JUNE 2020

INTELLIGENT SPEED ASSISTANCE (ISA) INTERFACE STUDY

POLICY BRIEFING

EXECUTIVE SUMMARY

The results of the 'ISA Interface Study' show that *speed control alone* would be **the most effective human-machine interface (HMI) for Intelligent Speed Assistance (ISA)**, as it was rated most acceptable by drivers, followed by the haptic pedal and the speed control with vibrating pedal.

On the contrary, the study shows that the *auditory warning* and *vibrating pedal* are **unsuitable HMIs for an effective ISA system**, as drivers rated them as annoying and unsatisfactory.

The study furthermore confirms that **drivers see value in being supported by an ISA system.**

INTRODUCTION

The study led by Professor Oliver Carsten at the Institute for Transport Studies, University of Leeds, looked at the most effective and user-friendly HMI options for ISA.

ISA is one of the vehicle safety technologies included in the EU's new General Safety Regulation for Motor Vehicles and will become mandatory for all new vehicles types as of 2022 and all new vehicles as of 2024.[1] The text of the regulation however does not provide any specifications for ISA's HMI. Instead, these technical requirements are currently being prepared. As no research was available on effective HMI design for ISA, the European Transport Safety Council (ETSC) commissioned this study in order to fill the gap by evaluating several HMI variants for ISA and provide recommendations on interface design.

1 Regulation (EU) 2019/2144 of the European Parliament and of the Council of 27 November 2019 on type-approval requirements for motor vehicles and their trailers, and systems, components and separate technical units intended for such vehicles, as regards their general safety and the protection of vehicle occupants and vulnerable road users. https://bit.ly/2019GSR

ETSC
European Transport Safety Council

This policy briefing of the ISA interface study was prepared by ETSC, providing a concise overview of the main findings of the study led by Professor Oliver Carsten. The full report on the study can be downloaded from: bit.ly/ISA-HMI-Study

FIVE DIFFERENT HMI VARIANTS EXAMINED

The study aimed to find the most effective system designs, by evaluating the alternative HMI approaches for ISA shown in the table below. The study looked both at their effectiveness in terms of promoting speed compliance and at their acceptability to drivers.

HOW WAS THE STUDY CONDUCTED?

The study was conducted using a simulator featuring a full-size car cabin and a motion system that gives the participants a realistic feeling of driving the vehicle.[2] 30 participants, (15 male, 15 female) in a range of different ages, each conducted a baseline drive with none of the listed HMI-variants enabled. They subsequently drove the same route for each of the HMI variants.[3] The route the participants drove was 14.3km long, during which they encountered every UK speed limit.

Auditory warning	When speed was non-compliant, bursts of a high pitch beep sound were played at intervals.
Haptic pedal	When speeding was non-compliant, force feedback was applied to the accelerator pedal, requiring the driver to push harder on the pedal in order to retain the non-compliant speed. The force feedback was proportional to the vehicle speed above the posted speed limit, and could be overridden.
Vibrating pedal	When speed was non-compliant, the accelerator pedal started to vibrate until the vehicle speed was compliant again.
Speed control with kick-through and vibrating pedal	The speed control operated as a "dead throttle", which limited vehicle speed to the speed limit by limiting engine power accordingly, unless the driver deliberately kicked through the limit. When speed was non-compliant, the accelerator pedal would vibrate.
Speed control alone (with kick-through)	Similar to the previously mentioned item, however without the vibrating pedal when speed was non-compliant.

WHAT DID THE STUDY LOOK AT?

In order to determine the most effective HMI, the study looked at two aspects:

1. How effective is the HMI variant in making the participants comply with the posted speed limit?
2. How acceptable is the HMI variant to the participants?

Acceptability is a key element in the assessment of the HMI variants' effectiveness, due to the fact that the GSR allows for ISA systems to be turned off by the driver. It is considered very likely that a highly effective, but also highly annoying HMI variant would be unacceptable to drivers, leading them to turn off the ISA system, thereby negating the effectiveness of the system and its potential to improve road safety.

The effectiveness of the HMI variants on speed compliance was determined by retrieving data on the speed participants drove at compared to the posted limits. The acceptability of the HMI variants was determined based on the responses to several questionnaires the participants filled in after each drive. These questionnaires focused on the experienced mental demand, physical demand, time pressure, performance, effort, frustration, and usefulness and satisfaction, as well as pleasantness and annoyance.

2 The images on the cover page show the exterior and interior of the driving simulator at the University of Leeds.

3 The participants tested the HMI variants in a counterbalanced order, so as to randomise the order of encountering the ISA variants and thus ensure that there were no systematic impacts from driving with one particular variant on behaviour with and acceptance of another.

RESULTS ON SPEED COMPLIANCE

The data on vehicle speed did not show a significant difference between the HMI variants regarding speed compliance. The drivers were generally quite compliant in the baseline situation, and performance with the various ISA systems was rather similar.

Explanations for this may lie in the demographics of the participants, as they were all from the UK - a generally speed compliant country.

Participants had furthermore not been asked for their propensity to speed prior to the selection procedure. Participating in a supervised test in a simulator may furthermore also explain their tendency to observe the speed limits during the experiment.

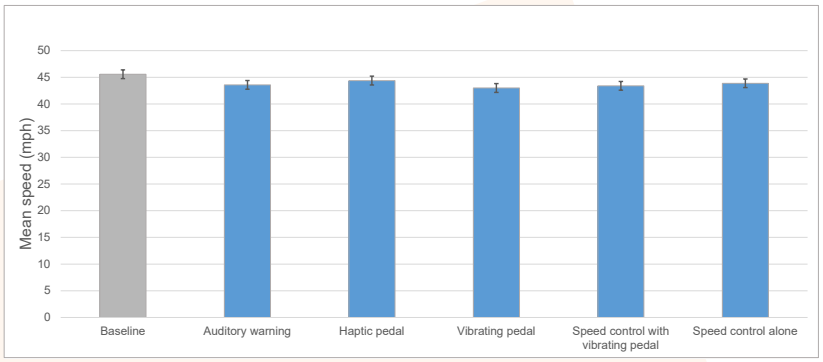

Figure 1. Overall mean speed by condition.

RESULTS ON DRIVER ACCEPTANCE

Mental Demand, Physical Demand, Time Pressure, Performance, Effort

The results indicate a trend that speed control alone is most suitable, as it consistently scored the best in all but one of these categories.

Stress

The questionnaire results show that the vibrating pedal and the auditory warning were regarded by the drivers as stressful. In turn, the other HMI variants were scored with a positive (non-stressful) feeling, with speed control alone being scored most positive, followed by the haptic pedal and speed control with a vibrating pedal.

Usefulness and Satisfaction

Participants rated all HMI variants positively in terms of usefulness, thereby indicating that drivers see value in ISA support. There was however no significant difference between the usefulness of the different HMI variants.

The results on satisfaction however show that only speed control alone was regarded as a satisfactory HMI. The vibrating pedal and the auditory warning were regarded as the most unsatisfactory HMIs by the participants.

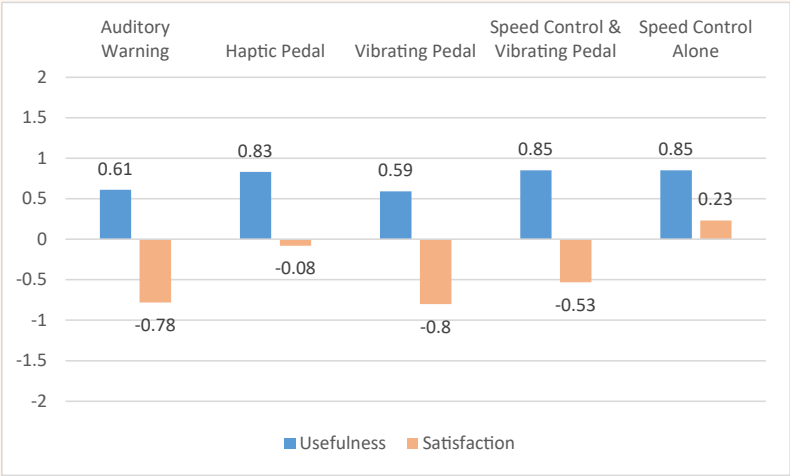

Figure 2. Usefulness and Satisfaction.

Annoyance and Pleasantness

The results show that overall, speed control alone was rated as the most pleasant HMI, while the auditory warning and the vibrating pedal were rated as the most annoying HMI.

Moreover, speed control alone is rated as more pleasant when having a passenger, perhaps because it is not detectable by a passenger.

By contrast, the auditory warning is rated as substantially more annoying when driving with a passenger, no doubt because, with this HMI, a passenger can detect that a driver is receiving a warning for speeding. The differences are statistically significant.

Figure 3. Pleasantness and Annoyance. Participants completed the pleasantness/annoyance questionnaire twice: once as though they were driving on their own and a second time as though they had a passenger in the front seat.

CONCLUSIONS

In many ways, the results of the questionnaires provide more insights than the data on speed compliance, as the drivers were already generally quite compliant in the baseline situation, and performance with the various ISA systems was rather similar.

The ratings on annoyance however deserve special attention. If a driver assistance system is considered to be unpleasant or annoying, it will very likely be switched off. The overall effectiveness of an ISA system will be the combination of its direct impact on speeding and drivers' willingness to leave it enabled. The ratings on annoyance when driving with a passenger should be particularly noted. Drivers will not be content to use a system that alerts their passengers that they are receiving a vehicle-generated warning for speeding, as is the case with auditory warning.

Therefore, the results of the study show that **the auditory warning and the vibrating pedal (without speed control) should not be chosen as the HMI for ISA systems**, as drivers considered them annoying as well as unsatisfactory, and furthermore induced negative (stressful) feelings. Given the annoyance levels of the auditory warning and vibrating pedals, drivers can be expected to turn off their ISA systems, thereby negating the system's benefits for road safety.

Speed control alone is shown to be the best choice for ISA's HMI, as it was considered by drivers as the most pleasant system, and furthermore regarded as satisfactory. It can therefore be considered to be an acceptable assistance system to drivers, meaning that drivers are more likely to leave the ISA system on, thereby realising the system's road safety benefits.

Speed control alone was followed by the haptic pedal and speed control with vibrating pedal on the pleasantness/annoyance scale, and the results show that both would also have reasonable acceptance.

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