What is Intelligent Speed Adaptation and would implementation be beneficial in developing world?

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Biographical Note

Marianne Vanderschuren obtained her Bachelor's degree in Transport in 1989 and her Masters degree in System Engineering, Policy Analysis and Management at the Technical University of Delft (1999). After working at the Technical University Delft she worked at the Netherlands Organisation for Applied Scientific Research for over ten years. She was appointed a Senior Lecturer, with responsibility for developing the teaching of transport studies, in the Department of Civil Engineering at the University of Cape Town in 2000. Her research focus is Intelligent Transport Systems (ITS), Road safety and Transportation planning and the transferability of models etc. to the Developing World context.
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Abstract

Road fatalities are a major cause of death all over the world; about 3000 people are killed every day. Detailed international comparisons show that South African cities have exceptionally high rates of people killed on the roads. Within South Africa speed has been identified as a major contributor (75 %; http://www.transport.gov.za/projects/arrive/closer.html).

As European countries and cities appear to be much safer than South Africa and America, it was decided to investigate the measures they have taken or explored. One of the measures being investigated in Europe since 1997 is Intelligent Speed Adaptation (ISA).

This paper provides an overview of ISA, the research results of completed projects, and the aim of the current European project. Moreover, an indication of the possible benefits of ISA for South Africa, as a Developing World example, are given.
Based on the calculation it can be concluded that implementing ISA in the Developing World would be beneficial. The Road safety costs will be reduced with R4.7 billion per year (the equivalent of 587 500 thousand Euro). Moreover, crude oil dependency of the country will decrease with between 1 500 barrels and 2 000 barrels per annum.

**Background**

Over the last 20 years European countries have introduced several measures to improve the safety situation on roads. The EC has recognised the contribution that new technologies can make in achieving the goals of its Common Transport Policy through a reduction in road speed. Introduction of road speed management based on information technology (i.e. ISA) requires international co-operation to overcome technical, legal and policy barriers.

The PROSPER (Project for Research On Speed adaptation Policies on European Roads) proposal responds to the Key Action ‘Sustainable Mobility and Intermodality’, and specifically to research task 2.3.1/16 ‘Road Speed Management Methods Assessment’ defined in the call for proposals. The University of Cape Town is part of the PROSPER consortium.

**Road safety in South Africa**

Various studies have proved that a reduction of speed results in fewer fatalities on the road, as well as a reduction of fuel consumption and emissions. In the Netherlands, the calculation shows that if nobody exceeded the speed limit, fatalities on the roads would decrease by 21%
and injuries by 15% (Peters and Y van Asseldonk, 1996). In the Netherlands, this measure would save 520-million guilders (approx. 235-million Euros) per year (Duynstee and G. Martens, 2000b).

South Africa has very high fatality rates on its roads. A detailed international comparison shows that South African cities have exceptionally high rates of people killed on the roads (figure 1). A comparison with other countries shows that South African cities are among the unsafest in the world together with Seoul, Kuala Lumpur and Houston. Bloemfontein’s fatality rate is particularly high. The reason therefore has not yet been established. Future research is planned to investigate the exceptional high rate of fatalities in Bloemfontein.

*Insert figure 1 about here*

Comparing the total amount of fatalities in South Africa with other countries reveals a similar picture. South Africa and the Netherlands, for example, have approximately the same amount of cars. The total amount of kilometres driven in both countries is also similar. Unfortunately, this is not the case for road fatalities. In 1998 South Africa had approximately 9100 fatalities on its roads whereas the Netherlands had about 1300 fatalities.

‘Don’t fool yourself, speed kills’ is one of the slogans used during the Arrive Alive campaign. During the 1998 Easter holidays the Arrive Alive working group collected information on the factors contributing towards road fatalities. Human factors contributed to 75% of all fatal accidents. Of this, high speed contributed 31%, pedestrian jaywalking 29.2% and alcohol/drug abuse 11.9%.
Based on statistics it can be concluded that South Africa has a traffic safety problem. Speed and speed differences are viewed as important factors with regard to fatalities and severity of injuries. Therefore, measures to reduce the role of these factors should be pursued.

**What is Intelligent Speed Adaptation**

Technologies in vehicles and along the road are developing rapidly and may be the most promising of the different routes to follow. Vehicles have significantly more features that concern engine, driving and vehicle dynamics control on board. Communication with the roadside is likely to become a standard feature in the future. Several initiatives have been initiated to test and implement communication for traffic enhancement, such as broadcasting information on weather, traffic and travel circumstances.

One of the current technological developments is Intelligent Speed Adaptation (ISA). ISA is a tool that can be used for ‘Electronic Traffic Calming’. It is defined as follows:

‘Intelligent Speed Adaptation comprises processes which monitor the relationship between current speed of a vehicle and a suitable speed and have a corrective effect when this relationship is incorrect in the vehicle’ (Witziers, 1998)

This means that speed limit information, which is specific to the local road and traffic conditions, has to be available in vehicles on that road. In the vehicle, this information is used to inform, stimulate and/or correct the driver.
ISA includes different techniques and variants (Veenbaas and E.G. Oostenbrink, 1997). In general, the vehicle will react if the speed is over the limit but the way the vehicle reacts can differ. There are three variants:

- **The closed variant:** The vehicle reduces the speed as soon as the speed limit is exceeded. The on-board computer gives the instruction to reduce the speed. The amount of fuel to the engine will be reduced. The car will reduce speed automatically and smoothly until the speed limit is reached. Pushing the accelerator-pedal will not increase the speed (the car will not react).

- **The half-open variant:** In this variant the car will not reduce speed. If the speed limit is exceeded the driver will feel a counter pressure while pushing the acceleration-pedal encouraging him to slow down. This force will increase when the speed limit continues to be exceeded. Although it is uncomfortable to exceed the speed limit, the driver is still able to do so.

- **The open variant:** In the open variant the use of ISA is not compulsory. The system does not intervene with the fuel or gas-pedal. The driver gets a signal if the speed limit is exceeded. The driver does not have to react to the warning given by the system.

During a feasibility study (Veenbaas and E.G. Oostenbrink, 1997) carried out for the experiment in the Netherlands, an estimation of possible effects of ISA was made. The estimations included effects on road safety, mobility (especially traffic performance) and on the environment. Additionally, ISA might have an impact on the road design. Table 1 summarises these possible effects on safety, the environment, mobility and some other effects (for example the reduction of infrastructure measures).
In the field of ISA, different ways of implementing Speed Control can be looked at, along with the effects of these implementations on society. Major areas of difference between the various alternatives are:

♦ Format of ISA. Is the open, half-open or closed variant of ISA being chosen for implementation?
♦ Implementation environment. Should ISA be implemented on highways, rural roads or in urban areas?
♦ Technology. Should ISA, as it is presently perceived, be a combination of existing technologies, like beacon technology, GPS/GSM technology, combined with in-vehicle systems?

The various alternatives for the implementation are often interrelated: Should ISA be carried out as an advisory measure on highways, using GPS/GSM, or should it be an enforcing measure on rural roads using beacons?

Insert table 1 about here

Arguments for the different alternatives are based on the interests of the different ISA stakeholders:

♦ Road users, ranging from those who might see ISA as a useful tool to prevent speeding fines, enhance safety and improve comfort on different road-types to those who might see ISA as ‘big brother’ invasion of privacy and freedom of choice;
♦ Industry, who might see advantages in comfort and enhanced passive safety, but might also see ISA as a threat to their competitive advantage or marketing strategy;
♦ Traffic managers, who might see ISA as a possibility to improve traffic flow and improve road safety.
One approach to assessing all the issues, arguments and technical implementation possibilities is to conduct surveys and experiments.

**European ISA studies**

In order to estimate the different effects of ISA, several investigations into the feasibility and acceptance have been carried out by different organisations in Europe. In Great Britain, a Stated Preference survey has been carried out on the issue of speed limiting alternatives. In Sweden, there have been several actual experiments with different technologies in which the individual response of drivers and the acceptance of the idea of ISA, before and after using ISA, were determined. This section gives an overview of the European experiments.

**Sweden**

Sweden was the first European country to start with ISA experiments in 1996. The research in ISA within Sweden has been carried out with good co-operation between the government and the Research&Ddevelopment parties. After finalising the first trials and having positive results, the Swedish National Road Administration (SNRA) decided to run a large-scale trial involving ISA in urban areas. Several thousand cars were equipped with smart, supporting, open systems to help motorists keep to the speed limits. Borlänge, Lidköping, Lund and Umeå were the trial cities and were responsible for running the trial in the individual areas. Four systems will be tested: Informative, Informative with display, actively supporting ISA systems and ISA systems for quality assurance. The project was evaluated from three angles: acceptance, functionality and effects. The main issues in the evaluation were to confirm
positive safety effects from earlier studies and to identify possible negative safety effects that had to be tackled (Almqvist, 1997). The different Swedish trials are summarised in table 2.

Insert table 2 about here

The results of the Swedish trials have been summarised as follow (http://www.rws-avv.nl/avv/us/prosper/sweden.pdf):

- The test drivers in the ISA trial were considered a good representation of the average driver in Sweden.
- On the whole, ISA entailed a substantial improvement in road safety. If everyone had an ISA system in their car, the number of people injured in traffic could be reduced by 20% to 30%.
- Travel times were unchanged (a marginal improvement was even found) despite the lower maximum speed. This can be explained by fewer stops and braking situations with ISA. The drivers were skilful in adapting to this new technology and contributed to this result.
- There was a high level of acceptance of ISA in urban areas. A clear majority of the drivers thought that you should keep to the speed limit on 30 km/h and 50 km/h streets.
- ISA is the best idea yet, along with police surveillance, for solving road safety problems on 50 km/h streets in built-up areas. This is where most injuries occur and where the acceptance of physical measures such as road humps is lower than for ISA.
- Approximately two out of three drivers wanted to keep the system if it were free, while about one out of three would consider paying up to 1 000 Swedish crowns (about €125).
Denmark

The University of Aalborg is now planning an ISA trial with young drivers. This target group has less driving experience and shows little respect for speed limits. In the county of North Jutland, 300 car drivers aged 18-24 will drive an ISA equipped car. The use of ISA is stimulated by a financial incentive on the insurance premium. The project is to start in 2005 and ends in 2008 (http://www.rws-avv.nl/servlet/).

Great Britain

The ISA-UK project began in January 2001 and has a duration of 52 months (http://www.rws-avv.nl/servlet/). The project is funded by the Department for Transport (DfT) and the project partners are the University of Leeds and MIRA Ltd. The main tasks of the project are:

- To investigate user behaviour with ISA by means of a set of field trials
- To study overtaking behaviour with ISA in a driving simulator
- To prepare an ISA design for motorcycles and large trucks and to build a demonstrator of each
- To prepare a system architecture for mass production configuration of ISA
- To have an input into relevant standards activities at an international level
- To carry out a process of technology watch throughout the project duration
- To further investigate the costs and benefits of ISA.

The trials are designed to be non-intrusive as the vehicles will behave like normal cars apart from the ISA feature, data will be logged automatically and summary data will be collected daily through a GSM link. The ISA can be over ridden by the drivers. The intention is to give drivers ISA support for almost all their regular driving.
Finland

In Finland the interest in ISA focuses on weather-related systems. During the winter months, the chance of having an accident increases by 20%. In Finland the government wants to implement ISA on a voluntary base. A trial has not yet been implemented (Duynstee, 2000a).

France

The French National Institute for Transport and Safety Research has planned to study the acceptance of ISA systems, influences on driver behaviour, and the technical performance of ISA equipment (http://www.rws-avv.nl/servlet/). In this so-called Limiteur s'Adaptant à la Vitesse Autorisée (LAVIA) project, 20 vehicles will be equipped and lent to 100 drivers in a test site in the Paris region. The French DoT, Renault, Peugeot, and French researchers are involved in the project. The ISA project will focus on urban roads and motorways. Up to the speed limit, the car behaves as normal; above that limit, the accelerator is without effect, but by pressing the accelerator harder, it is possible to drive faster in an emergency situation.

Belgium

Belgium has founded a new organisation that aims to introduce intelligent car systems to improve traffic safety. The new organisation consists of different partners: government (National, Flemish and local governments), industry, an insurance company and different research organisations. These partners are involved in the different trials (table 3).

*Insert table 3 about here*

The Netherlands

From October 1999 until October 2000, the Transport Research Centre (AVV) of the Dutch Ministry of Transport conducted a trial involving ISA for 20 passenger cars and one
passenger bus (http://www.rws-avv.nl/servlet/). The trial took place in an urban area of the city of Tilburg and three speed limits were used 30, 50 and 80 km/h. When the vehicle exceeded the maximum speed limit for that area, the speed of the vehicle was automatically adjusted (the fuel inlet was automatically restricted). This enforced speed restriction makes the Dutch trial substantially different from trials undertaken elsewhere (for example in Sweden). The project fits within the long-term Dutch road safety policy and within the Sustainable Safety Program.

The primary goal of this practical study was to examine whether ISA was a realistic option as an instrument for speed control, both from a technical-operational and from a social point of view. A major evaluation objective was to measure public acceptance of this type of ISA application, both with test drivers and with the general public.

Results show that response was high and predominantly positive, as was appreciation for driving test cars. Relatively few drivers held arguments that should prevent authorities from implementing this type of ISA.

*Insert figure 2 about here*

As far as driving behaviour is concerned, ISA resulted in lower average speeds. Measurement of differences in speed during the Dutch trial indicated a reduction in speed variation. Less variation resulted in increased road safety. Figure 2 provides an overview of the results in one location. Obviously, the traffic situation is not identical in both measurements. As far as driving behaviour is concerned, ISA resulted in lower average speeds. Over-all conclusion: ISA, as tested in the Netherlands, has a high potential as a new and intelligent way to help solve speeding problems.
What are the effects of speed limitation?

Internationally, research on speed limitation is still in its early stages. Nevertheless, results are generally positive. In a recent interview a spokesman of the Dutch AA, Ton Hendricks, said, ‘if we really want to break the negative trend with regards to road safety, ISA is the tool’ (Verkeerskunde, 2004).

Trials, as well as several modelling studies have shown that ISA and other measures, which influence the speed, are effective. The results of a modelling exercise, carried out by the Transport Research Laboratory (TRL) in the UK, are given as an example.

TRL conducted three runs for each measure: Low traffic flow (first dot), medium traffic flow (second dot) and high traffic flow (third dot). Moreover, 90% of the vehicles were fitted with the modelled equipment. The TRL study indicated that the average speed was hardly affected at low or medium flows. For the high flow, all types of external speed limitation showed an increase in the average speed. Static speed limiters, with or without Autonomous Cruise Control (ACC), showed the largest speed increases; the average speed increased from 82 km/h to 88 km/h. In earlier ACC tests alone, for 100% of the vehicles and only slightly higher flows, the average speed dropped. Figure 3 gives an overview of the results of the modelling done by TRL.

Insert figure 3 about here
In general, it was concluded that a combination of measures provided the most promising results. A decrease of the average speed of up to 4% was calculated. Results of single measures were clearly less promising.

Modelling the effects of ISA, Lui and Tate (2000) found that speed would decrease by about 10% while the overall travel time only increased by 1%. Although no direct safety indicators (shock waves or time-to-collision) were available, the decrease of overall speed provides an indication for a safer road environment.

**User acceptance**

ISA will only be able to improve the safety situation if society accepts the measure. Several European countries carrying out trials have been looking at the potential acceptance. After informing the public, the attitude towards ISA was very positive. Table 4 gives an overview of the initial attitude in Tilburg, the Netherlands (De Mol, 2001).

*Insert table 4 about here*

Most test drivers were positive about ISA. Unfortunately it was found that the attitude became less positive during the trial. Attitude before the test was positive for 84% of the selected test drivers. This number dropped to 64% one month after starting the tests (De Mol, 2001).
During the second trial in Umeå, it was found that the user acceptance of ISA was high in a low-speed environment and decreased in a high-speed environment (70 km/h and above) (Sundberg, 2001).

During the Dutch trial, people were asked for their opinion about the places where ISA should be introduced. Table 5 gives an overview of the results (De Mol, 2001).

*Insert table 5 about here*

Test drivers (people who tested the ISA system) were almost always more positive towards the introduction of ISA than non-test drivers. Moreover the Dutch results underpin the results in Sweden (Umeå) that acceptance of ISA is higher in low speed areas.

Questioning the test-drivers during the Dutch trial provided some additional information on the acceptance of ISA in the Netherlands. All test-drivers indicated that they needed a short time to get used to driving with ISA. They were in general positive about the interface with the system although they had some remarks. Some people did not get used to the retracting accelerator-pedal when ISA restricted the fuel inlet. The emergency-button (ISA off) is necessary, but has only been used in cases with technical problems. Almost all drivers considered the LED-indicators, showing the actual speed limit and the technical status of the system, redundant and sometimes even distracting. Moreover, the test-drivers reported that the lack of ‘extra power’ lead to a decrease in overtaking manoeuvres (increase of road safety). The distance while following another vehicle also increased (Duynstee and Martens, 2000b).
The European Commission (EC) has recognised the contribution that new technologies can make in achieving the goals of its Common Transport Policy through a reduction in road speed. The EC resolution of June 2000 explicitly identifies ‘...the use of advanced assisted driving technology…which has considerable potential for improving road safety’ and ‘...technology relating to speed limitation devices and to identify any technical, organisational, administrative and legal difficulties in introducing them…’ as important measures for further investigation. Introduction of road speed management based on information technology (i.e. ISA) requires international co-operation to overcome technical, legal and policy barriers.

The Project for Research On Speed adaptation Policies on European Roads (PROSPER) proposal is responding to the Key Action ‘Sustainable Mobility and Intermodality’, and specifically to research task 2.3.1/16 ‘Road Speed Management Methods Assessment’ defined in the call for proposals. The PROSPER project is designed to comply fully with the task description, as regards to objectives, indicated methodology and expected results as depicted in figure 4.

The overall project objective is to answer the following questions:

- How efficient is the use of road speed management methods based on information technology (ISA) in comparison with traditional physical means?
- How will road users across Europe react to such developments?
- What are suitable strategies for implementation and what obstacles have to be overcome?
South Africa plays a minor role in the Prosper project. Based on the knowledge available in Europe on ISA the possible safety benefits for South Africa will be estimated through experiments and surveys initiated in new environments.

**Discussion: is ISA an option for South Africa?**

As indicated at the beginning of this article, South Africa has a major road safety problem (figure 1). Moreover, speed on its own plays a contributory role in 75 % of all crashes on our roads (http://www.transport.gov.za/projects/arrive/closer.html). As such the benefits of any possible measures, including ISA, to improve the situation should be explored.

The rule of thumb that results from various studies is: an average speed increase of 1 km/h means a 3% higher risk of an injury accident (www.swov.nl). In severe accidents, the increase is even bigger: 1 km/h means a 5% higher risk of serious or fatal injury. These percentages have been verified in several countries with different road and traffic conditions. It is, therefore, not unlikely that South Africa could achieve similar reductions.

During Arrive Alive Phase 2, a total of 299 000 notices were issued for speeding (www.arrivealive.gov.za). Currently 40% of South African drivers exceed the 120 km/hr speed limit, 80% the 100 km/hr and 90% the 60 km/hr limit. Assuming that exceeded speed limits follows a normal distribution, a 10% speed reduction can be applied to the 40%, 80% and 90% speed limits respectively. Table 6 provides an overview of the estimated safety improvement.
It is estimated that the reduction in fatalities is almost 70%. Injuries will reduce with more than 40% and damage only accidents will reduce with 34%. These estimates seem exceptionally high. Developed world estimates for the Netherlands, for example, are 21% reduction of fatalities and 15% reduction of injuries (Peters, 1996). South Africa’s road safety statistics should be comparable with the Netherlands, based on the similar amount of vehicles registered and the similar number of vehicle kilometres driven; if it wasn’t for speeding and alcohol abuse (another major road safety problem in South Africa). A reduction of fatalities with almost 70% will take South Africa to the road safety situation of the Netherlands in the early seventies. Large campaigns to reduce alcohol abuse and a wide implementation of traffic calming measures have improved the road safety situation on the Dutch roads since.

The estimated safety cost reduction is R 4.7 billion per year (the equivalent of 587 500 thousand Euro). It is obvious that implementation of technology, that forces drivers to respect the speed limit, would achieve a road safety benefit. Further research in this area is needed.

Although the main objective of ISA is safety, a reduction of speed will also generate a reduction in fuel consumption. The PROSPER consortium has estimated a fuel consumption reduction of 4.7% for a mandatory system with 100% penetration (PROSPER consortium, 2005). Without any other sources available, this figure was used to estimate the possible reduction in fuel consumption in South Africa.
Several assumptions had to be made to do the estimations. These are:

- ISA will be introduced in South Africa from 2010. Between 2005 and 2010 legislations, policies etc. will be put in place,
- All public transport vehicles will be fitted with ISA from 2010 onwards. The reason is that the South African government has shown an interest in ISA before. At that stage the idea was that the minibus taxi vehicles would be fitted with ISA,
- From 2010 private vehicles will be encouraged to implement ISA. Speed limit offenders might be forced. By 2020 all private vehicles will be equipped with ISA, and
- In the current scenario ISA was not implemented for freight vehicles.

The Long-range Energy Alternatives Planning (LEAP) model was used to estimate the change in fuel consumption. LEAP is an integrated scenario-based energy-environment modelling tool. Its scenarios are based on comprehensive accounting of how energy is consumed, converted and produced in a given energy system under a range of alternative assumptions on population, economic development, technology, price etc. LEAP allows for user defined end-use detail depending on data availability. LEAP also includes a built-in Technology and Environmental Database (TED) containing data on the costs, performance and emission factors for over 1 000 energy technologies (including region specific data e.g. gasoline cars in South Africa). When linked to TED, LEAP can be used to calculate the emissions profiles (CO2, N2O, CH4, NOx, SO2, PM5, PM10, VOCs, etc.) of energy scenarios (http://forums.seib.org/leap/).

The data used by LEAP in this scenario calculation is for the Western Cape Province, as this data base is more complete and accurate than the South African data available at the
University of Cape Town. It is assumed that the Western Cape is representative for the rest of the country. Results have been translated to a national level.

*Insert figure 5 about here*

It is clear that the introduction of ISA will result in a reduction of fuel consumption. The estimate is that implementing ISA in all public transport vehicles (see 2010) will reduce the crude oil dependency of the country by almost 1 500 barrels. If all private vehicles are also equipped with ISA, more than 2 000 barrels will be saved.

It is impossible to estimate the financial impact of saving 1 500 to 2 000 barrels of crude oil as the price for crude oil and the exchange rate fluctuate continually. Currently a barrel of crude oil costs about US$60. With the current exchange rate the total saving would be between R594 000 and R792 000 (between €74 250 and €99 000) annually.

It is clear that the safety cost reduction and crude oil savings are substantial. Moreover, the implementation of ISA may reduce the need to build traffic calming measures. As funding in South Africa is limited, ISA might well be the more affordable measure.

Intelligent Speed Adaptation (ISA) has not been implemented in South Africa. Moreover, pilot or acceptance studies have not been carried out. It is, therefore, difficult to make an estimate with regards to ISA acceptance. Generally, the impression is that South Africans do not want to be limited. Especially Previously Disadvantaged Individuals (PDI), who have been suppressed for many years during the apartheid era, do not want to give up their freedom. Experiences of the introduction of other technologies in the transportation field are used to demonstrate the expected acceptance problems.
There is no problem with accepting technologies into the South African market. The use of Automatic Teller Machines (ATMs) to draw money is used by a vast part of the population. The use of mobile phones is also common; almost 42% of the population owns a mobile phone. It is clear that South Africans are not averse to using technology. Nevertheless, ATMs and mobile phones benefit the user. ISA, on the other hand, would limit the users.

The technology currently used in South Africa, that is quite similar to ISA, is a fleet monitoring system. Using tracking systems, companies are aware of the position of a vehicle at any time. More advanced systems record speed violations. Driver ID systems, integrated in the fleet monitoring systems, provide an opportunity to analyse the behaviour of drivers.

Providers of fleet monitoring systems have indicated that implementation processes have been difficult in the past. Drivers and Unions are not keen to cooperate. The introduction of a fleet management system to 7 500 vehicles of a large, national civil service company took 4.5-5 years. Drivers did not want ‘Big Brother’ to watch them and many systems were vandalised after implementation.

For the company, the benefits after the implementation of the system were huge. Awareness of their driving behaviour (resulting in lower speeds), better route choices and a reduction of private use of the vehicle resulted in fuel savings of between 15%-25%. There was a significant reduction of accidents, decreasing repair costs by a phenomenal 70%. Other benefits experienced were less wear and tear to tyres, gear boxes etc. There was even a reduction in telephone costs as the companies did not have to call the drivers to verify their position. Moreover, fleet monitoring systems can be used as tracking devices in case of vehicle theft. Insurance premiums for companies using fleet monitoring systems are reduced.
It has become clear over the years that the implementation of fleet monitoring systems requires careful planning. All stakeholders, including the drivers and Unions, need to be part of the process from the beginning. Newsletter distribution and ‘public’ hearings need to take place to create acceptance. It needs to be very clear to the drivers that management is not implementing the system to have a ‘big stick’, but rather to optimise performance. Moreover, driver benefits, like quicker response in case of an accident or security problems are highlighted. Some companies even started a competition for the most economical driver, providing a prize or bonus (mostly a financial incentive).

A more recent implementation process at a company in Cape Town with 60 vehicles showed that an open communication process prevents vandalisation of the system. Only four drivers (6%) tampered with the system as they were not willing to accept the monitoring of their driving. In the end the company forced them to pay for the repairs. Other companies apply an instant dismissal for tampering with the equipment. These measures have virtually eliminated vandalism of the systems.

Conclusions

The Swedish results and Dutch homogenisation of the speed indicate that ISA is a technology that will help to reduce the amount of fatalities and severity of accidents on the roads. More research is required to establish which format, environment and technology should be implemented on a large scale. It is expected that the PROSPER consortium will produce more results in this direction.
Within the developing world context it can be concluded that road safety is a tremendous problem. Using South Africa as an example, the death toll on the roads is approximately ten times as high as in the developed world, based on vehicle kilometres. Per inhabitant the risk in South Africa is three to seven times as high than for the average European inhabitant.

Speeding is a major contributor to the number of accidents in South Africa. In 75% of the cases speed is (one of) the factors why an accident occurs. The implementation of ISA has, therefore, a major impact on road safety statistics. It is estimated that fatalities will be reduced by almost 70%, while injuries decrease by more than 40% and damage only accidents by 34%. The estimated safety cost reduction is R4.7 billion per year (the equivalent of €587 500 thousand).

The implementation of ISA will also lead to a reduction in crude oil consumption. The estimated reduction is between 1 500 and 2 000 barrels per year if all public transport and all private passenger cars are equipped with a mandatory system. In current terms, this is a financial saving of between R594 000 and R792 000 (between €74 250 and €99 000) annually.

User acceptance is an important issue for the introduction of ISA. Different studies have shown that the acceptance of ISA is higher after drivers have experienced the technology. Respondents indicate, in their opinion, that ISA is more appropriate for low speed areas. Moreover, suggestions have been made that accessibility advantages (shorter routes for ISA vehicles) will increase the acceptance of this technology.

In South Africa, the banking and the mobile phone industry it has been proven that the society is open to the introduction of Technology. Nevertheless, the introduction of restricting
technology, like ISA, will not be appreciated easily. The introduction of fleet monitoring systems has shown that about 6% of the drivers rejected the system. Moreover, Kenya originally had problems introducing speed limiters on commercial vehicles. Fortunately, both systems show that perseverance of the government/fleet owners results in acceptance and recognition of the benefits by the public/driver.

**Acknowledgement**

I would like to thank all providers of fleet monitoring systems in South Africa who have contributed to this paper, by sharing their experiences with me. Moreover, I would like to thank Glen Heinrich of the Department of Chemical Engineering (UCT) for running the LEAP scenario.
References


Duynstee, L., 2000a, *De onzichtbare hand van ISA, een praktijktest in Tilburg*, Verkeerskunde (Dutch).


Peeters P.M., and van Asseldonk, Y., 1996, *Hoofdrapport, Een onderzoek naar de maatschappelijke en economische kosten van verlaging van snelheden van personenauto’s*, Werkgroep ‘2Duizend, Technische Universiteit Delft en de Vrije Universiteit van Amsterdam, for PbIVVS, January (Dutch).
Sundberg, J., 2001, *Smart Speed – Results from the large scale field trial on Intelligent Speed Adaptation in Umeå, Sweden*, 8th World Congress in Intelligent Transport Systems, Sydney, October.


Figure 1  Road accident fatalities in various international cities
(Fatalities per 100 000 inhabitants per year)

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<thead>
<tr>
<th>Possible effect of introducing ISA</th>
<th>Intensity effect</th>
<th>Priority effect</th>
<th>Status</th>
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<tbody>
<tr>
<td><strong>Traffic safety</strong></td>
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<tr>
<td>less serious injuries</td>
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<td>++</td>
<td>oo</td>
<td>proved</td>
</tr>
<tr>
<td>increase the liveability</td>
<td>++</td>
<td>oo</td>
<td>hypothesis</td>
</tr>
<tr>
<td>increase of the use of secondary roads</td>
<td>-</td>
<td>oo</td>
<td>hypothesis</td>
</tr>
<tr>
<td>dangerous behaviour because of frustration about ISA</td>
<td>-</td>
<td>o</td>
<td>hypothesis</td>
</tr>
<tr>
<td>habit behaviour for the use of the acceleration-pedal</td>
<td>-</td>
<td>o</td>
<td>hypothesis</td>
</tr>
<tr>
<td><strong>Environment</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>less fuel consumption and a decrease of emissions</td>
<td>++</td>
<td>ooo</td>
<td>proved</td>
</tr>
<tr>
<td>less sound pollution</td>
<td>+</td>
<td>oo</td>
<td>proved</td>
</tr>
<tr>
<td>less vibration nuisance</td>
<td>+</td>
<td>o</td>
<td>estimated</td>
</tr>
<tr>
<td><strong>Mobility</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>better performance of the traffic</td>
<td>+</td>
<td>oo</td>
<td>estimated</td>
</tr>
<tr>
<td>reduction of congestion problems</td>
<td>+</td>
<td>ooo</td>
<td>hypothesis</td>
</tr>
<tr>
<td>reduction of the mileage</td>
<td>+</td>
<td>ooo</td>
<td>estimated</td>
</tr>
<tr>
<td>increase of the use of the bicycle and public transport</td>
<td>+</td>
<td>oo</td>
<td>hypothesis</td>
</tr>
<tr>
<td>less separation of travel modes</td>
<td>+</td>
<td>o</td>
<td>hypothesis</td>
</tr>
<tr>
<td>increase of the mobility options for disabled people</td>
<td>+</td>
<td>oo</td>
<td>hypothesis</td>
</tr>
<tr>
<td><strong>Other</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>less infrastructure speed reducing measures (like speed bumps)</td>
<td>++</td>
<td>o</td>
<td>hypothesis</td>
</tr>
<tr>
<td>more narrow roads</td>
<td>+</td>
<td>o</td>
<td>hypothesis</td>
</tr>
<tr>
<td>no speed enforcement</td>
<td>++</td>
<td>oo</td>
<td>hypothesis</td>
</tr>
<tr>
<td>less insurance claims</td>
<td>+</td>
<td>o</td>
<td>hypothesis</td>
</tr>
<tr>
<td>lower costs for transport and insurance</td>
<td>+</td>
<td>ooo</td>
<td>hypothesis</td>
</tr>
<tr>
<td>profit for the economy</td>
<td>+</td>
<td>oo</td>
<td>estimated</td>
</tr>
<tr>
<td>less attention to safety furnishing principles</td>
<td>-</td>
<td>oo</td>
<td>hypothesis</td>
</tr>
<tr>
<td>need for the control of the ISA equipment</td>
<td>--</td>
<td>ooo</td>
<td>hypothesis</td>
</tr>
</tbody>
</table>

+++ = very positive  ooo = highest priority  
++ = relevant positive  oo = priority  
+ = positive  o = low priority  
-- = relative negative  - = negative  

Source: Veenbaas. and Oostenbrink, 1997
<table>
<thead>
<tr>
<th>Table 2 Summary of the Swedish case studies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>First trial in Umeå</strong></td>
</tr>
<tr>
<td>Some 100 vehicles (buses, taxis and other cars) in Umeå were equipped with an electronic module called a speed checker. The system warned the driver using a light sound signal when the speed limit was exceeded on a special controlled section of the road with a 30 km/h speed limit.</td>
</tr>
<tr>
<td>The results were favourable:</td>
</tr>
<tr>
<td>♦ the number of people who said that they often kept to the 30 km/h speed limit increased from 25% to 90%</td>
</tr>
<tr>
<td>♦ the number of people who actually kept to the speed limit increased from 60% to 80%</td>
</tr>
<tr>
<td>♦ due to the trial, subjects felt that they became more aware of their speed on the road sections on which the speed checker was active</td>
</tr>
<tr>
<td>♦ in spite of their opposition at the start, taxi drivers now accepted the system.</td>
</tr>
<tr>
<td><strong>Eslöv</strong></td>
</tr>
<tr>
<td>Some 25 vehicles were equipped with a system, a speed limiter, which makes it impossible to drive faster than 50 km/h in urban Eslöv. It is important to mention that the speed limiter could easily be de-activated by the test driver by simply pressing a button on a control panel on the dashboard.</td>
</tr>
<tr>
<td>Results based on user interviews and observations after having the system installed for three months:</td>
</tr>
<tr>
<td>♦ often users experienced ISA as an effective support to avoid driving too fast, as a result of the discrete reminder on the accelerator</td>
</tr>
<tr>
<td>♦ users mentioned a change in time planning: they set off earlier. This means that they changed their behaviour to some degree</td>
</tr>
<tr>
<td>♦ better interaction at intersections between drivers and other road users</td>
</tr>
<tr>
<td>♦ the system gave better comfort and was not felt to be an unpleasant control by the test driver.</td>
</tr>
<tr>
<td><strong>Borlänge</strong></td>
</tr>
<tr>
<td>The municipalities and national government financially subsidise good quality of life and safety. Concerning transport facilities, payments are only made if the transport company provides information on safe transport in compliance with actual speed limits. To provide that information the company needs a system that records information such as speed, position, road and speed limit on the road. One taxi in Borlänge used a system during certain weeks in February and March 1998. The system warned the driver if he was speeding and he then had 20 seconds to slow down. If he did not slow down the speeding was recorded. GPS and digital maps provided the position and speed limit information. Functional tests showed that the concept worked and that the driver also kept within the speed limits more than before.</td>
</tr>
</tbody>
</table>
In Lund, an experiment was carried out using GPS and digital maps. The vehicle was equipped with a GPS-system complemented with corrective signals (including so-called map matching). The ISA function in the vehicle, which could be overruled, was limited to existing speed limits when entering a certain area. The speed limiter is the same type as used for the trials in Eslöv.

The results of 17 test drivers after one hour of driving:
♦ positive reactions on how the system provided information and the ISA function
♦ especially young drivers (18-24 years) and taxi drivers were satisfied with the automatic activating ISA function
♦ it was a better support than surveillance and control.

Sweden carried out a national programme on ISA field trials from 1999 to 2001. The city of Umeå hosted the largest of these trials with more than 5000 vehicles and the main part of the city area was included. The vehicles and street network were equipped with a short range communication infrastructure, thus allowing the in-vehicle equipment to alert the drivers through light and sound signals when speeding within the city.

Source: http://www.rws-avv.nl/servlet/
### In-vehicle telematics project with Dynamic ISA

In 2002 the Flemish government (Road Authority), D’Ieteren (Belgium’s largest automobile distributor) and ACUNIA (telematics technology provider) jointly launched an on-road pilot project to research the potential of a single telematics platform for in-vehicle safety applications and commercial services.

The actual field test with a 100 vehicles started in December 2002 and ran until June 2003. It involved 40 vehicles from the Road Authority, and 60 commercial vehicles. During the first months, an ‘informative’ type of ISA was implemented in all test vehicles. Later on during the test, the Road Authority installed an ‘active supportive’ type of ISA (i.e. pressure on the gas pedal when a driver exceeds a speed limit) in 10 to 15 of its vehicles. Traffic operators could add or remove speed limits depending on local events such as accidents, congestion, road construction zones, weather conditions, etc. They could also use time frames, e.g.: defining a limit of 30 km/h around schools, daily between 7h30 and 9h00. A third possibility was to work with user or vehicle classification, e.g. set limits for trucks only. This was all done using the interface of the application centre at the Antwerp Traffic Management Centre.

All logged information was processed in order to analyse the effects of ISA on driver behaviour. Furthermore, the Flemish government will also assessed the differential effects of ‘informative’ and ‘active supportive’ ISA on driver behaviour. It engaged a research group from Leuven University to conduct this part of research. Analyses are currently underway.

### City of Ghent

In the city of Ghent’s strategy, traffic safety and liveability are two of the main issues. At different locations private cars were speeding and because of this causing severe problems. The city invested a substantial amount of money over the last few years in physical speed limiters. Instead of another redesign of the problem areas, the city is considering to introduce ISA. The expectation is that ISA might be cheaper and more efficient. A final decision on the type of ISA and the specific area still has to be made.

In the course of the ISA demonstration project in Ghent, objective and subjective information was collected in order to find out what the impact of the half-open ISA system would be. The driving behaviour and the behavioural changes according to the use of ISA were analysed.

The computer in the vehicles registered a number of vehicle parameters. The personal experiences of the drivers and of other road users were questioned by means of logbooks, interviews or inquiries. In the field of technique and ergonomics, the reliability and the comfort of the half-open ISA system were evaluated. Measuring the emissions and fuel consumption indicated the ecological impact of ISA. An analysis of the legal and organizational aspects concerning ISA was also done.
City of Ghent (continued): First results

Producing the speed map of the test area in Ghent required a lot of effort. An inventory of the speed limits within the ISA zone in Ghent was made by means of desk research and fieldwork. Different speed limits (15 km/h, 30 km/h, 70 km/h, 90 km/h and 120 km/h) were indicated. The test drivers informed the researchers about the inaccuracies concerning the speed limits, which led to a current accuracy of the map of 95%. The remaining inaccuracies could be attributed to several factors:

- a lack of reliability of the GPS or a bad reception of signals (as a result of the situation in Iraq or as a result of driving underground)
- interference with data of nearby roads with other speed limits

Source: http://www.rws-avv.nl/servlet/
Figure 2  Example of speed patterns without and with ISA active

Source: Duynstee and Martens, 2000b
Figure 3  Percentage difference between values of average speed for individual runs

Source: Wood et al, 2002

SSI  =  Static Speed Limiters
VSL  =  Variable Speed Limiters
ACC  =  Autonomous Cruise Control
HC  =  Headway Control
<table>
<thead>
<tr>
<th></th>
<th>Test rider car</th>
<th>Test rider bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>64</td>
<td>90</td>
</tr>
<tr>
<td>Neutral</td>
<td>24</td>
<td>0</td>
</tr>
<tr>
<td>Negative</td>
<td>11</td>
<td>5</td>
</tr>
<tr>
<td>No opinion</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

Source: De mol, 2001
Table 5 Choice for introduction of ISA per type of road (percentage).

<table>
<thead>
<tr>
<th>Type of street</th>
<th>Introduce everywhere</th>
<th>Selective introduction</th>
<th>No introduction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Test driver</td>
<td>Test driver</td>
<td>Test driver</td>
</tr>
<tr>
<td></td>
<td>Non test driver</td>
<td>Non test driver</td>
<td>Non test driver</td>
</tr>
<tr>
<td>30-50 km/h</td>
<td>75</td>
<td>22</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>61</td>
<td>30</td>
<td>9</td>
</tr>
<tr>
<td>50 km/h</td>
<td>47</td>
<td>43</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>39</td>
<td>44</td>
<td>17</td>
</tr>
<tr>
<td>80 km/h</td>
<td>49</td>
<td>41</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td>48</td>
<td>21</td>
</tr>
<tr>
<td>Highways</td>
<td>40</td>
<td>34</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>24</td>
<td>35</td>
<td>40</td>
</tr>
</tbody>
</table>

Source: De Mol, 2001
Figure 4 PROSPER Project Approach
### Table 6  Rough estimation of road safety improvement (accidents statistics 2000)

<table>
<thead>
<tr>
<th>Severity</th>
<th>Accidents</th>
<th>Speed related</th>
<th>Possible reduction*</th>
<th>Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fatal</td>
<td>8 590</td>
<td>6 443</td>
<td>5 862</td>
<td>68%</td>
</tr>
<tr>
<td>Injured</td>
<td>145 977</td>
<td>109 483</td>
<td>59 777</td>
<td>41%</td>
</tr>
<tr>
<td>Damage only</td>
<td>399 907</td>
<td>299 930</td>
<td>136 468</td>
<td>34%</td>
</tr>
<tr>
<td>Costs (billion)</td>
<td>R 14.6</td>
<td>R 11</td>
<td>R 4.7</td>
<td>32%</td>
</tr>
</tbody>
</table>

* Based on information the weighted speeding in South Africa is 18.2 km/h; a reduction of 5%, 3% and 2.5% is applied for respectively fatalities, injuries and damage only accidents. The costs reduction does account for the ‘move’ of fatal accidents to injury accidents etc.

Source accident statistics: NDoT, 2002
Figure 3  Crude oil savings due to the introduction of ISA