

# WEATHER RELATED ISA – EXPERIENCE FROM FIRST STUDIES

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## ABSTRACT

The safety potential of dynamic Intelligent Speed Adaptation (ISA) has been evaluated greater than for fixed options. Before dynamic ISA is ready for the market, problems have to be solved regarding for example reliable detecting of adverse weather conditions. There are also problems to be solved in choosing relevant maximum speed settings for and selecting the safest ISA HMI for adverse weather conditions like ice or snow on the road.

Some indications on the problems and solutions regarding dynamic ISA can be received from studies that are carried out on Finnish road network, in an UK driving simulator and by driving tests with an instrumented car of VTT in Finland. These studies will be presented together with preliminary conclusions drawn from the results.

## 1. INTRODUCTION

### Lower speed limits during winter months

In many northern countries accident risks are higher in winter than in summer /1/. To tackle the problem winter maintenance has been intensified and systems developed to help drivers. However, safety benefits have been partly lost because drivers are tempted to travel faster in these improved conditions.

Speed limits have been very effective in reducing accidents. Fixed speed limits at all times are probably most effective in good road conditions and slightly less so in adverse ones. In some cases, however, speed limits can encourage excessive speeds if they do not match prevailing conditions. This is also true – perhaps even more so – of variable speed limits.

In 1987 a joint 2-year experiment was launched by the Ministry of Transport and Communications and the Finnish National Road Administration, in which speed limits were changed according to the season of the year. Speed limits were raised in summer and lowered in winter. Following good experience with the latter, coverage of lower wintertime speed limits was gradually extended. Higher speed limits in summer have not been used since the experiment. This paper focuses on the effects of lower speed limits in winter both during and after the experiment /2/. Special attention is given to findings that might have some relevance when considering the needs of dynamic ISA system.

### **Intelligent speed adaptation in a simulator**

When the weather differences between seasons are great, seasonally changing speed limits are a step forward. The next step would be to adjust speed limits automatically, taking into account conditions like heavy rain or snowfall, fog, darkness and slippery road surfaces, together with the use of special winter tyres, which in Finland are often studded.

When speed limits are more flexible and take into account several elements of road and traffic conditions, it becomes more important to help the driver in the driving task by keeping track of the speed limit, or rather the safe speed. When driver assistance systems take care of tracing the appropriate speed, it becomes very important to include all the relevant factors in the decision making process – including weather related factors, which are especially important in the North European countries. Systematic differences in driving conditions and assistance systems were introduced in a simulator study at the University of Leeds (UK) advanced driving simulator to be able to study the reactions of drivers /3/.

### **Drivers experiencing ISA in an instrumented car**

In real traffic the drivers might react unexpectedly to ISA systems. Different ways of informing drivers about the speed limit were tested using 24 subjects driving in the instrumented car of VTT during winter time to study their reactions /4/.

## **2. LOWER SPEED LIMITS DURING WINTER MONTHS /2/**

The effects of seasonally changing speed limits were evaluated using similar pairs of road sections randomly selected as experimental and control roads for the first winter. During the second winter the experimental and control roads were exchanged. Data was collected before and after the changes in speed limits. During the experiment comprehensive data was obtained on speeds, accidents and drivers' opinions.

Despite its limited extent, the 2-year scientific experiment in 1987-1989 produced a significant safety benefit. The number of accidents decreased on roads where speed limits had been reduced. Especially good was the result in fairly good conditions – where speed changes were greatest.

Analysis of the data from the years after the experiment (1989–1996) shows that the effects of expanding the measure have been very positive. The latest study suggests as much as a 28 % reduction of injury accidents on the large part of road network now covered by the system.

Drivers have supported the idea of changing speed limits according to the time of year. They have also accepted surprisingly well the lower speed limits imposed in wintertime. It seems that drivers are ready to adapt their behaviour once they know and understand the reason for it.

Lower wintertime speed limits have a good safety effect, as they seem to have a positive effect even on most roads with a fixed 100 km/h speed limit. The safety effect has been especially good for the number of killed (Figure 1).

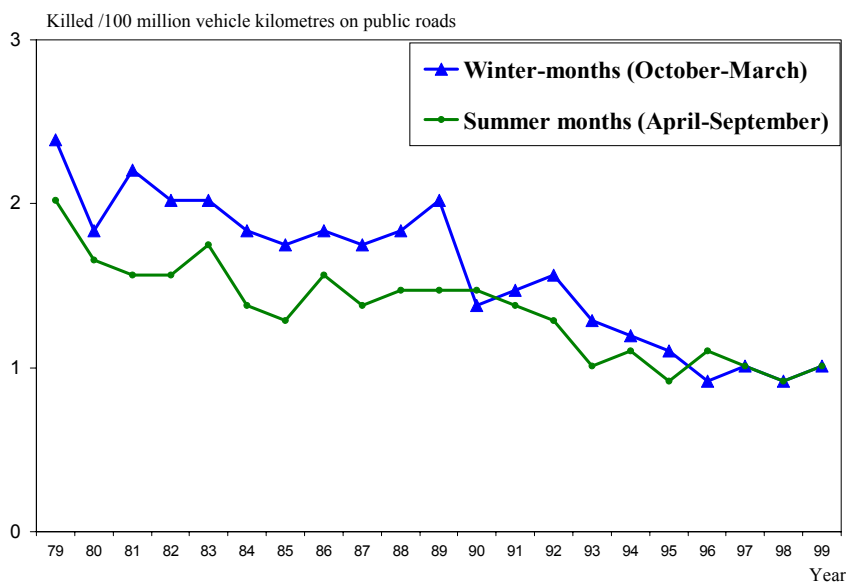


Figure 1. Risk to die in traffic during winter months was reduced due to lower speed limits first introduced at the end of 1980's /1/.

### 3. INTELLIGENT SPEED ADAPTATION IN A SIMULATOR /3/

Simulator tests were done in the advanced driving simulator of the University of Leeds, United Kingdom. In this fixed base simulator the driver sits in a complete Rover with all the basic controls and dashboard instruments operational. On the screen in front of the vehicle is projected a real-time, computer generated "out-of-the-window" image of the virtual world. Although the simulator is fixed-base, feedback is given via simulated steering forces at the steering wheel.

A special test route was designed for the study. It was a rural, 8-meter wide road with a 50-mph (80 km/h) speed limit. The road had 44 curves with a radius of 100 ... 1500 metres and a length of 50 ... 350 metres and 16 straight sections 50 ... 300 metres in length. In winter conditions half of the route was slippery (friction 0.2 and visible differences on the road surface). The slippery sections occurred in between non-slippery sections.

Three different levels of driver support systems were compared for 24 UK drivers in winter conditions (Figure 2) as follows:

- 1) No extra driver information (feedback as in usual winter driving)
- 2) Advanced driver information (variable message signs, VMS, every 400 meters indicating "ICE" when the road surface had low friction)
- 3) Weather related Intelligent Speed Adaptation referred later as WISA (on slippery roads the car cannot override the speed limit and the safe speed, which is calculated based on the curve radius and friction).

Overall travel speeds using different systems were as follows:

- No assistance system: 63.3 km/h
- Variable Message Signs (VMS) 62.4 km/h
- Weather related ISA (WISA) 64.6 km/h.

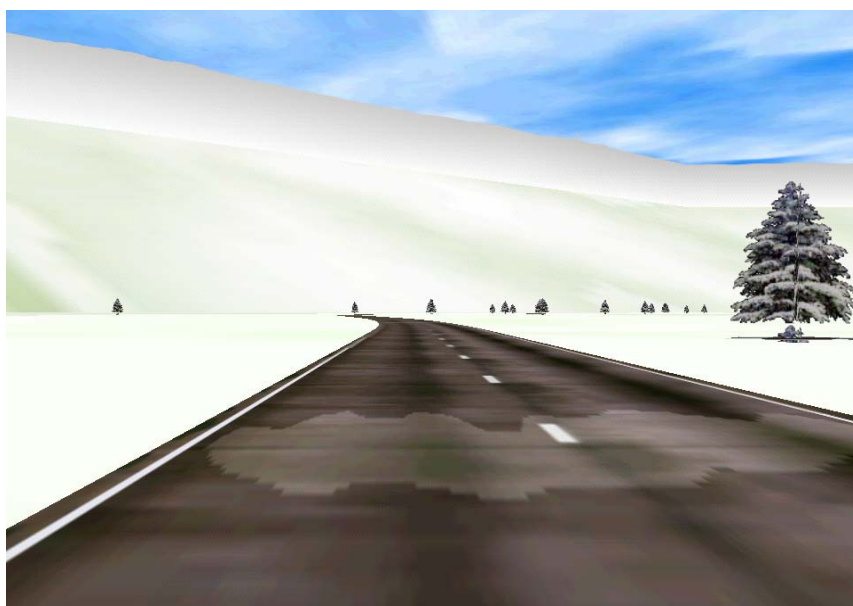
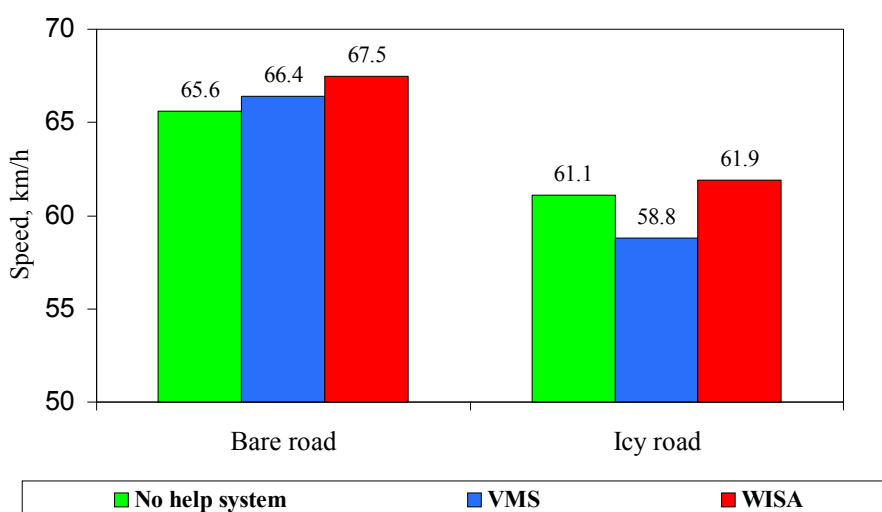


Figure 2. A scene from the winter simulation. The lighter patch is an icy spot with low friction

The average travel speeds calculated for all drivers over the whole test route were surprisingly highest when using the WISA system. Average travel speeds on icy and non-icy sections using different systems are shown in figure 3. Average speeds on icy as well as non-icy sections were the highest using WISA. The VMS system slightly increased the speeds on bare roads but decreased them respectively on icy roads.

Figure 3. Mean travel speeds according to friction using different help systems.



From figure 4 one can see that the VMS system especially reduces speeds on icy straight and large radius curves, and the WISA system reduces speeds on icy sharp curves (small radius). Because the tested WISA system reduces speed only on icy and notably icy sharp curves, drivers can adapt their behaviour to this system by increasing their speeds on non-icy sections and icy straight and large radius sections.

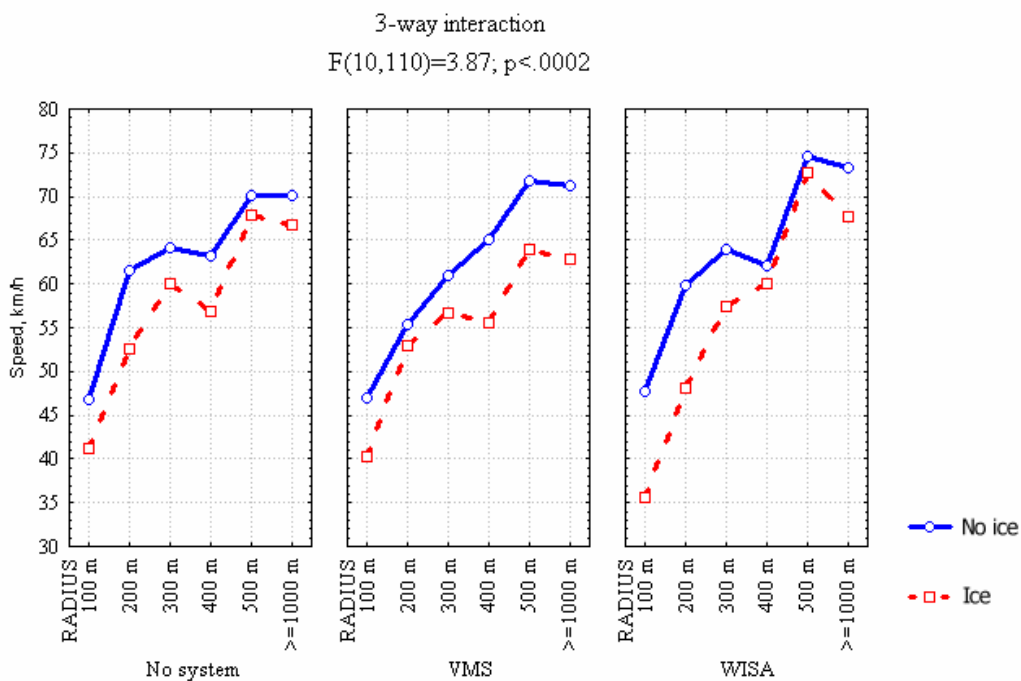


Figure 4. Average travel speeds according to curve radius and friction using different help systems. VMS refers to Variable Message Signs every 400 metres and WISA to Weather-related Intelligent Speed Adaptation.

#### 4. DRIVERS EXPERIENCING ISA IN AN INSTRUMENTED CAR /4/

The 24 specially selected subjects drove an 18 kilometres long route four times using the instrumented car of VTT (Figure 5). They got different information each time: Once the route was driven with only route guidance. It was used as a base level. The other three times drivers used different types of ISA. Each driver used the systems in a different order to minimise the influence of learning. The ISA systems were an informing system, a compulsory system and a recording system.



Figure 5. The driver's view of the system in the instrumented car.

The system modes in the test were:

1. **Only the route guidance.** The driver was only given the direction arrows at the intersections. No information about the current speed limit.
2. **Informative system.** In addition to the route guidance, the driver was given the information on current speed limit on the monitor. If he drove faster, the system voice signal said – SPEED OFFENCE and the same text was displayed on the monitor. The voice signal was repeated every ten seconds until the speed was dropped to within the limit. Despite the feedback, the driver was free to drive at the speed he wanted.
3. **Compulsory system.** In addition to the route guidance, the current speed limit was shown on the monitor. When the vehicle reached the current speed limit, a yellow spot was displayed to inform the driver of the situation. At the same time, the block on the gas pedal was activated, so the car could not exceed the speed limit.
4. **Recording system.** The driver was aware that his speed behaviour was recorded. On the monitor the system gave information on how long time the driver had been speeding from the beginning of the drive. The speeding offences were categorised in three different groups.
  - Speed offence less than 5 km/h
  - Speed offence from 5 to 10 km/h
  - Speed offence over 10 km/h

To avoid too much information on the monitor, the diagram was not shown when the route guidance arrow was there. The drivers were told that the speed limit offence diagram would only be used by the driver himself and by the experimenter.

The route included speed limits from 40 to 80 km/h and it took around 26 minutes to drive the whole route. There were no significant differences in driving times between system modes.

On some parts of the route, speed limits are often exceeded. During the base drive (route guidance only), speeds over the speed limit (speeding) were used around one third of the driving time (Figure 6).

Compulsory system was most effective in reducing too high speeds (some speeding could happen due to inaccuracy of the system and lack of braking function). Informing system reduced also too high speeds quite effectively, but this could be only a novelty effect.

Recording system did not have a very good speed reducing effect, but in the interviews it was considered as rather convenient and good for safety. In stead of online information, feedback from the recording type of ISA could be given daily or weekly to avoid continuous looking at the monitor. In addition the speed patterns could be monitored also by the company owning the car or by the parents worried about their children's safe speed behaviour etc. This would probably enhance the motivation to obey speed limits in general and not only when speed control is visible.

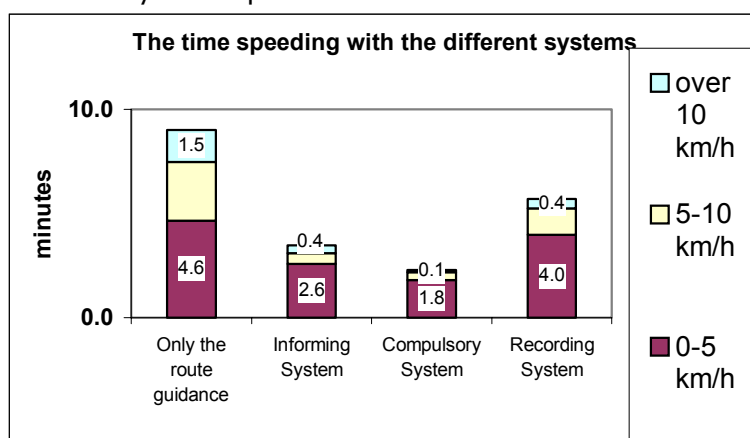


Figure 6. Time of speeding with the different systems.

## 5. CONCLUSIONS

There are certain benefits in seasonally speed limits especially if there are lots of factors affecting safe speeds at the same time (heavy rain or snowfall, fog, darkness and slippery road surfaces, together with the use of special winter tyres). When speed limits are fixed for a whole season, you know what speeds you can use the following day. To make a system to provide this kind of reliable information in advance is a challenging task.

Dynamic Intelligent Speed Adaptation has great safety potential but it may be very well lost if new technology will be used to increase speed when the conditions are not that bad. Extremely bad conditions are so rare, that small safety losses in good conditions are easily greater than the safety benefits from adverse conditions.

A recording type of ISA could have clear safety benefits without obvious compensation, provided that the feedback is given appropriately and maybe also to persons who can affect the driver.

## 6. ACKNOWLEDGEMENTS

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## 7. LITERATURE

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