Cars In The Future : Intelligent Speed Adaptation

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What Is Intelligent Speed Adaptation (ISA)?

One of the potentially most important changes in future vehicle technology will be the introduction of Intelligent Speed Adaptation (ISA) on to road cars.

Intelligent Speed Adaptation is a term that must be defined. The following definition was proposed by The Project for Research On Speed Adaptation Policies on European Roads (PROSPER)

"ISA: An Intelligent Speed Adaptation (ISA) system is one that aids the driver or rider in maintaining road speeds compliant with relevant local statutory or desirable speed limits"

The first clear point to make is that every country that has performed widespread trials of ISA has also deemed that it will be feasible to introduce this technology throughout the national vehicle fleet. The methods of introduction are discussed later.

A vehicle equipped with ISA technology will be aware of the speed limit of the road that it is travelling on. The most likely way of doing this that is being researched is to have the vehicle’s co-ordinates transmitted to it from a satellite network, such as the GPS, or the future Galileo satellites. The vehicle can then relate these co-ordinates to an onboard map to determine which road it is travelling on.

There are 3 different ways that the ISA interacts with the driver, which are being researched. A closed ISA system will force the vehicle to keep to the speed limit by restricting the fuel supply. An open ISA system informs the driver of the speed limit in vehicle, and alerts the driver that the speed limit has been exceeded via an audio or visual system. The half-open variant of ISA attempts to alert the driver to excess speed by giving a physical feedback, for example, by increasing the force that the driver needs to exert on the accelerator pedal. This means that compliance with the limit should be made much easier.

The results of ISA trials in the UK and around Europe are examined by the PROSPER, which is supported by the European Commission, Directorate General for Energy and Transport, and is co-ordinated by the Swedish National Roads Authority. PROSPER contains partners from 10 European countries which allows a wide range of projects to be conducted, each looking at a different aspect of ISA.

There are 3 main questions which the PROSPER seeks to answer –

1. How efficient are the use of road speed management methods based on information technology (ISA) in comparison
with traditional physical means?

2. How will road users across Europe react to such developments?

3. What are suitable strategies for implementation and what obstacles have to be overcome?

The results will help to inform the policy of all stakeholders, by providing information on a variety of topics. The results of the project will look at the feasibility of implementing ISA, as well as legal, environmental, and technical issues. The cost efficiency of ISA will be compared to that of other traditional traffic calming techniques and the attitude and behaviour of its users will be evaluated, as well as the attitude of society as a whole towards ISA.

There are several ISA projects being conducted across Europe, the results of which will contribute to PROSPER. The most pertinent study to this document is the evaluation currently taking place in Leeds, as this studies the use of ISA in the UK, with the associated national trends in driver attitude, behaviour and roads engineering. There are other ISA studies being conducted through out Europe, which are also discussed in less detail.

**External Vehicle Speed Control (EVSC)**

The forerunner to the current study at the University of Leeds was carried out with the help of the then Department of Environment, Transport and the Regions (DETR) and the Motor Industry Research Association (MIRA).

The project looked at three different types of EVSC, each one allows the driver different levels of control over the system, and so the three would have different levels of effectiveness.

- Advisory EVSC is the most permissive form of EVSC; it constantly displays the speed limit of the road to the driver and doesn't seek to limit the driver's speed choice in any way, other than by keeping the driver better informed about the road.
- Voluntary EVSC was trialled, and this type of system allows the driver to toggle the speed limiter on and off, and so whilst the vehicle is restricted to the speed limit, he or she has the choice to turn it off.
- The last version of EVSC is the mandatory version that restricts the driver to the speed limit at all time.

The speed to which the vehicle was limited was divided into three categories.

- With fixed EVSC, the vehicle is restricted only to the speed limit of the road. This means that the driver could still select speeds that may not be appropriate for the conditions.
- Variable EVSC, informs the driver of additional hazard locations where a lower speed is appropriate where the vehicle is also informed of the locations of hazards (e.g. pedestrian crossings or schools) and suggests a more appropriate speed for the situation.
- Finally, dynamic EVSC will help the driver keep to an appropriate speed, as additional speed restrictions were based on the current circumstances (e.g. bad weather, congestion).

Two different types of user trials were performed in order to look at driver behaviour and how the systems would affect speed choice.

A simulator study was conducted in order to get the driver's responses to the system in a controlled environment. The study found that the system reduced maximum speeds, but had no effect on mean speeds, possibly suggesting some level of driver compensation during slower parts of the course. The course had the biggest effect at the approach to changes in the speed limit where drivers were more likely to reduce their speeds in response to a lower speed limit ahead. From the simulated trials there were some more dangerous driving habits, and drivers tended to move into, or pull across when turning, smaller gaps than they would without the system. Drivers using the system would be more likely to follow the vehicle in front closer.

The second section of the trial was conducted on the road; once again, speeds and the driver's behaviour when using the system were studied. The results were more promising than the simulator trials, as no negative compensatory driver behaviour was noted. The problem of closer following also disappeared, due to the fact that unrestricted vehicles in front would break the speed limit and pull away.

Drivers preferred the voluntary system because they felt vulnerable when moving slower than other traffic and being overtaken.
approximately twice as many times when constantly limited to the speed. (If a high percentage of drivers were using ISA, it is reasonable to suggest that this feeling of vulnerability and frustration would decrease). The report, therefore, concluded that it would be unwise to make the system mandatory until a significant number of vehicles on the road were equipped with it.

A disadvantage with the voluntary system was that drivers tended to disengage it in areas where speeding was the norm, so it was only half as effective as the mandatory one. The benefit to cost ratio is not as high when voluntary systems are used, because it is not in constant use. In all cases the benefits of ISA outweigh the costs.

Future variants of ISA may have an adaptive mode to further help drivers with their speed choice. Whilst the speed limit sets the maximum risk that can be tolerated by society on a road, in certain conditions the risk of driving at the speed limit speed limit may be disproportionately high. This is the difference between inappropriate speed (driving too fast within the limit) and excess speed (driving over the limit).

Currently it is up to the driver to define how much they wish to control and reduce this risk below the speed limit. Adaptive ISA will help drivers control this risk, further to training and experience. Variable ISA will help drivers receive information about location risks (black spots, road works) whilst dynamic ISA will add to this by helping the driver controlling risks that are dependent on time rather than location, such as poor weather conditions.

**ISA In The UK**

The second trial is being conducted with MIRA using DfT funding. Four trials have been conducted in which ISA has been fitted to twenty cars with a mix of male, female, young and old drivers in the Leeds area and the East Midlands.

The results of the trial are due to be released in 2006, however preliminary results back up other studies of ISA and show that it would have a positive impact in the UK.

The initial study was conducted with 20 volunteers, which were split evenly between genders. Half of the drivers are younger and half were older, and the 20 had a range of opinions about ISA.

The results looked at the number of errors and violations that drivers committed before using the system, during the early and later stages of the system’s use and driving a normal car after using ISA. The study found that both decreased; as did the number of conflicts on observation drives. After using the system, the number of errors and violations remained lower than initially, and although the number of conflicts increased for both men and women, they did not return to the number of pre ISA use conflicts.

Drivers reported that their perception of how useful the system is increased during its use, and also increased after the drivers had finished using the system and were driving a non-ISA equipped vehicle. The trend of driver satisfaction also followed the same pattern of improving attitudes.

A review of how a locally implemented system would reduce casualty numbers found that a scheme in which all vehicles registered within a 5 km radius were fitted with ISA would be 63% as effective in that area as a nationally implemented ISA. A scheme of 10km radius would be 73% as effective and 15km radius would be 84% as effective. These results are especially relevant in estimating the effectiveness of the system if it were to be introduced into a region, such as London or the West Midlands, although the results may vary depending on the nature of the location.

**ISA In Denmark**

There have been two ISA projects conducted in Denmark; INFATI looked at 24 vehicles over 2 six weeks period, and interestingly also a project called Safe Young Drivers, which offers ISA equipment in return for discounted insurance premiums.

Even with the relatively recent Young Drivers Act in the UK, meaning that enforcement of the law and the risk of being caught may more commonly result in a ban, young driver deaths have risen over the last couple of years. It is well documented that young drivers are at a higher accident risk than more experienced drivers, and part of this problem is the inexperience of young drivers and a lack of adherence to the speed limit.

In order to study if ISA can improve the safety of young drivers by influencing their speed choice, The Safe Young Drivers...
project has taken a sample of 300 young drivers (aged between 18 and 24) in the Danish county of North Jutland. The project will last over 2 years and is due to finish in 2008. The large sample size, lengthy duration of the project, and mix of urban and rural roads will provide interesting results that can influence policy on young drivers.

The results of this trial may give feedback about introducing of ISA into a graduated licence scheme.

Another similar, useful, study may be looking at the use of ISA as part of the rehabilitation process for drivers who are banned for speeding. A similar approach is being taken with the introduction of Alcolocks into the vehicles of those convicted of drink driving. There may be many crossover conclusions that can be made from the current Alcolock studies.

### ISA in Sweden

A wide scale trial was conducted in Sweden using the ISA technology in four different cities between 1999 and 2002. It identified the primary application of ISA to be in towns and urban areas where speed humps are currently used to slow down traffic speeds.

#### Borlänge
In Borlänge, 400 vehicles were fitted with a system which monitored the driver’s position using GPS and then matched it to a map of the speed limits. If a speed limit was exceeded, a tone sounded in the vehicle, which repeated if the offence continued. This type of system that constantly gives the driver information of their speed is referred to as an ‘informative display system’.

#### Lidköping
In Lidköping 150 vehicles were fitted with the informative system, and 130 of those were also fitted with active accelerator (described below). A speed sensor monitored the vehicle’s speed and again map matching was used to determine if the vehicle was exceeding the speed limit. The trial compared the differences in attitudes of drivers using the two systems in the same environment.

#### Lund
In Lund, 290 vehicles were fitted with active accelerator pedals that interfaced with the driver by exerting a counterforce to the pressure applied by the driver when depressing the pedal, but only when the vehicle exceeded the speed limit. If the driver exceeded the limit, s/he needed to exert three to five times the force usually required to depress the pedal. The idea being that when a driver feels a mildly uncomfortable sensation through their leg, the instinct will be to lift the foot off the pedal, which will slow the vehicle back below the speed limit. It also removes the need for an audible tone to alert the driver. The drivers were constantly reminded of their speed by a display in the car and GPS monitored the vehicles’ speed and position.

#### Umeå
4,000 cars (representing approximately 10% of the vehicle kilometres travelled in the municipality) participated in the Umeå trial, which allowed the effects of ISA on overall traffic flow to be assessed. The main difference with the other trials was that the speed limit was not constantly displayed inside the vehicle. Transmitters mounted on lampposts let the vehicle know the speed limit and if the driver exceeded it, an audio and visual signal was activated inside the vehicle. This system is an example of a warning ISA system. This trial also compared the effects of the warning system with the informative system.

### Results

ISA had a clear effect on the average speed of the vehicles during the time of the trial although it was small, due to the average speed being dependent of the traffic flow and road design as well as the speed to which a vehicle is limited. The report also concluded that the average speed at which a vehicle travelled would have little effect on safety as it is not a vehicle’s average speed that causes problems but the 5-10% of vehicles which drive the fastest.

The number of speed violations fell sharply with the use of ISA and drivers returning to non-regulated vehicles were found to be less likely to exceed the speed limit. The percentage of drivers exceeding the speed limit increased again after a short period of time.

The widespread trials in Umea found there was a slight noticeable drop in the average speeds and the number of vehicles travelling above the 85th percentile taken from traffic speeds in the area before ISA, showing that even the introduction of 10% of the vehicles having the system leads to a drop in speed.
The findings of the active accelerator pedal in Lund were that there was an initial decrease of speeds – possibly due to the driver not being used to the resistance force – followed by an increase in speeds as the driver became more familiar with the counterforce applied by the brake. This increase between the short term and long term use of the system was only between 5 and 50% of the initial decrease, meaning that long term use did lead to a reduction in mean vehicle speeds on different types of roads. The largest reductions in speeds were found on the faster 70mph and 50mph roads.

The effects on driving at intersections during the Lund trials were studied by recording an average speed profile of vehicles approaching them. For crossroads and roundabouts the maximum speed during approach was reduced by 5% but there was no reduction of minimum speed. For T-junctions a different trend was found with a 5% reduction to the minimum speed and a slight reduction in maximum speed.

The turning speed was also studied for the Lund and Borlänge trials. It was found that ISA had no bearing on the speed at which these manoeuvres were performed.

Previous small-scale trials had found that distances between vehicles increased with the use of ISA and this was one of the areas investigated in the Umea trials. It was found that there was no overall difference to the time gap between the vehicle with ISA and the vehicle it was following. To further test the hypothesis a trial was conducted in Lund where both standard and ISA equipped vehicles followed a route 33km long, it was again not possible to detect a difference between the two sets of vehicles.

A driver’s awareness of pedestrians was also studied. Selecting six intersections in Umea where pedestrians were judged to be at a high risk of being involved in an accident, the number of conflicts between pedestrians and cars was monitored. It was found that the number of serious conflicts fell by 54%, if ISA was fitted to a higher percentage of vehicles.

The overall accident statistics were examined as part of the Umea trial although this does not necessarily mean that casualty numbers would fall by this amount. The fall in casualties was minimal over the year, however, when judged against a national increase of 7% the trial was concluded to have improved road safety.

A large user survey was conducted to assess driver’s attitudes towards ISA, one area of this which needs drawing out of the report is that drivers felt that the ISA systems changed their workload and took their attention away from other important aspects of driving.

The survey found that there was no great change in a driver’s perceived stress. However, drivers did feel more frustrated in general with a greater proportion stating that the active gas pedal increased frustration. A reason for this was that a greater proportion of drivers felt as if they were in the way of others – which in turn lead to the feeling that such a system would have to be implemented on all cars, otherwise the traffic flow would become disjointed.

Drivers also felt that they were being controlled and that their freedom had been reduced. A clear majority of drivers answered that they did not feel that ISA was distracting them from other matters although in Lund a slightly reduced number of drivers said that it was not the case.

A further bonus found with the use of active accelerator pedals was the reduction of environmentally harmful emissions such as HC, CO and NOx groups. The relationship between speed and emissions is an important one.

A huge benefit of speed constraint is that it will reduce the environmental impact of motoring, and this aspect has yet to be explored in as much detail. Further analysis and discussion of the fuel savings for drivers and reduction in emissions may also increase the acceptability of ISA.

**Introducing ISA and Possible Driver Acceptance**

There have been several proposed deployment methods for ISA, it is important that as soon as the ISA trials in the UK have finished, the results are widely disseminated and implementation scenarios studied.

The Project for Research on Speed Adaptation Policies on European Roads published a report entitled Recommendations for Technical Implementation of ISA Functionalities, which identifies a large series of conclusions based on current research from across Europe, and also makes a series of recommendations about how to progress ISA rapidly.
RoSPA supports these recommendations and highlights the need for rapid progress to be made by all stakeholders, in order to ensure that this vital, life-saving, technology is helped to become commonplace.

It is urgent that drivers can make use of this technology as soon as possible, as ISA has a lot of potential to reduce the number, and severity of accidents. This requires a communication and introduction strategy. Once again ETP has a major part to play.

In addition, if ISA introduction is conducted at a European level, then it will be essential to address the different cultures and attitudes to speed across Europe through education measures, in an attempt to harmonise them.

An ideal point when the first ISA systems can be phased in would be when road user charging is introduced. The two technologies both rely on a satellite network to track a vehicle’s location and the road that it is on. Data about the speed of the road could be transferred to the car at the same time as data about the roads charging scheme. This point is highly important as it may bring about the benefits from ISA at an earlier date to it being introduced separately.

There are two general scenarios for implementation, either authority led or market led.

**Market driven**

In a market driven scenario, the emphasis would lie on car manufacturers to provide ISA as an option on new vehicles, and then on fleet managers and private car buyers to purchase the vehicles.

In a market driven scenario, there would be no incentives for buyers to equip ISA, other than the clear safety gains.

It is a fair assumption to consider the possibility that the initial introduction of ISA equipped vehicles would be slow – as, naturally, a commercial organisation would not expend the money to develop an item of technology without the proof that there would be consumers who would purchase it. This has meant that historically, many beneficial safety technologies have taken a long period of time to be equipped to all vehicles.

This type of scenario would also likely result in a greater initial take up of ISA systems which are designed to alert the driver or rider to the speed limit of the road rather than confine the driver to it.

In this scenario, an appropriate level of safety would be based solely on a societal judgement, rather than being led by a technical assessment of safety benefits. Clearly, continued education and publicity about the dangers of speeding would help bring social judgement on the risk of speed in line with the technical judgement, and would provide a more realistic focus for car buyers on the issue.

To further speed up this process of fitting, consumer organisations such as EuroNCAP could develop protocols and offer points to reward manufacturers who fit ISA.

In order to increase consumer demand, it is important that the advantages of ISA as a way if reducing the risk of driving to employees is put forward to businesses, and fleet managers should be encouraged to purchase vehicles fitted with ISA. There is a lot that can be done in the MORR context for ISA.

The dangers with leaving the introduction of ISA down to purely market forces is the longer period of time that it would take for ISA to be fitted to all vehicles on the road, and the likelihood that the majority of vehicles would be fitted with an advisory system. Lives will be lost the longer it takes to equip all vehicles with ISA.

**Authority driven**

Under an authority driven scenario, there is a more proactive role played by bodies that can enable a quicker ISA take up rate. This role will generally be through either financial encouragement or legal punishment.

Government bodies would take the lead on ISA and can equip their vehicle fleets with it in order to lead by example. This fitment would also extend to public service vehicles that authorities are responsible for licensing, such as buses and taxis, and there is no reason why a licensing authority in the UK could not specify ISA as a licensing requirement.
A method of increasing ISA awareness during this stage and promoting it to both private and fleet buyers in an authority driven scenario is via lower insurance premiums. Speed already plays an influence on insurance premiums in two ways.

Firstly the ability for a vehicle to speed, and the severity of the likely damage, is taken into account when determining a vehicle’s group rating. Insurance companies use a relationship between the top speed of a vehicle and both the risk of that vehicle being involved in an accident, and the level of damages paid.

If the top speed is limited to 70 (or indeed to the speed limit of the road), then it follows that ISA equipped vehicles may be a special case in qualifying for a lower group rating.

Secondly, the propensity for a driver to speed will also affect insurance costs as many insurance companies increase premiums for drivers who have speeding convictions.

Although the technology is relatively new and there may be a limited amount of data available on it for the insurance industry to analyse to determine its real world effects, the increased risks of speed is an old one problem and is already appreciated by insurance companies.

In order to help speed up the introduction of ISA, an evaluation would need to take place based around how ISA mitigates the serious and ever present risk of speed, and how this would affect the frequency and cost of potential claims.

The value of this process could be added to by reviewing current evidence about speed and ISA. This evaluation would need to be complete by the time the first commercially available ISA systems appear in order to be the most beneficial towards society as a whole.

Within an authority driven scenario, ISA can be used to help prevent crashes and injuries amongst high-risk groups of road users.

The risk that young drivers encounter on the roads due to inexperience is well documented, and inexperience with using speed can be dangerous.

It may also be a viable option for learner drivers to take their driving test in an ISA equipped car, and to then receive a licence to only drive an ISA equipped car following the test – much like how there is currently a separate licence for automatic transmission vehicles only. This may well occur with many different technologies as the level of automation available on vehicles increases and the skills required to use a vehicle also change.

Much like how alcolock programmes can now legally be made part of the rehabilitation process for convicted drink drivers, a mandatory ISA could be fitted in the vehicles of drivers who are convicted and banned from driving due to speed. The process is that the system will help the driver make a distinction between the acts of driving and the need for using excessive speeds.

One of the key points within an authority driven ISA implementation strategy would be that a date is set, after which users of an advisory ISA system switch over to a mandatory system.

Initial estimates suggest that the date when mandatory ISA is fitted and used in the whole of the European vehicle fleet would be around 2035, although this may clearly slip to a later date without strong political backing for ISA.