected cars it was assumed that there would be more than one driver, for example the bus drivers. The total (restricted) number of test drivers was 62: 42 male and 20 female spread over different ages.

RESEARCH METHOD

Data logging

All 37 vehicles were equipped with data-logging facilities and a flash-memory. This made it possible to collect data on speed, speed limit, position, time, date and voluntary use of the system outside the test area. Data was saved at a frequency of 5 Hz whenever the vehicle was inside the test area and at a frequency of 1 Hz whenever the vehicle was outside the test area. Data were logged for 1 month before the active accelerator pedal was activated and then during the entire trial. Logged data were used to analyse changes in speed, driving-behaviour and voluntary use of the ISA-system.

In total 99 million loggings were recorded inside the study area. To exclude incorrect loggings, a filter was applied on all fields for extreme values. Due to these filters, 19% of all data was withheld. From 99 million loggings, 80 million loggings were used for further analyses. For 21 out of 37 vehicles enough data were available from both periods, with and without the system. In the period before activating the ISA-system (26 October 2002) reference measurements were done, but due to problems with the logging device it was not possible to recover the data for the reference period. The demo was prolonged with a reference period without activation of the A.A.P.-system *after* the ISA-active period. When effects of ISA on speed are discussed, this concerns differences between driving data with the Active accelerator pedal or A.A.P -system and data after deactivation of this system.

After filtering all data on minimum and maximum values, all data were categorized into classes with a band width of 1 km/h. Outputs were frequency counts per car for each class. According to the parameter to be examined further distinction was made on A.A.P./ no A.A.P., speed limits, time of day or month.

Speeds were analyzed on two levels: time-based and distance-based. Time based speeds were based on average speeds at which people travel per second. This means that idling speed (0km/h) was incorporated in the calculation of average speeds. Distance-based speeds were calculated based on average speeds at which people travel per meter. This means that idling was not incorporated in the calculation as no distance was covered and that higher speeds became more important in the calculation of averages as more distance was covered per second. Only distance-based results are reported in this paper.

Questionnaires to the test drivers

All test-drivers were interviewed three times: before their vehicle was equipped with ISA, after driving with the system for four months and finally at the end of the test-period. Most of the questions from the base-line questionnaire were repeated, but there were more specific questions about driving experience and acceptance. The objective of the questionnaire was to

study the drivers' attitudes, behaviour, acceptance and experiences with ISA and possible changes after using the system for a long period.

The questionnaires were based on a study done by the Ghent University and the Belgian Institute on Road-Safety (BIRS). This method denotes how people see mobility and transportation in relation with road-safety, especially on speed, speeding and restriction. Public acceptance is based on the attitudes and opinions given by individuals, which stand for the general public. The concept determines several layers with mutual relations.

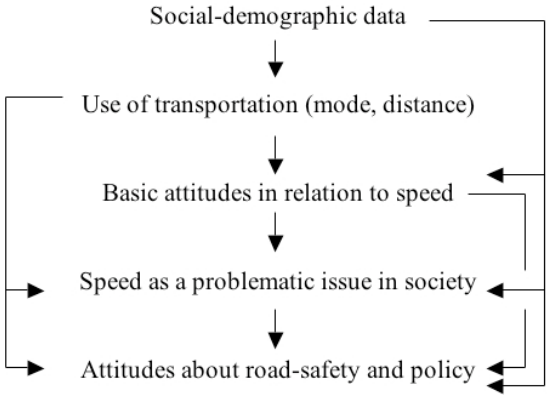

Figure 1 - a working model on measuring the carrying capacity of ISA

Socio-demographic data and use of transportation

The social-demographic issues and the individual transportation habits are the 'basic' factors for the creation of a carrying capacity. These determinants will influence almost all the layers of the carrying capacity or support model.

Basic Attitudes

The basic attitudes denote how people see mobility and transportation, in particular the perception of speed in relation to motorised vehicles. The basic attitudes were: 'driving is only satisfying with a nice car'; 'speeding is exciting'; 'drivers have to be too aware of other road users'; 'if I drive, I live it up'; 'driving fast saves time'; 'a car is only used for transportation'; 'driving fast is liberating'; 'people should be stimulated to use the car less'; 'driving fast is fun'.

A Problematic Issue in Society

A social carrying capacity or the social support of a measure is also determined by 'being a (problematic) issue in society:' If there is no social indication that there is a problem about road-safety, speed and speeding; there will not be a possibility in future acceptance on ISA.

These indications are related to the actual situation on road-categorisation and speed limits, and how people see their own behaviour on speed and speeding. Questions are posed about how people see the relation between road-accidents and speed; in which conditions speed and speeding will be a problem; determination of speeding behaviour; and the feeling of insecurity.

Attitudes about Road-safety and Policy

Some of the abstract norms and values are made concrete in issues concerning in how people think about road-safety measures. At this level the 'real' discussion on possible acceptance will take place.
These 'layers' can be interpreted as sequential: the basic attitudes will determine in how issues about speed and speeding will be perceived as problematic and how people will experience the policy on road-safety to handle the problem of speeding. For example: A driver who described his car as liberating and exciting and who drives fast, will not recognise speeding as a problem. This driver will also not see measures taken against speeding as a priority or as useful.

MAIN RESULTS

Based on data logging

Aggregated speeds

The effect of the active gas pedal on average speed (V) was small. Effects were largest in the 90 km/h zone with a decrease of average travel speed of only 1.1 km/h. Average speed is not influenced in the 30 km/h and 70 km/h zone and even increases in the 50km/h zone. A possible explanation is the fact that cautious drivers who mostly obey the speed limit drive faster with ISA and that this effect evens out the reduction of speeding. A more obvious effect is in the 85 percentile (85P). For all speed zones the 85 percentile decreases.

Speed limit	Km driven	A.A.P. inactive			A.A.P. active			Change in		
		V	SD	85P	V	SD	85P	V	SD	85P
30 km/h	5569	23,8	11,4	39,0	23,8	10,2	36,5	0,0	-1,2	-2,5
50 km/h	95509	30,9	14,9	49,9	31,6	14,6	49,6	0,7	-0,2	-0,4
70 km/h	13297	47,5	19,3	71,3	47,5	19,1	68,9	0,0	-0,2	-2,5
90 km/h	17194	69,1	19,3	89,4	68,0	17,6	86,9	-1,1	-1,7	-2,5

V = mean speed, SD = standard deviation, 85P = 85 percentile

Table 1 - Driving speeds average, standard deviation and 85 percentile of test area

Speeding

The amount of speeding was lower when the active gas pedal was operational. Effects were largest in zones with the highest speed limit. Although speeding was reduced, there still remained a large percentage of speeding. Especially in the 30 km/h zone the effect on speeding was minimal, although the amount of speeding was high. The counterforce, exerted by the pedal, wasn't strong enough to discourage drivers to exceed the speed limit.

Speed limit	Km driven	A.A.P. inactive	A.A.P. active.
30 km/h	5569	45,9%	42,8%
50 km/h	95509	14,7%	13,1%
70 km/h	13297	17,6%	12,6%
90 km/h	17194	13,5%	3,8%
Total	131569	16,3%	13,1%

Table 2 - Percentage of distance speeding in test area

Evolution of speeding

An important issue with making use of an active accelerator pedal is the applied counterforce. Speed offences can again become more frequent as drivers get used to the counterforce exerted by the pedal. To test this effect, loggings were compared on a monthly basis. Deactivation of the pedal took place for all cars during month 10 and month 11. In these periods both loggings with and without the A.A.P.-system activated were logged. After these months only loggings without the system are recorded.
In all speed zones, speed offences have increased in month 9, just before the start of the deactivation period, compared with the first month. In low speed zones speed offences increase rapidly the first three months and then stay more or less at the same level until deactivation. In high speed zones the increase is more gradually.

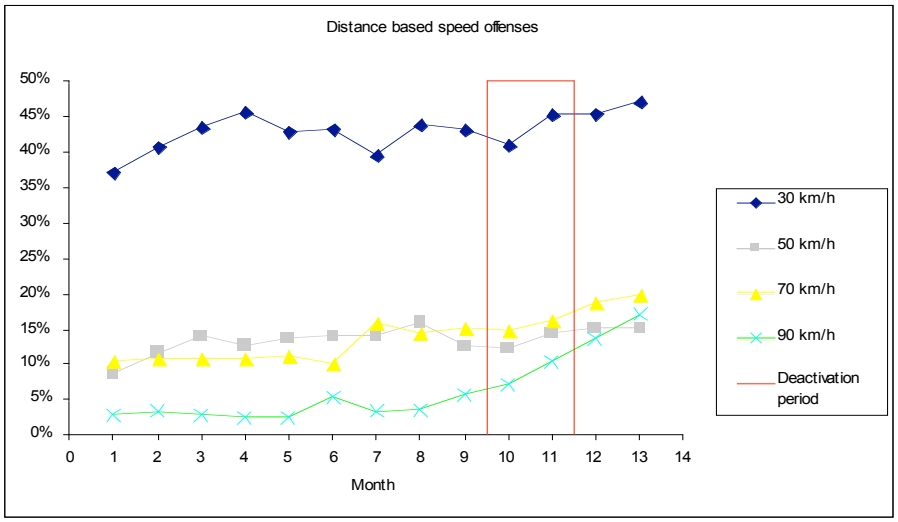

Figure 2 - Percentage of distance speeding on monthly basis for different speed zones

Driver-specific analysis

The effect of the A.A.P. system on total speeding was already mentioned. Effects of the system were largest in 90 km/h zone and lowest in the 50 km/h zone. Speeding remained by far largest in the 30 km/h zone. To study the effect on speeding in more detail, results are given per driver in figures 3 and 4.

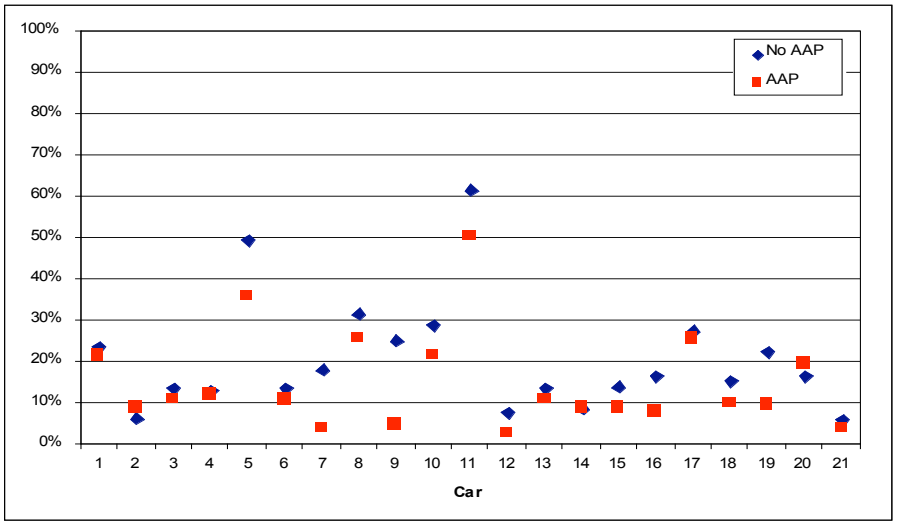

Figure 3 - Percentage of total distance speeding per car

Differences between drivers were large. Speeding without the system varied between 6% and 61%. Speeding with the system varied between 3% and 50%. For most drivers speeding reduced with the system. There were however 3 drivers out of 21 for whom speeding even had increased (cars 2, 14 and 20).

Effects on average driving speed were also very diverse. For 8 drivers out of 21 average driving speed increased. For less frequent speeders average driving speed almost always increased. Of the 10 least frequent speeders, 9 had an increase in average speed due to activation of the A.A.P.. For more frequent speeders average tends to increase. Of the 10 most frequent speeders, 8 had a decrease in average speed due to activation of the A.A.P..

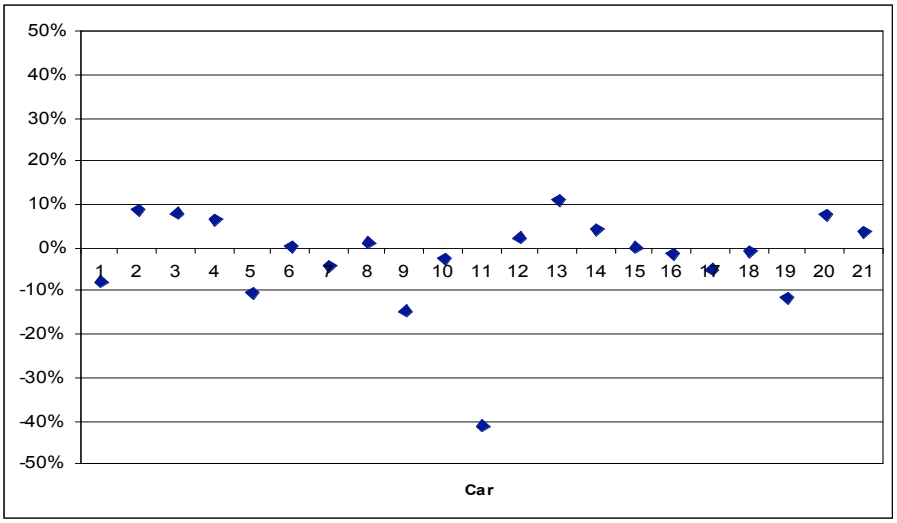

Figure 4 - Relative change of average driving speed due to activation of A.A.P. system

Activation of active gas pedal outside ISA-area

When drivers were outside the ISA-zone, no speed limits were available and the gas pedal was not activated. Drivers did however have the possibility to manually insert the speed limit into the system. This manual mode caused the active gas pedal to be operational. Whether the

system was activated, was logged during the trial. The speed limit which was inserted was however not logged. Some drivers for instance stated in the survey to insert a speed of 130 km/h on 120 km/h roads to use the pedal as some kind of cruise control. The percentage of loggings with the ISA system manually activated is however still a good indication of the willingness of people to use the system.
Results in figure 5 show that in some 30% of the time a speed limit was manually inserted into the system. This percentage tends to increase as the trial continues. The percentage in month 7 is much lower than in other months, but the holiday period and festivities in the city centre could explain why. After deactivation of the A.A.P., the speed limit was naturally not implemented as no benefit could be gained from this insertion.

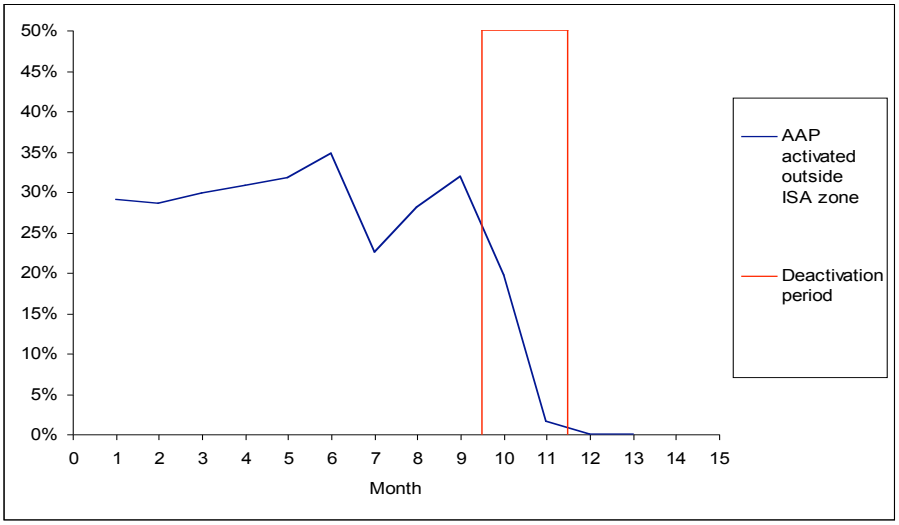

Figure 5 - Percentage of loggings outside ISA zone with A.A.P. manually activated

Based on Questionnaires

Basic Attitudes

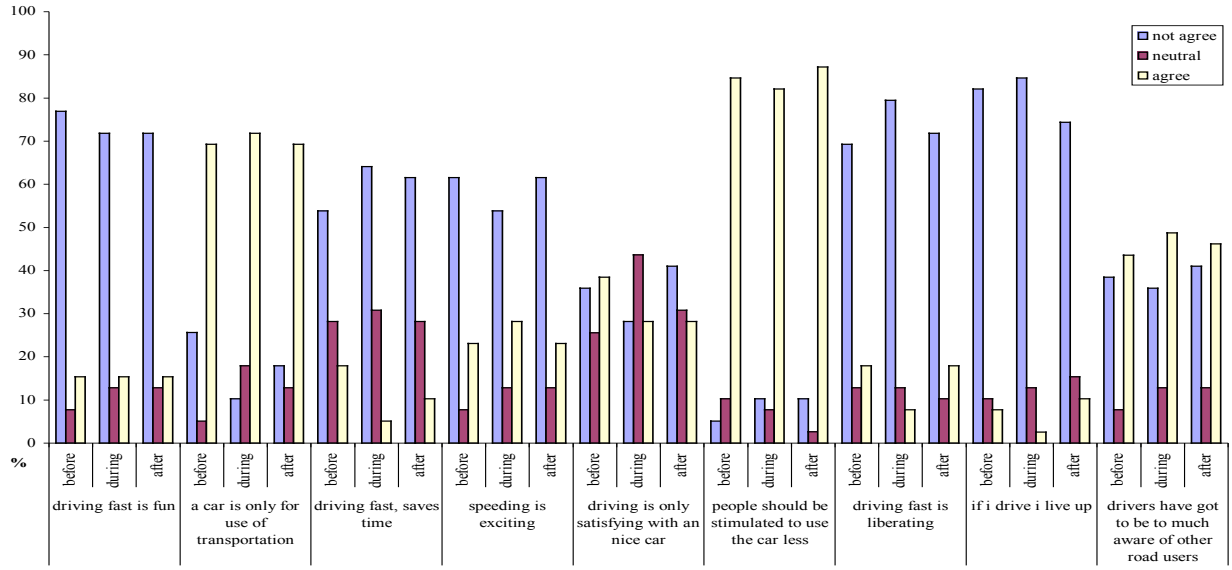

Figure 6 - Frequencies of responses on basic attitudes in percentage.

ISA had a certain effect on the drivers' opinion on basic attitudes. Basically, most of the drivers didn't think that driving fast is fun (average, more than 70%), or exciting (average, more than 53%). Their opinions about these issues did not change dramatically during or after the trial. More people agreed on 'driving fast is liberating' during (79%) than before (69%) or after (71%). More than 75% did not agree with the attitude 'if I drive, I live it up', although this opinion increased (84%) during the trial and decreased (74%) after the trial. Before the trial 1 out of 5 drivers thought that 'driving fast saves time', during the trial only 5% agreed and after the trial, only 1 out 10 thought that 'driving fast saves time'. Before (84%), during (82%) and after (86%), a huge majority agreed that 'people should be stimulated to use the car less' and that 'a car is only a way of transportation' (around 70%). Before the trial, 38% thought that 'driving is only satisfying in a nice car'. During the test most of them (43%) were neutral, while after the trial most did not agree.

Speeding Behaviour

Compared with their speeding behaviour before ISA, the test-drivers declared that they were driving slower during the project. On highways, the answer on 'never speeding' increased during the project with 49%, outside urban areas with 26%, in urban areas with 16%, in 30 km/h zones with 7%. The answers on 'regularly speeding and mostly speeding' decreased on most categories during the trial. The answers given after the trial on 'never speeding' stayed level for outside urban areas, in urban areas and 30 km/h zones.

Speed and Speeding as a Problem

The attitudes on speed and speeding were analysed before, during and after the trial. The following possible attitudes were given to the test-drivers: 'speeding is dangerous'; 'speeding is sportive'; 'speeding is reckless'; 'speeding causes the most traffic accidents'. Although their opinions changed during and after the trial, the most drivers thought that speeding is 'dangerous', 'reckless' and 'not sportive'. The most remarkable changes were about their opinion of 'speeding causes the most traffic accidents': 74% agreed before, 69% during, and 56% after the trial.

The drivers were also asked if they felt safe or unsafe, when they saw other cars driving to fast in different speed areas.

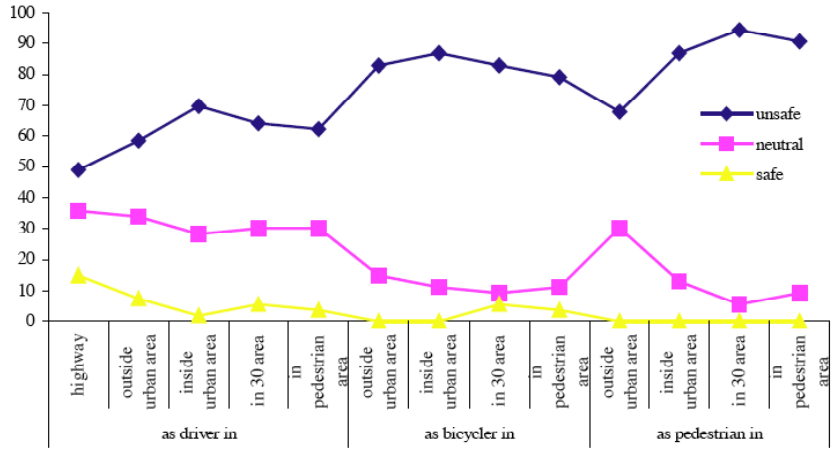

Figure 7 – Feeling of insecurity in different roles

The respondents would never feel save as a pedestrian in any speed area when other cars were driving to fast. The test-drivers felt the most insecure as a pedestrian in 30 area (94%) and pedestrian areas (90%). As drivers, 49% felt unsafe on highways, 70% in urban areas when they noticed other cars driving too fast. As cyclist, 87% felt unsafe in urban areas, 83% outside urban and 30 areas, 79% in pedestrian areas.

Road-safety Policy and Measures taken against Speeding

The test-drivers were asked how they thought about the different speed limits in different areas. On average, more than 60% of the drivers declared before, during and after that the speed limits are good in all areas. During and after the trial, more and more drivers claimed that speed limits in 30-areas (23% before, 36% during, 41% after) and pedestrian areas (82% before, 61% during, 51% after) are too low. Main reason was that with the A.A.P. they were forced to adhere to the speed limits in these area. Most drivers said that 'driving 30 or 15 is slow', although they did not want to declare that '30 areas and pedestrian areas are not useful for road-safety'.

The test-drivers were asked two main questions were about measures taken against speeding: how important is it to take actions against speeding in different speed areas and which methods are the most appropriate?

The test-drivers declared that taking action against speeding in urban areas (53%) is a priority, followed by 30 zones (51%), pedestrian areas (47%), outside urban areas (34%) and highways (28%). The respondents did not think it important to take measures against speeding on highways. The best methods taken against speeding were police controls and cameras, followed by speed bumps. The worst methods were road-safety campaigns.

Driving behaviour with ISA

Based on the questionnaires, the following experiences were given by the drivers:
- 3 out of 5 drivers declared that they drove more comfortably and relaxed than without ISA.
- 1out of 3 drivers said that they had more consideration for other road-users.

- The drivers looked less often at the speedometer and they let their foot 'rest' relatively often on the counterforce of the accelerator pedal, even as some of them tried to drive in such way that the pedal would not be activated.
- Most drivers did not notice any difference while driving with or without the active accelerator pedal regarding looking at speed signs, recognition of and involvement in certain traffic situations or keeping distance with other cars. If they experienced some changes it was more in favour of driving with ISA.
- 1 out of 2 test-drivers declared that they overtook less while driving with ISA.
- 1 out of 2 drivers found it easier to keep a constant speed with ISA.
- The ISA-system assisted them well to maintain the right speed. Certainly for upholding the 30 km/h limit of which they noted that it was not an easy speed to drive at without assistance.

The drivers' Acceptance of ISA

The acceptance of ISA was measured by three methods [4]:

1) The method used to measure the acceptance was the procedure of Van Der Laan, Heino and De Waard [5]. Acceptance is measured by direct attitudes towards a system and provides research with a system evaluation in two dimensions. The technique consists of nine rating-scale items. These items are mapped on two scales, a scale denoting the usefulness of the system, and a scale designating satisfaction.

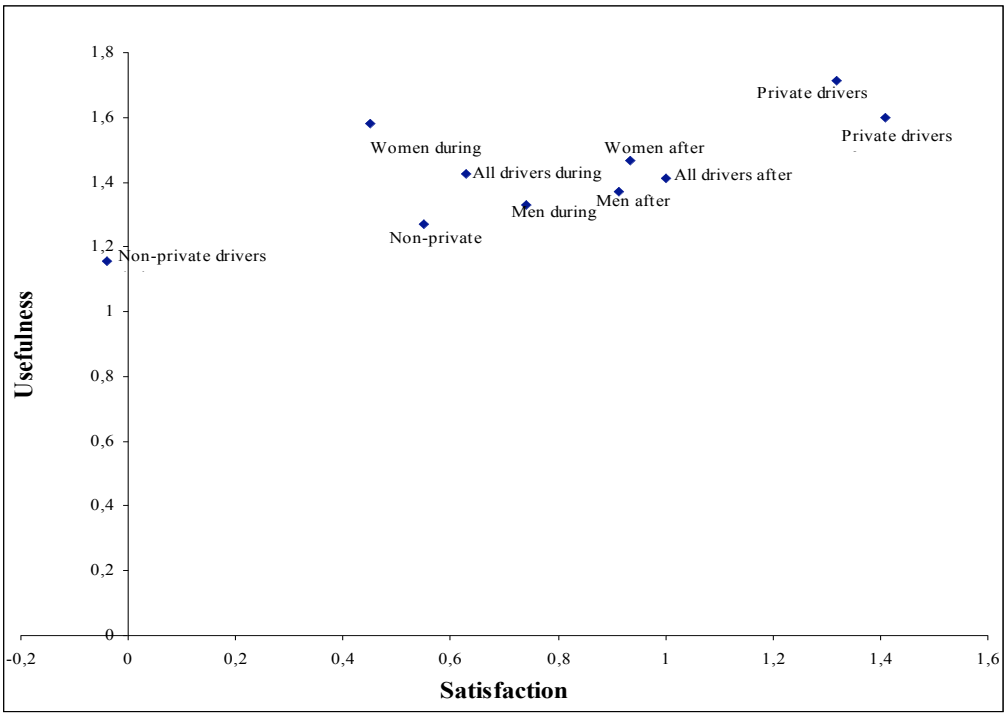

Figure 8 - Acceptance of the active accelerator pedal

All drivers (total) accepted the active accelerator pedal. After the trial they experienced the pedal as being even more satisfying. The most pleased with the active accelerator pedal were the private drivers. During the project they found it more useful but less satisfying than after

the project. The most remarkable change is seen by the non-private drivers: while during the project they experienced it was not satisfying, although useful, they declared it was more satisfying and useful after the trial.

2) The drivers were also asked if they used the A.A.P. manually (voluntary) outside the test-areas, and on which roads. Mostly it was used on highways (56% during, 60% after) and outside urban areas (56% during, 50% after), less in urban areas (46% during, 41% after) or 30 roads (33% during and after) outside the test area. This voluntary use indicates a first acceptance.

3) At the end of the trial, the private test-drivers could choose to keep the ISA-system in their car. 15 private car holders chose to keep the system in the vehicle after the test-period which is a significant indication that there is an acceptance of the active accelerator pedal. The main reasons given for keeping the system was that it was assisting, comfortable and relaxed driving.

CONCLUSIONS

Comparison of logged speed data during the activation period and speed data after this period shows ISA had an effect on speeding. Effects were highest in the 90 km/h zone where speeding decreases by almost 10%. At lower speed limits effects were smaller all though speeding was more frequent. In the 30 km/h zone distance speeding decreased from 45.9% to 42.8%, which means that the counter pressure was overridden in a vast amount of distance. Comparing effects on a monthly basis shows a higher amount of speeding at the end of the activation period than at the beginning. Especially in low speed zones speeding increased during the first months.

Differences between drivers were however large. Speeding without the system varied between 6% and 61%. Distance speeding with the system varied between 3% and 50%. For most drivers speeding reduced with the system. Average speed of less frequent speeders tended to increase as drivers accelerated faster to the speed limit and drove exactly at the speed limit in stead of safely below. Average speed of more frequent speeders tended to decrease.

About the basic attitudes in the results of the questionnaire, most of the drivers did not think that driving fast is fun, liberating or exciting, before, during or after the project. Most drivers declared that speeding is dangerous, reckless and not sportive. Driving with ISA changed their behaviour on speeding: during the project, most of the drivers declared that they never drove faster on highways, outside urban areas, in urban areas and 30-zones. The drivers used the system voluntary on highways and outside urban areas, which gave a first indication of their acceptance of the active accelerator pedal. They also experienced the pedal as satisfying and useful. After the trial, the private test-drivers could choose to keep the ISA-system in their car. 15 private car holders chose to keep the system in the vehicle after the test-period which was a significant indication that there is an acceptance of the active accelerator pedal. The drivers noticed that the system assisted them well in upholding the speed limits and provided for comfortable and relaxed driving, although certain technical issues could be better.

REFERENCES

Vlassenroot S., Broekx S., De Mol J., Brijs T., and Wets G. (2006), Driving with intelligent speed adaptation: final results of the Belgian ISA-trial. Forthcoming in: Transportation Research A.

Broekx, S., Int Panis, L., Verlaak, J. (2005), Intelligent Speed Adaptation in the city of Ghent, Belgium. PROSPER working paper.

Vlassenroot, S., De Mol, J. (2005), Intelligente snelheidsaanpassing ISA-project Gent, Centrum voor Duurzame Ontwikkeling universiteit Gent.

Várhelyi A, Rook A, Broekx S, Int Panis L (2005), Driver behavioural effects from ISA, Deliverable 3.4 PROSPER.

De Mol, J., Broeckaert, M., Van Hoorebeeck, B., Toebat, W., Pelckmans, J. (2001), *Naar een draagvlak voor een voertuigtechnische snelheidsbeheersing binnen een intrinsiek veilige verkeersomgeving (Towards a Carrying Capacity on In-vehicle Speed warning Devices within an Intrinsic Traffic Environment)*, Ghent: Centre for sustainable development/Ghent University – BIVV.

Vlassenroot, S., De Mol, J. (2004), Trial on intelligent speed adaptation in Ghent, Belgium: the results on acceptance and driving-behaviour of the test-drivers. In Proceedings *4th European Congress on Intelligent Transport System*s, Budapest. ERTICO.

VLASSENROOT. S., DE MOL, J. (2005), "The Acceptance of Intelligent Speed Adaptation and the use of role-models: A strategic procedure in implementation of speed warning devices," paper for: 12th World Congress and Exhibition on Intelligent Transport Systems, 6-10 November 2005, San Francisco, USA.