isa - UK

intelligent speed adaptation

Results of Truck Trial

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EXECUTIVE SUMMARY

This deliverable describes the implementation and assessment of an Intelligent Speed Adaptation (ISA) system for trucks. This work was part of the Intelligent Speed Adaptation project, which developed ISA systems for passenger cars, motorcycles, and trucks, and tested the car and truck systems in real-world field trials.

The objectives of the work reported here were:

- To define a functional specification for ISA appropriate for a goods vehicle
- To identify the additional safety hazards associated with an ISA when being used by goods vehicles
- To select an appropriate example vehicle and define an ISA architecture suitable to be installed in the selected vehicle
- To assess ISA functionality and performance as well as user acceptance

The ISA system, originally created for a fleet of passenger cars, was successfully adapted for a modern 7.5 tonne rigid truck, and the modified vehicle was used for a field trial involving short-haul commercial operation in South-West Leicestershire. The trial design followed that used in the passenger-car trials, i.e. an initial period without ISA, followed by a period of driving with ISA active and then followed by another period in which ISA was switched off.

The adapted ISA system performed as intended, indicating that there is little difficulty in transferring ISA technology from the passenger car environment into the goods vehicle environment. Because of the constraints imposed by the sample size (i.e. one vehicle driven by one driver), the trial results are indicative rather than conclusive, and should therefore be interpreted with caution. Although the driver was somewhat hostile to the ISA concept, the actual level of compliance with ISA was high. The participant also demonstrated greater speed compliance during the post-ISA phase, in comparison with the pre-ISA phase.

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1. INTRODUCTION

1.1 Overview of the ISA project

This work reported here was part of the Intelligent Speed Adaptation (ISA) project, which developed ISA systems for passenger cars, a motorcycle and a truck. The ISA system informs the driver of the legal speed limit on the road which the vehicle is travelling and is able to limit the vehicle's maximum speed according to the corresponding speed limit. The ISA system implemented in this project was by default turned on upon ignition, which means that the driver would not be able to exceed the speed limit. However, an override function for the drivers to turn off the ISA system was provided.

Earlier research into ISA carried out for the Department for Transport in the External Vehicle Speed Control project (Carsten and Tate, 2000) considered the impact of ISA as implemented on a single passenger car and used in limited road trials. Based upon the results of the earlier work, this project has extended the field assessment to a longer period and a wider extent of geographic areas on a fleet of passenger cars, and has carried out an initial examination of ISA for other vehicle types.

1.2 Objectives of the ISA project

The main objective of the ISA project was to assess the effects of ISA systems on driver behaviour during prolonged exposure to the system. This was achieved through designing and implementing ISA functionality on a range of vehicle types and carrying out field trials to investigate user responses and evaluate impacts upon road user behaviour.

This vehicle range consisted of:

- A passenger car fleet of 20 vehicles
- A single goods vehicle
- A single motorcycle

This deliverable describes the implementation of ISA on a 7.5 tonne MAN TGL 180 truck and the assessment results obtained from the field trial when the vehicle was used in daily service in a commercial organisation.

The objectives of the ISA truck trial were:

- To define a functional specification for ISA appropriate for a truck
- To identify the additional safety hazards associated with an ISA when being used by a truck
- To select an appropriate example vehicle and define an ISA architecture suitable to be installed in the selected vehicle
- To assess ISA functionality and performance as well as user acceptance

1.3 Scope of the ISA truck field trial

The trial was carried out in the South West Leicestershire area. Driver behaviour was assessed by data recorded in the ISA truck while driver attitude was tapped by questionnaires. Other traffic surrounding the ISA truck was not monitored.

2. DEVELOPMENT OF AN ISA SYSTEM FOR THE TRUCK

2.1 ISA functional requirements

The development of the ISA system to be implemented on the ISA truck was based on the fundamental system architect of the passenger car system, with the following considerations given to a trunk environment:

- It should be developed using technology developed for the ISA passenger car fleet.
- The selected vehicle should have a retarding function in addition to the primary friction braking system, enabling the application of gentle braking. This was in order to help ensure compliance with the speed limits particularly on downgrades.
- The system should be sufficiently robust to endure the typical environmental conditions found in a truck.
- The system should be constructed and fitted in such a way that the ISA system interface provides minimal intrusion in into the driver's environment of the vehicle (e.g. layout of ISA display and buttons) and that it could be removed easily and the truck returned to its original condition at the end of the trial (due to the fact that the vehicle was lent to the team by the manufacturer).

2.2 Selection of vehicle

The new 7.5 tonne MAN TGL 180 commercial vehicle (released in February 2005) was selected to be the vehicle for the ISA truck trial. It had the advantage of having a CAN bus, an electronic throttle and a user configurable cruise control as part of the base vehicle design. Figure 1 shows the vehicle that was used for the ISA truck trial.

Figure 1: The MAN TGL 180 used in the ISA truck trial

2.3 Considerations for intervention methods

The initial strategy for modification of the vehicle was to use the navigation module from the ISA passenger car system design and then pass data on the applicable speed limit to the truck using the on-board CAN to enable the in-built speed limit control to undertake the control function. However, the manufacturer was not willing to allow such an interface to the vehicle control system in this proactive manner. The only permitted access to CAN interfaces was signal and operation monitoring when the truck was stationary.

A second option investigated was to intercept the signals from the driver's electronic throttle and provide these for processing in the ISA control system prior to being passed to the truck's engine control unit in a similar manner to that employed on the ISA passenger car system. However, this option was disregarded after engineering assessment, as the vehicle was fitted with a digital electronic throttle rather than the analogue type fitted to the ISA passenger car system.

The third option that was investigated, and subsequently implemented, was to interface the additional ISA control system to the truck's built-in cruise control system. This approach proved to be the most practical but required additional development of both software and hardware of the ISA passenger car system to accommodate the environment and control architecture of the MAN TGL truck. This is described in more detail below.

2.4 Control architecture

Figure 2 illustrates the architecture developed for the ISA truck trial, which used the Location and Interpretation modules from the ISA car. There are four sub-systems that made up the ISA system for the truck:

- The **Navteq Sensor Box**, the LOCATION sub-system, which provided the vehicle's geographic location (coordinates) to the Navigation Computer
- The **Navigation Computer**, the INTERPRETATION sub-system, which identified the appropriate speed limit for the vehicle's location
- The **ISA Command Unit**, the COMMAND sub-system, which compared the vehicle speed with the applicable speed limit and determines the appropriate response required
- The **ISA Speed Limit Control Switch Interface** (**SLSI**), the CONTROL sub-system, which physically implemented the intervention in order to control the vehicle speed

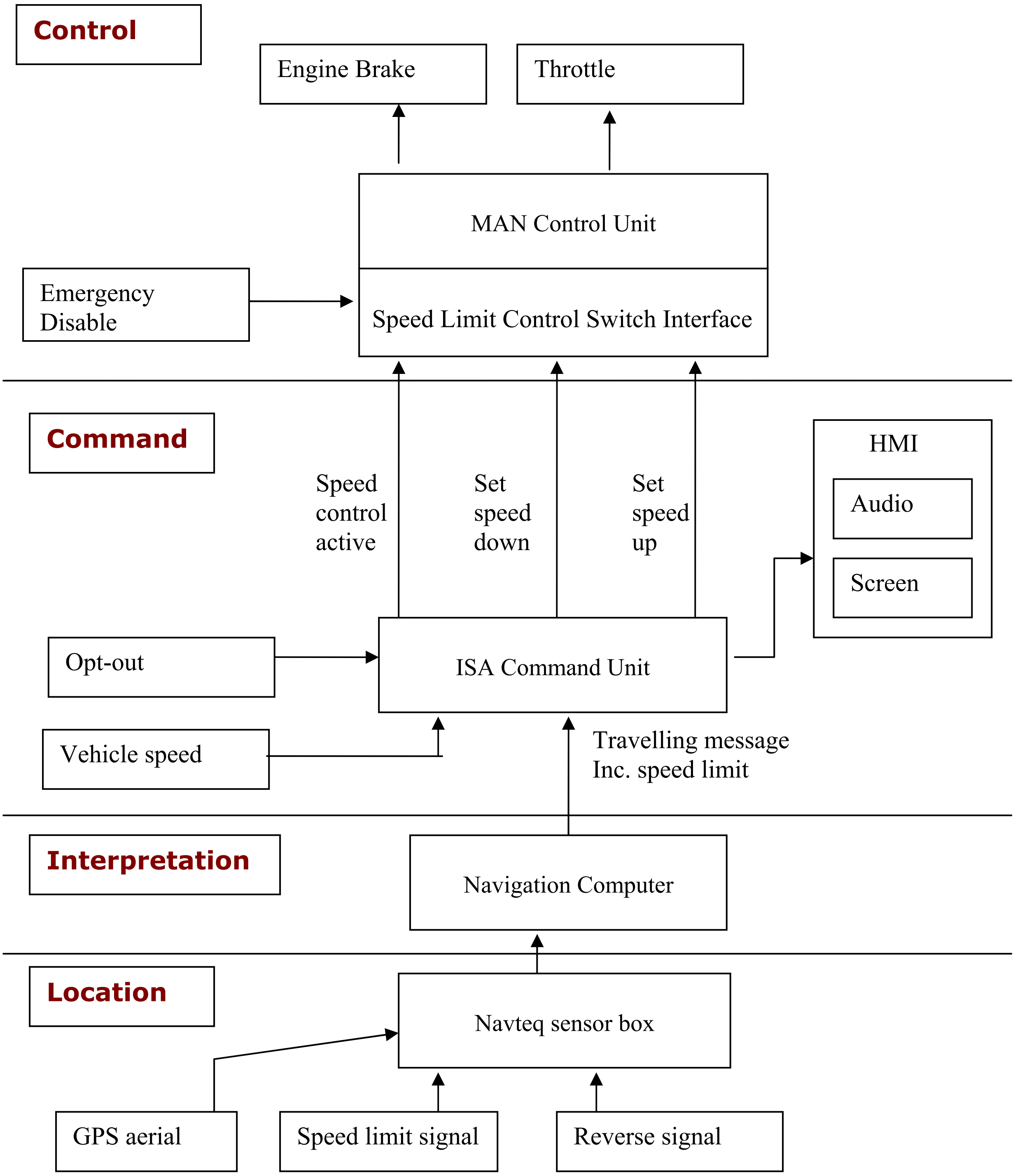

Figure 2: Overview of the key elements of the ISA system implemented on the truck

2.5 Implementation

2.5.1 Location and Interpretation

The ISA truck used the same location and interpretation method as the ISA cars, which applied the Global Positioning System (GPS) and Dead Reckoning (DR) technology to determine the vehicle's position. GPS utilises a constellation of at least 24 medium Earth orbit satellites which transmit precise microwave signals, the system enables a receiver to determine its location, speed and direction. DR is a technique that continuously monitors vehicle speed and direction, and which enables the provision of uninterrupted positioning when GPS signals are poor such as when obscured by tree foliage, tunnels or tall buildings. Upon vehicle location information being available, the ISA system then identified the applicable speed limit by matching the vehicle's location onto the digital speed limit map stored in the vehicle.

2.5.2 Command and control

The ISA system's control function made use of the MAN TGL truck's factory-fitted cruise control system. The truck's cruise control was a user-configurable system and was accessible via a stalk on the steering column as shown in Figure 3. The cruise control could be turned on and off via pressing the 'MEM' and 'OFF' buttons. Increasing or decreasing the cruising speed in increments of +/- 1km/h could be set by flicking the stalk up or down.

Figure 3: MAN TGL cruise control column stalk

Similar to other vehicle manufacturers' cruise control systems, the MAN's cruise control accelerates or decelerates the truck according to the speed set by the driver. When deceleration was needed, the cruise control used engine braking in addition to reducing throttle output. The ISA system was linked to the truck's cruise control interface and utilised the speed reduction function of the cruise control system, i.e. the ISA system set the desired cruising speed at the appropriate speed limit rather than this being done by driver input.

The ISA system continuously monitored the vehicle speed. Before the truck's speed reached the speed limit, the cruise control remained off. When the truck's speed exceeded the speed limit, the cruise control was turned on by the ISA system which set the desired cruising speed at the speed limit. Once the truck's speed was reduced to the speed limit (i.e. the cruising speed set by the ISA system), the ISA system turned the cruise control off until the truck's speed was above the speed limit again. The iteration of speed control mechanism in the ISA truck is illustrated in Figure 4.

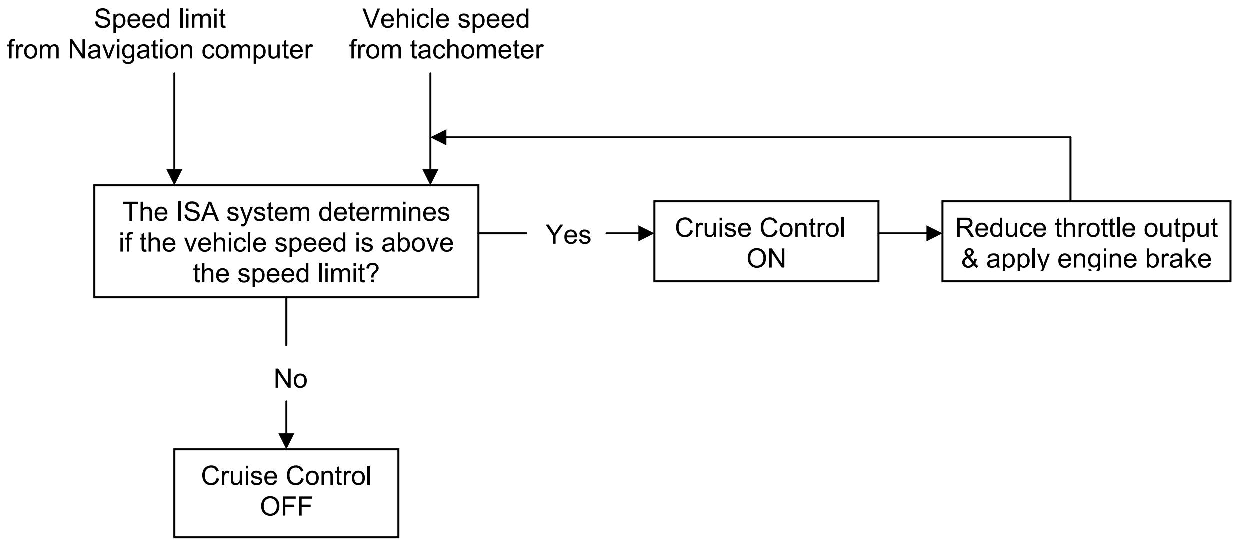

Figure 4: The process of speed control mechanism in the ISA truck

2.5.3 ISA truck HMI

The HMI used in the ISA truck was similar to that implemented in the ISA passenger cars. There was an opt-out button and an Emergency Disable button located in the central console. The speed limit was shown on a LCD display and changes of speed limit were accompanied by an auditory beep. The layouts of the ISA truck HMI are shown in Figure 5. In addition, opt-out could also be initiated by the kick-through function implemented on the acceleration pedal.

Figure 5: HMI in the ISA truck

However, there were aspects of the ISA truck HMI which were different from the ISA car HMI. For example, the accelerator pedal did not vibrate. This was due to the consideration that most commercial vehicle drivers wear safety boots with thick soles. It would therefore be unlikely for the driver to feel the vibration through the pedal vibration unit. However, there were no technical difficulties that prevented the addition of this feature to the ISA truck.

In addition, engine braking was used instead of the service brake in the ISA truck. This design decision was taken as the braking system on this MAN truck had a different functional characteristic from the comparable installation on the ISA passenger cars, with a more aggressive initial retardation force. It was considered that utilising engine braking alone would provide a smoother speed reduction and be more effective than using the service brakes which might be perceived to be jerky and uncomfortable. Because the vehicle's service brake was not used, when the ISA system slowed the truck down, the brake pedal was not pushed down.

Furthermore, experience learned from the passenger cars trials suggested that an "Opt In" function was not necessary, as the ISA system designed in this project was switching on by default upon ignition. If the driver opted out during the trip, the ISA system would reinstate itself as soon as the vehicle speed fell below the speed limit.

2.5.4 System monitoring

In a similar manner to the ISA car, the ISA truck's Command Unit monitored the state of the vehicle, including parameters such as the vehicle location, vehicle speed, throttle position and brake application etc. The ISA truck also used GSM network to deliver SMS (Short Message Service) messages back to the ISA trial data centre upon the ignition being turned off. It is worth noting that data collected was used for analysis in this project, and that data collection capability would not be an essential part of a production ISA system.

3. EVALUATION OF THE ISA SYSTEM

3.1 Trial requirement

The objective of the trial was to place the ISA truck with professional drivers to use during their normal activities over a relatively long period of time in order to assess user behaviour in the presence of the ISA system.

3.2 Trial methodology

3.2.1 Digital speed limit map

The trial was carried out in the South-West Leicestershire area. The digital speed limit map used for the truck trial was adapted from the speed limit map developed for the third and fourth ISA car trials (Lai, Chorlton, and Carsten, 2006; Lai, Chorlton, and Carsten, 2007). Figure 6 outlines the area within which all roads were coded with appropriate speed limits. It is worth noting that the national trunk road network was also coded with speed limits.

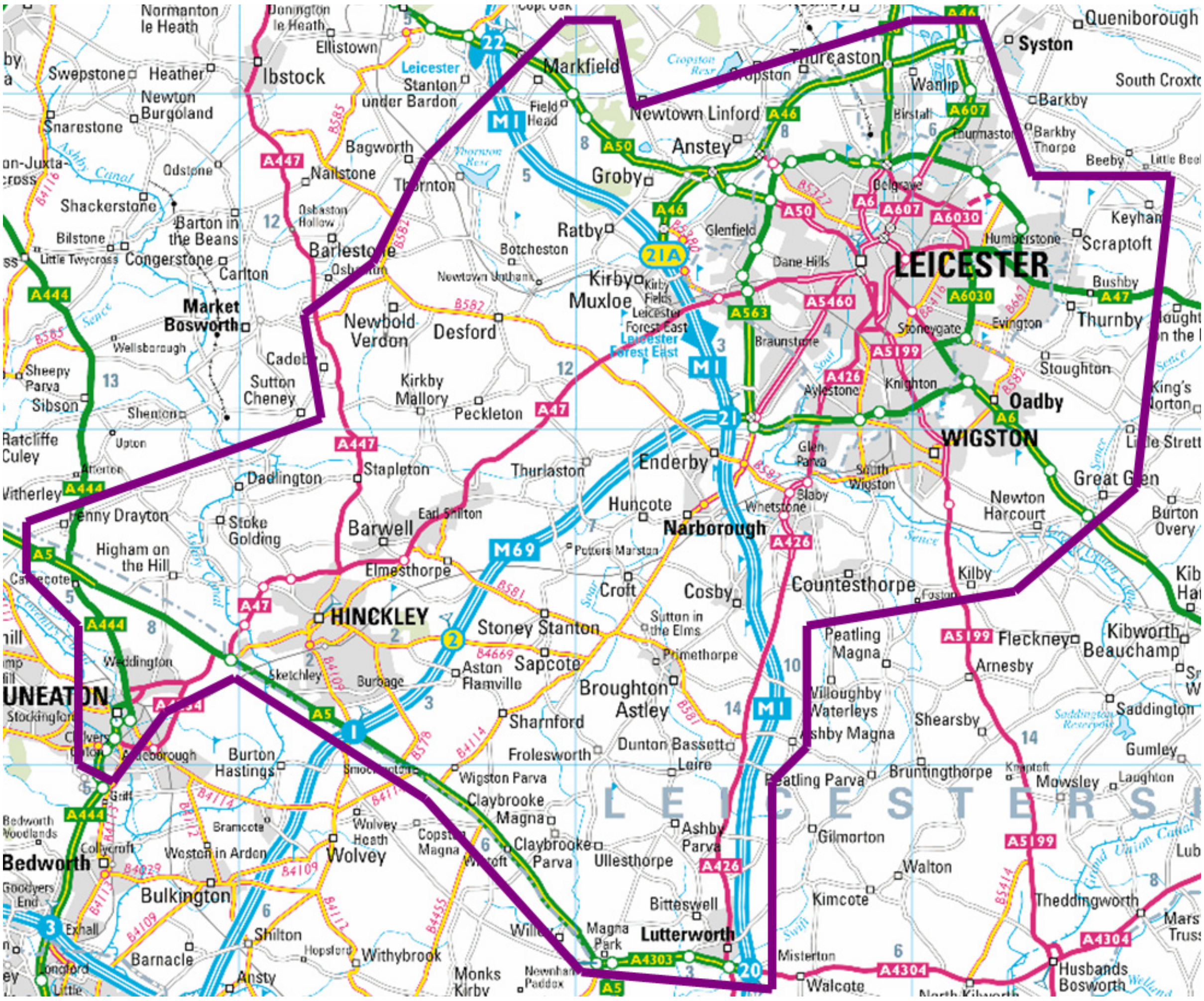

Figure 6: The South-West Leicestershire speed limit map

Due to the weight classification of the ISA truck, the speed limits incorporated in the digital speed limit map developed for the ISA cars were amended in line with Table 1.

Table 1: Speed limits applicable to cars and goods vehicles

Road type	**Cars and Motorcycles**	**Goods Vehicles not Exceeding 7.5 Tonnes Max Laden Weight**
Built-up	30	30
	40	40
Signed as 50 mph	50	50
Single carriageway with national speed limit	60	50
Dual carriageway with national speed limit	70	60
Motorway with national speed limit	70	70

Source: The Highway Code (HMSO, 2005)

3.2.2 Fleet selection

With respect to selection of trial participating company, the selection of a long-distance fleet operator was not considered, as this would take the ISA truck outside of the South-West Leicester area for most of the journey. Although the trunk road network was coded with speed limits on the digital speed limit map, excessive number of trips outside the South-West Leicestershire area would adversely reduce the amount of valid data available for later analysis.

A number of potential fleet operators within trial area were contacted. Negotiations were eventually concluded with a logistics company that was willing to contribute to the trial and had a parcel delivery and collection service within the area from a base in the city of Leicester to a local town Hinckley. This route included the following villages:

Desford
Newtown Unthank
Botcheston
Merry Lees
Newbold Verdon
Mallory
Stapleton
Earl Shilton
Barwell
Elmsthorpe
Stoney Stanton
Sapcote
Broughton Astley

It was hoped that this route would be served by several drivers. However, this company assigned a dedicated driver to each delivery route and therefore was not able to accommodate the request of supplying multiple drivers to participate in the ISA truck trial.

3.2.3 Trial protocol

The trial design followed the design developed for the ISA car trials; i.e. an A-B-A design, consisting of three distinct phases, as shown in Figure 7. The three trial phases were:

- Phase 1: the ISA system is switched off. This pre-ISA phase allows measurement of baseline behaviour and a period of adjustment to the unfamiliar vehicle.
- Phase 2: the ISA system is switched on. This extended phase allows sufficient time for novelty effects to occur (and dissipate) and for long-term behavioural adaptation to be studied.
- Phase 3: the ISA system is switched off. This post-ISA phase allows the evaluation of carry-over effects.

Phase 1	Phase 2	Phase 3
ISA OFF	**ISA ON**	**ISA OFF**
4 weeks	8 weeks	2 weeks

Figure 7: Field trial structure and proposed trial duration

As depicted in Figure 7, the trial was scheduled to run 14 weeks. However, due to delays in commencing the trial, the trial duration had to be shortened. The actual duration of the trial carried out is shown in Figure 8.

Phase 1	Phase 2	Phase 3
ISA OFF	**ISA ON**	**ISA OFF**
2 weeks	6 weeks	1 week

Figure 8: Actual trial duration

In addition to vehicle data logged along the trial, questionnaires were used to probe changes in user opinion and attitude towards the ISA system along the progress of the trial. The questionnaires were administered at the beginning of each phase as well as at the end of the trial.

3.3 Results

This section presents analysis of the data collected from the field trial. The sole participant was a 35-year-old male truck driver with 18 years of driving experience and 11 years experience of driving 7.5 tonne trucks.

3.3.1 Analysis of questionnaire data

Questions sought to determine the truck driver’s acceptance of the ISA system. Driver acceptance of the ISA system was measured using an acceptability scale of advanced telematics systems developed by Van der Laan et al (1997). This measure allows system evaluations across the dimensions of usefulness and satisfaction. The questionnaire was administered during each phase of the trial to monitor any changes in opinion.

As can be seen in Figure 9, the participant's acceptability rating decreased following experience with the system. Ratings of usefulness and satisfaction with ISA systematically declined beyond the removal of the system suggests that the driver showed little acceptance of the ISA system.

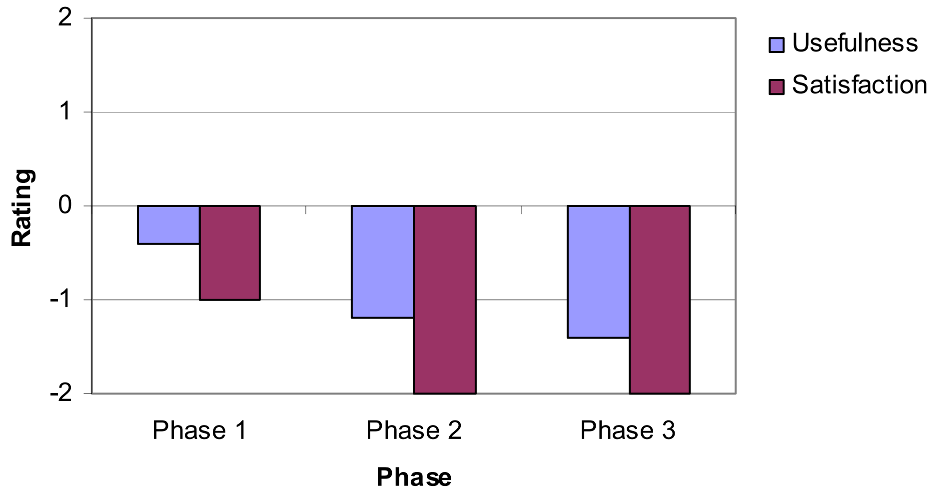

Figure 9: Acceptability ratings on dimensions of 'usefulness' and 'satisfaction'

Several sets of questions were also included to tap the truck driver's opinion about the ISA system in more detail. The first set of questions focused on how the ISA system would change various aspects of truck driving; the results are shown in Figure 10. The results suggest that in this truck driver's opinion, the introduction of ISA would decrease traffic safety, the joy of driving, the ease of overtaking and surprisingly the ease of keeping to the speed limits. Similarly, the driver believed that ISA would increase feelings of stress, accident risk, pressure from other traffic and the feeling of being controlled. The driver was unsure how the system increased his attentiveness to traffic and following distances. Experience with the system seemed only to confirm and strengthen his negative attitude to ISA.

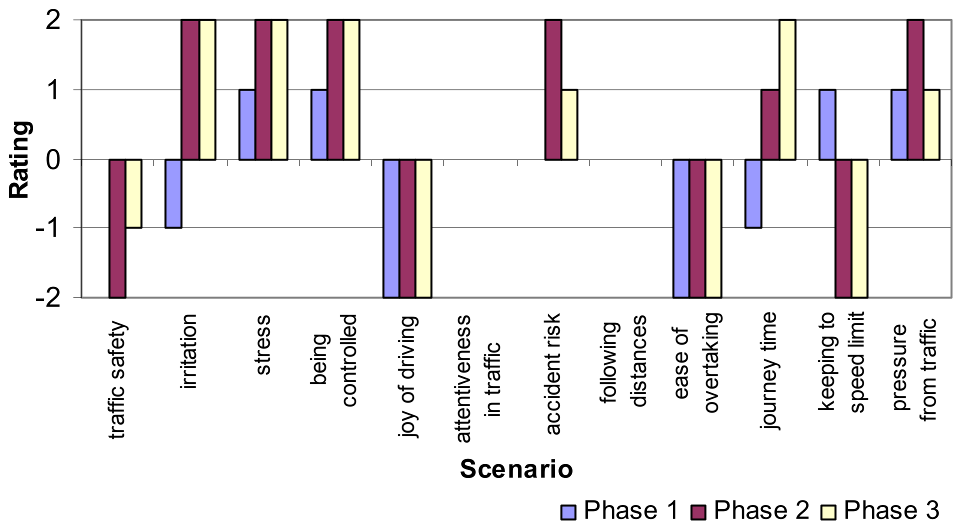

Figure 10: How do you think the following factors change when driving with the ISA system compared to when driving without ISA on your truck?

The second set of questions investigated where and when the driver would use the ISA system. As can be seen in Figure 11, he was unsure where he would make use of ISA before having gained any experience of the system. Following experience with the system, he felt that he would make use of the system in the majority of driving systems except on motorways and during foggy driving conditions. Once the system was removed, however, the participant's evaluation of the usefulness of ISA declined.

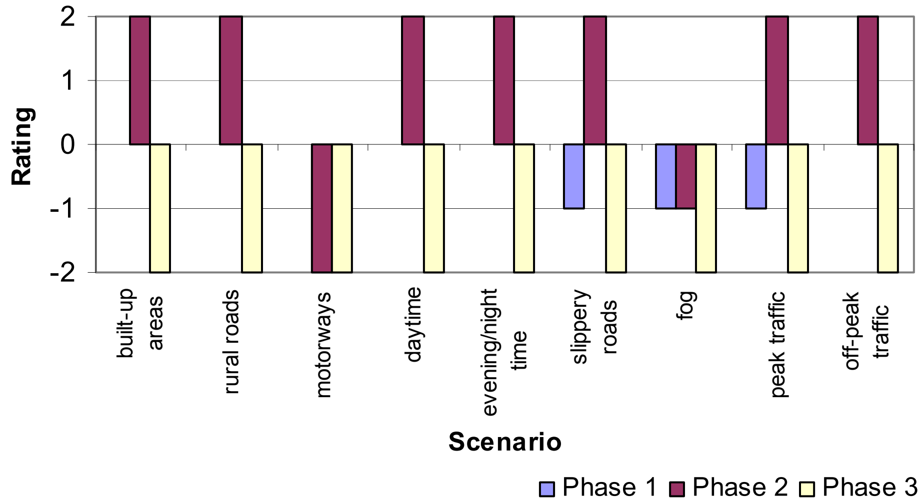

Figure 11: Where would you use the ISA system?

The third set of questions explored for which road user groups the participant felt the system was most justified. Figure 12 suggests that, whilst he thought that ISA could be justified for private drivers, experience with the system changed this belief. The results suggest that he could only justify the imposition of ISA for novice drivers, speed offenders and those who had recently regained their licence (the participant's own suggestion). He thought that ISA was more justifiable for novice drivers than speed offenders.

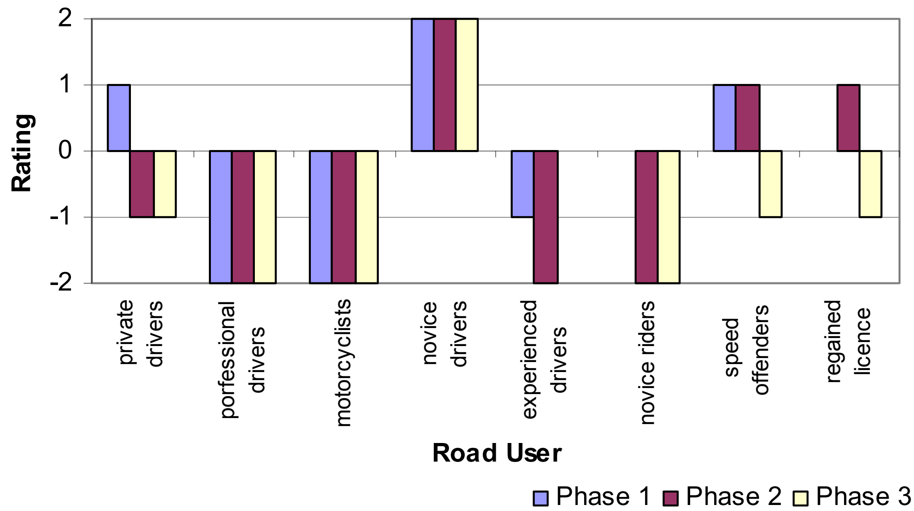

Figure 12: How justified do you think the system would be for the different categories of drivers?

Measures of trust were also taken (see Table 2). The method used a pencil and paper scoring system in which respondents mark their trust on a scale from 0 to 100 (Lee and Moray, 1992). The truck driver's ratings suggest that his trust in the system, having gained experience of ISA, was substantially lower than he had expected. His trust in the system continued to decline having returned to 'normal' driving (i.e. switched from Phase 2 to 3).

Table 2: Trust rating across phases

	Rating
Phase 1	55
Phase 2	13
Phase 3	5

When questioned about his willingness to install such a system, the truck driver would be unwilling to have an ISA installed in his truck even if its use was voluntary. Similarly he disapproved of any compulsory fitting of ISA to all new vehicles or the mandatory introduction of ISA for all truck drivers. The truck driver would not be interested in having ISA installed in his own private car.

3.3.2 Analysis of logged vehicle data

3.3.2.1 Data processing

Although the data logging system in the vehicle generates data at 10Hz (i.e.10 records per second), data used for analysis was distance-based rather than time-based. While time based data is intuitively valid, it introduces undue weight to the data stream when vehicle speed is zero (e.g. the vehicle stops at junctions) or very low (e.g. the vehicle moves slowly on a congested road). Conversion algorithms were therefore developed for extracting from the data stream a record per 5 metres of travelling distance.

This data processing also filtered out records without a valid speed limit attached to them, attributable to the vehicle being driven on roads where the speed limits were not recorded by Navteq, such as private roads (e.g. roads in a business park) or non-trunk roads outside the South-West Leicestershire area. The above process led to a data file containing 29,889,265 valid records across trial phases, ready for analysis.

3.3.2.2 Vehicle kilometres

Following data processing and reduction, the final data file ready for analysis represents a total travel distance of 6,787 kilometres. A breakdown of vehicle kilometres with respect to speed zones is illustrated in Figure 13, which shows that no trips were made on 20 or 70 mph roads. The largest portion of vehicle kilometres was attributable to 50 mph zones (i.e. rural single carriageways), followed by 30 mph zones (i.e. built-up areas)[1]. This distribution reflects the trip patterns of a delivery lorry operated within a rural region; i.e. travelling between towns and villages.

[1] These speed limits are applicable to the ISA truck's vehicle class as depicted in Table 1 (Section 3.2.1).

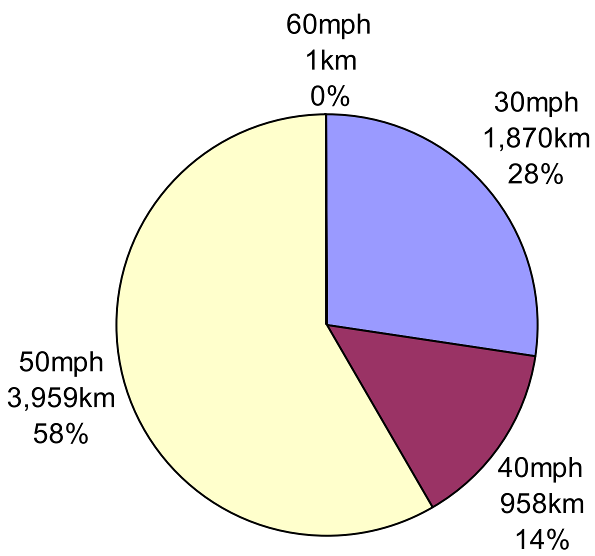

Figure 13: Distribution of total vehicle kilometres with respect to speed zones

Table 3 provides a further breakdown of the proportion of vehicle kilometres within individual trial phases, which suggests that the contribution of each of the speed zones to the total vehicle kilometres remains a very similar pattern across trial phases. It is worth noting that the total vehicle kilometres accumulated in 60 mph zones was only 0.6 km across trial phases (i.e. the shaded cells in Table 3). Due to the absence of data representativeness, data collected from 60 mph roads are excluded from the analysis presented in the following sections.

Table 3: Vehicle kilometres across trial phases

Speed zone	Vehicle Kilometres			Distribution based on trial phase (%)		
	Phase 1	Phase 2	Phase 3	Phase 1	Phase 2	Phase 3
30 mph	514.0	1,152.2	203.9	26.9	27.7	28.9
40 mph	269.3	586.5	102.1	14.1	14.1	14.4
50 mph	1,130.5	2,427.6	400.5	59.1	58.3	56.7
60 mph	0.2	0.3	0.1	0.0	0.0	0.0
Sum	1,914.0	4,166.6	706.5	100.0	100.0	100.0

3.3.2.3 Speed distribution

The logged vehicle data provides a comprehensive database of the speed distribution. Figure 14 to Figure 16 illustrate speed distribution across speed zones from 30 mph to 50 mph respectively.

It is worth noting that the ISA system developed in this project did not precisely restrict vehicle speed to the legal speed limits (i.e. the speed limits provided by the digital speed limit map stored in the vehicle, as depicted in Table 1 in Section 3.2.1). Considering that the vehicle could encounter a wide variety of road gradients, tolerance had been given to the throttle cut-off thresholds allowing the vehicle to be able to reach the speed limits on uphill roads. This design however led to the vehicle being able to cross the speed limits on flat or downhill roads. As a result, a slight drift of the speed distribution occurred in Phase 2, instead of a clean cut-off at the speed limit. For example, in 30 mph zones (e.g. Figure 14), over 15% of travel distance occurred in the speed band of 30-35 mph. Nevertheless, the trial results do demonstrate the effectiveness of the ISA system in reshaping speed distributions.

In addition, analysis of the three speed distributions suggests that the carry-over effect of using the ISA system was prominent in 30 mph zones. These are the roads where drivers are more likely to encounter conflicts with vulnerable road users such as pedestrians and cyclists as well as other traffic than in the rest of speed zones.

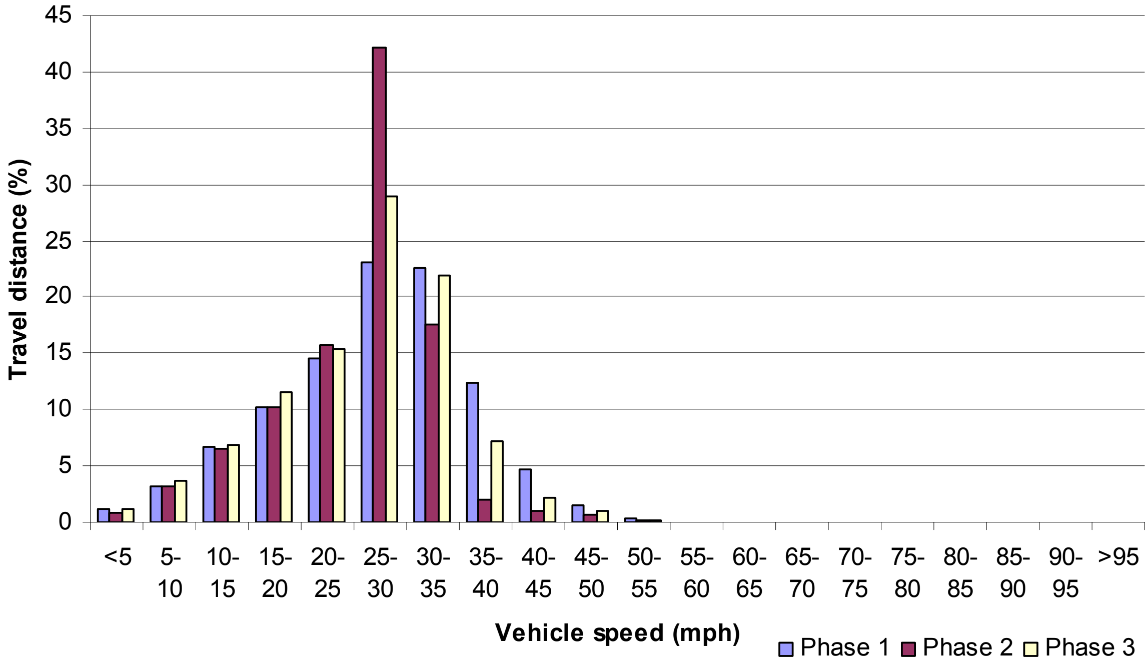

Figure 14: Overall speed distribution in 30 mph zones

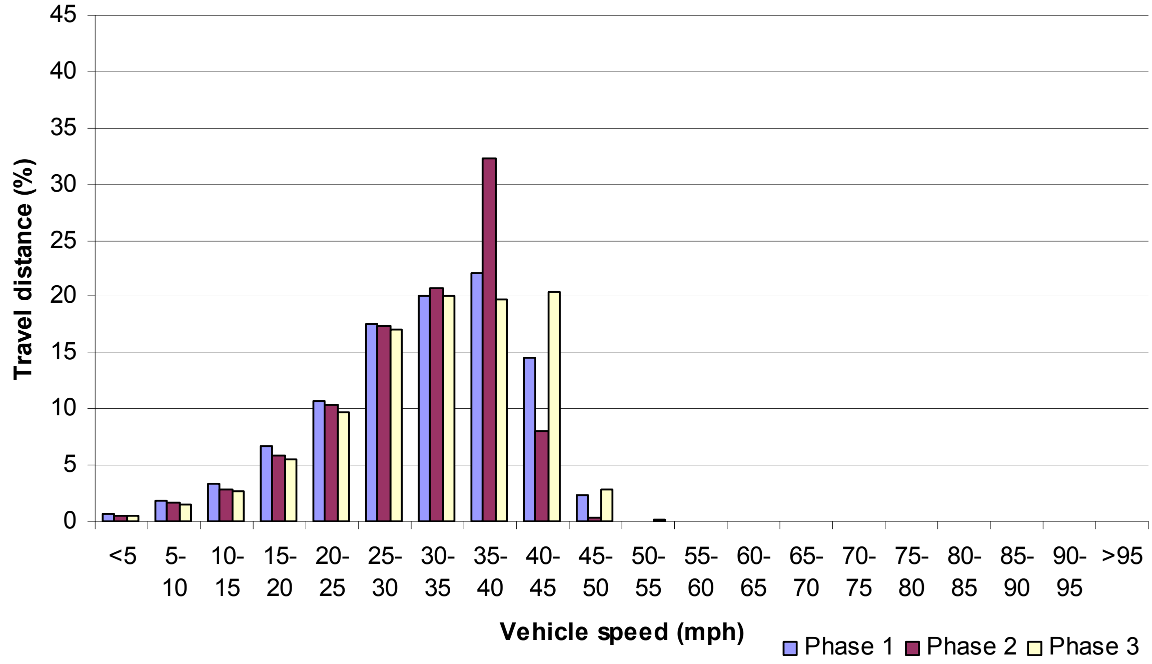

Figure 15: Overall speed distribution in 40 mph zones

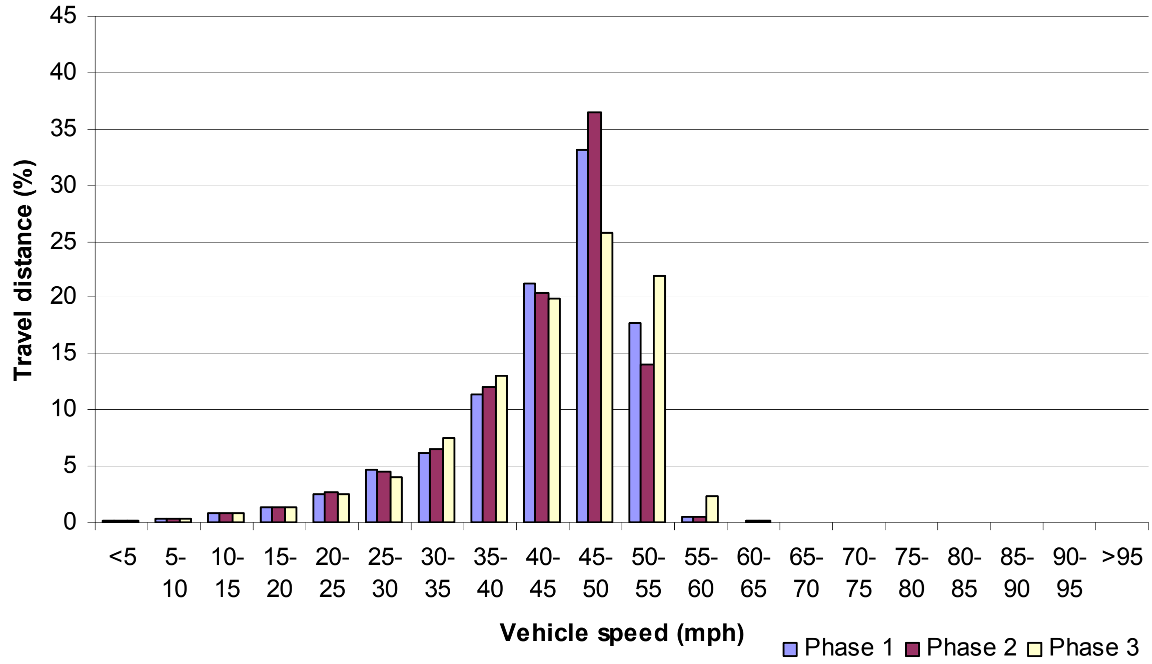

Figure 16: Overall speed distribution in 50 mph zones

3.3.2.4 Compliance with ISA intervention

Figure 17 compares the observed overriding behaviour across speed zones. The left-hand graph shows the total number of opt-outs (overrides) of the ISA system, while the right-hand graph shows the proportion of distance travelled with the system overridden. It can be seen that the participant overrode the system mostly in built-up areas. The lower opt-out frequency on 50 mph roads (mostly rural single carriageways) is considered to be primarily due to the constraints on driving speed imposed by road geometry and traffic, i.e. there was less opportunity to override.

Although the distance driven while the system was overridden only comprised a very small proportion of the total distance driven within the six-week trial period, the more frequent overriding behaviour observed was in built-up areas where drivers are mostly like to encounter vulnerable road users.

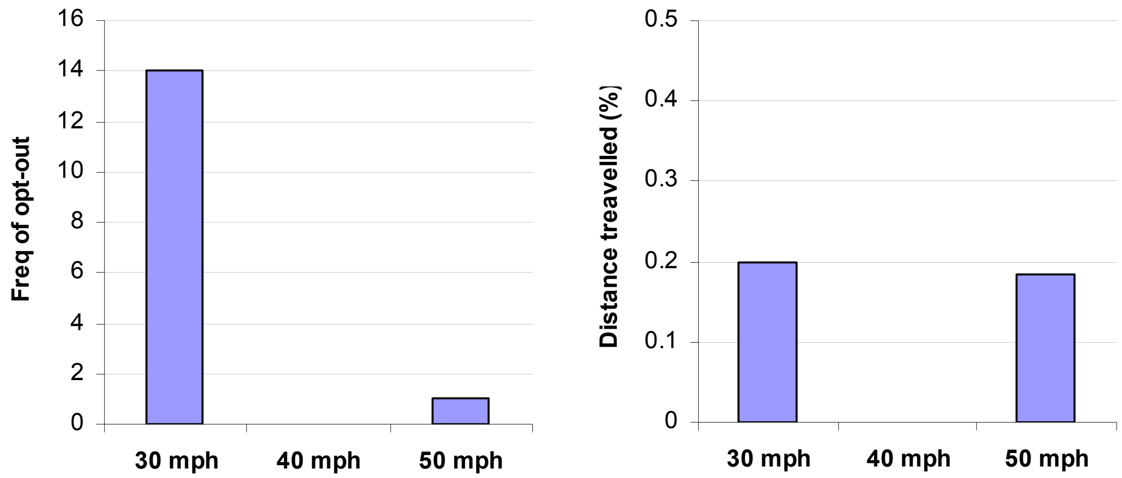

Figure 17: Comparison of overriding behaviour across speed zones

3.3.2.5 Comparison of vehicle speed across trial phases

Due to the constraints imposed by sample size (i.e. only one participant), vehicle speeds were analysed by means of descriptive statistics. Figure 18 compares mean and 85th percentile speeds along system exposure (measured by accumulated distance travelled) on 30 mph roads. It is clearly distinguishable that vehicle speeds in Phase 1 and Phase 3 were higher than those in Phase 2. This pattern is less prominent on 40 and 50 mph roads, as shown in Figure 19 and Figure 20. As Phase 3 only lasted for a week, not as much data was collected as in the first two phases of the trial. However, the Phase 3 data generally indicate an upward trend in vehicle speed with increased exposure, which suggests that the carry-over effect of using the ISA system was minimal.

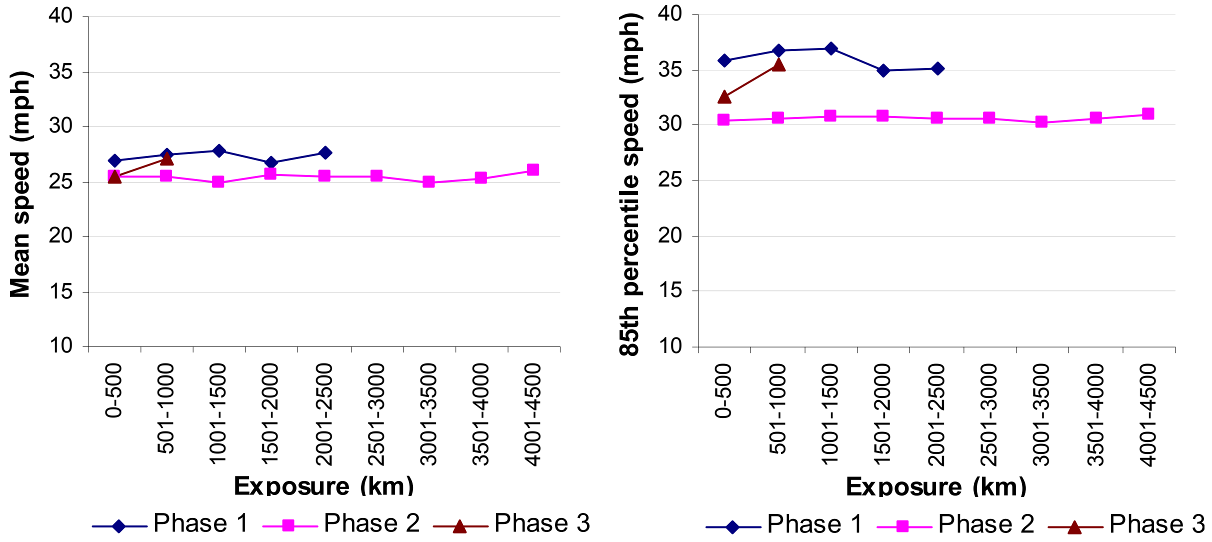

Figure 18: Comparison of vehicle speed on 30 mph roads across trial phases

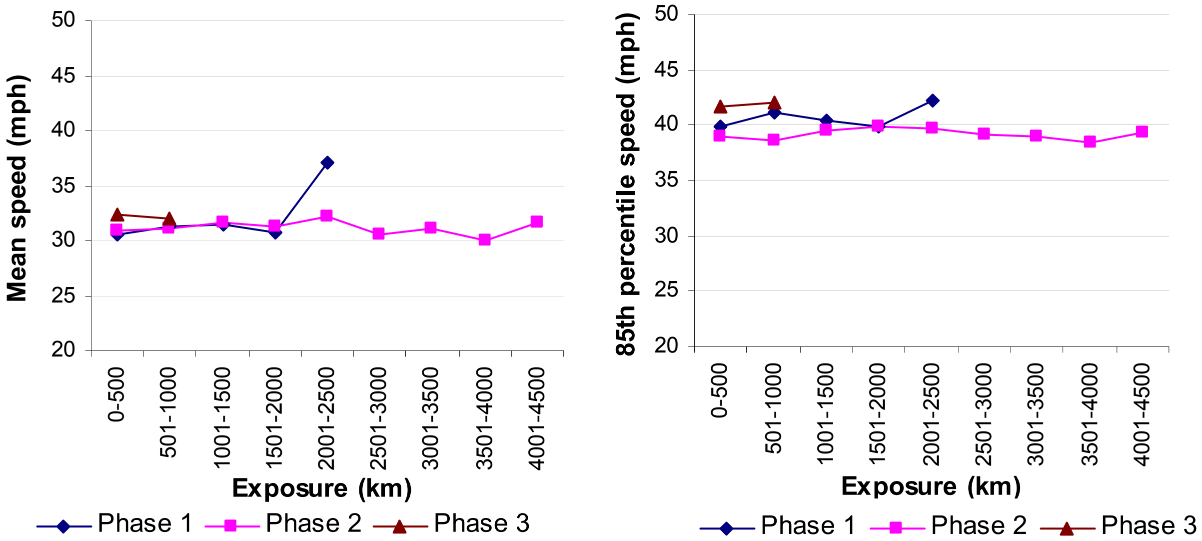

Figure 19: Comparison of vehicle speed on 40 mph roads across trial phases

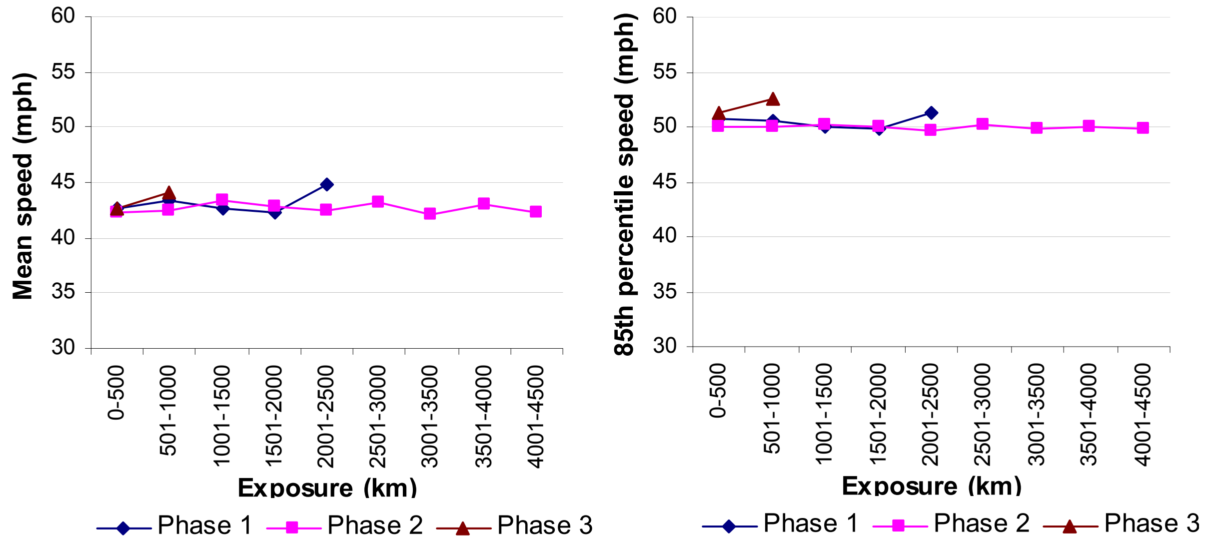

Figure 20: Comparison of vehicle speed on 50 mph roads across trial phases

Figure 21 compares the proportion of distance travelled when the vehicle speed was over the speed limit. It clearly demonstrates that ISA effectively diminishes speeding behaviour. However, it should be noted that the ISA system allowed vehicle speed to be slightly over the speed limit (as addressed in Section 3.3.2.3), which contributed to a portion of the distance driven while the vehicle speed was over the speed limit in Phase 2. As demonstrated in Section 3.3.2.4, the participant did not override the ISA control very frequently.

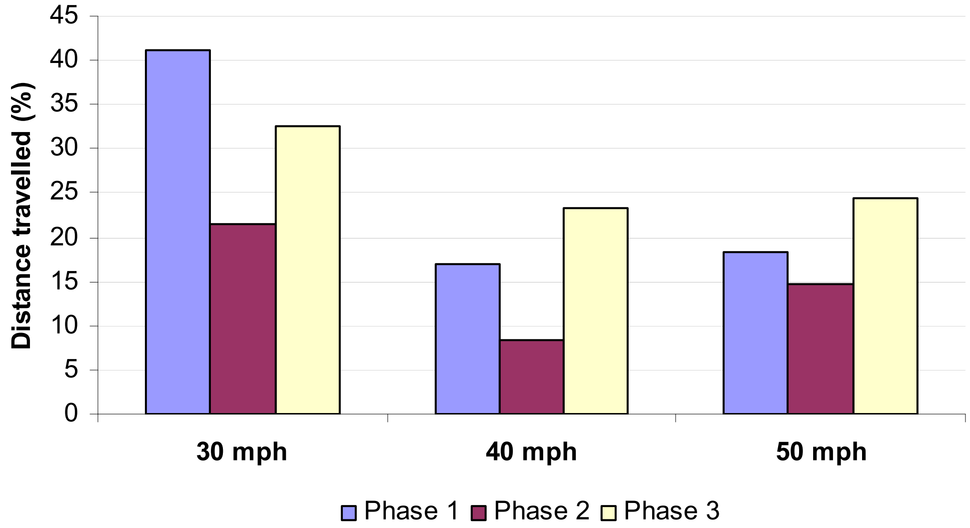

Figure 21: Comparison of percentage of distance travelled above the speed limit across trial phases

3.3.2.6 Speed variability

Table 4 presents the coefficient of variation derived from individual trial phases as well as speed zones, which indicates the variability of vehicle speed. The coefficient of variation is a dimensionless measure that allows comparison of the variation of populations having considerably different mean values, which is of particular use for this analysis since the speed zones range from 30 mph to 50 mph. ISA led to a reduction in coefficient of variation in all speed zones, as the coefficient of variation derived from Phase 2 was consistently smaller than that from Phase 1 or 3 (i.e. a 'V' shape).

The effect of ISA intervention on reducing speed variability was most prominent in lower speed zones, i.e. urban areas. This suggests a promising implication of any possible future implementation of ISA in terms of accident reduction, as it has been suggested that the coefficient of variation of speed is significantly correlated with accident occurrence in urban areas but the relationship is less prominent in rural areas (Taylor, Lynam, and Baruya, 2000; Taylor, Baruya, and Kennedy, 2002).

Table 4: Coefficient of variation of vehicle speed across trial phases

Speed zone	Phase 1	Phase 2	Phase 3
30 mph	0.334	0.286	0.324
40 mph	0.292	0.264	0.277
50 mph	0.205	0.203	0.213

3.3.3 Discussion

It should be noted that due to the constraints imposed by very small sample size (i.e. only one driver), data collected from this trial were unlikely to be representative of the whole population of truck drivers. Hence, the analysis results are indicative rather than conclusive.

3.3.3.1 Attitudinal changes

Overall the questionnaire highlighted the participating truck driver's dissatisfaction and mistrust of the ISA system. The participant appeared to start the trial with a negative attitude towards ISA and his experience with the system seemed not to have changed his beliefs. At the beginning of the trial he expressed some concern regarding the level of control of ISA:

"I think the system will have its place but should not be put into place to replace the responsibility of the driver to control the vehicle's speed. Drivers have at present too many aids which take away their concentration which leads them into false sense of driving ability in any given situation".

These concerns regarding driver distraction did not appear to have dissipated following experience with the system:

"The system could be of use to novice drivers or those that have gained maximum points on their licence for speeding offences but people should be trained further after passing their test to make them more aware of what they should be doing behind the wheel so as not to rely on computer generated safety features being relied upon at the expense of proper observation planning techniques being used".

3.3.3.2 Behavioural changes

The ISA system was observed to have a distinctive effect in terms of the transformation of the speed distribution across all speed zones by comparing the speed distribution derived from Phase 1, 2, and 3 of the trial. This means that speeds over the speed limit and in particular very high exceeding of the limit were curtailed. The proportion of distance travelled when vehicle speed was over the speed limit was diminished when ISA was switched on. That is, the percentage goes down from Phase 1 to Phase 2, then up from Phase 2 to Phase 3; i.e. a 'V' shape across trial phases as demonstrated in Figure 21. ISA has not only diminished excessive speeding, but also led to a reduction in speed variation, especially in the urban areas where lower speed limits apply. This delivers positive implications for a reduction in accident occurrence as a result of ISA intervention.

The use of an overridable ISA system also provides an opportunity to demonstrate potential resistance from the driving population against its implementation, based on true behaviour instead of opinion. Although the distance driven while the system was overridden only comprised a very small proportion of the total distance driven within the six-week trial period, the more frequent overriding behaviour observed was, as noted earlier, in built-up areas. It is worth noting that the overriding pattern revealed by the sole participant in this trial was not deemed to be likely to be representative of the whole population of truck drivers. As revealed by the car trials, driver characteristics (e.g. gender, age, and intention to speed) influence overriding behaviour.

It is also worth noting that the ISA trials were carried out in the real world, which is an uncontrolled environment as opposed to lab-based experiments. As the trial was implemented continuously across a long period (nine weeks), it is considered to be a reasonable assumption that the influence of surrounding traffic on the driver's speed behaviour did not have any systematic effects between non-ISA and ISA driving. The participant's speed behaviour was monitored throughout the trial and therefore the behavioural difference among trial phases is deemed to be attributable to the presence of ISA intervention. In addition, analyses of behavioural difference among trial phases were broken down to individual speed zones to ensure that the driving environment is as comparable as possible.

4. DISCUSSION

The ISA truck trial was a limited initial examination of how full ISA functionality, developed in the ISA car trials, could be applied to a goods vehicle operating in a real-world business environment. The scope of the trial was confined to one specific vehicle type, one operator and one commercial service, so it is restricted in its applicability to commercial vehicle operations in general. However it has demonstrated that the ISA car platform can be translated into an application for a truck and that, with suitable modifications to the supporting hardware and software, the vehicle control system architecture of a truck can be accommodated.

There were a number of alternative approaches as to how an ISA control system could be applied to a truck design. Alternative implementation strategies were investigated, but practical considerations prevented adoption of potentially more efficient methods, such as direct interfacing to the vehicle CAN, or direct throttle signal intervention. However the chosen implementation proved successful, reliable and entirely adequate for the purposes of conducting a restricted in-service trial. It should be noted that the ISA system was designed to be a retro-fit system with ease of removal post-trial being an important factor. The fact that there were various potential means of integrating ISA/Speed Limit data inputs into vehicle engine and other supporting powertrain systems suggests that future design for mass production is not restricted. For example, the availability of speed limiter function in this and other trucks makes fitting an ISA comparatively straightforward.

Technically the main deployment issue remains access to reliable, up-to-date speed limit database information. It should be noted that an in-vehicle ISA system will have to recognise vehicle type along with road definition (e.g. single versus dual carriageway) in order to convey the appropriate speed limits.

It is also worth noting that the mandatory requirement to fit large goods vehicles with a speed limiter set to the national speed limit does not negate the benefits of deploying ISA systems for this category of vehicles. The currently mandated speed limiters do not respond to the actual speed limits on a vehicle's route, and data collected by the roadside indicate for the annual survey Vehicle Speeds in Great Britain indicate a high level of speed violation by large trucks, particularly in relation to their speed limit of 40 mph on single-carriageway rural roads.

The time and logistic constraints imposed by project goals prevented a wider examination of ISA impacts on a range of truck operators, operating environments/schedules and drivers. However, within these constraints, some relevant observations can be made. Other truck operations, including long-distance haulage and vehicle categories such as articulated tractor/trailer combinations would provide a different operating context, but would not require radically different vehicle architecture. The test vehicle category is no different from these other vehicles in terms of requirements for professional driver licensing, operating legislation (such as driver working hour legislation) and speed limiter regulation. So the target truck application investigated here is an appropriate initial examination of impacts.

In this respect the reported feedback from the operator is instructive. Initial comments with regard to the need to perhaps provide additional support (additional vehicles and/or drivers) to assist the driver and operation of the trial speed limited vehicle during commercial operation, proved to be not required. The commercial operation and delivery/collection schedules were unaffected, despite initial concerns about possible loss of time due to compliance with the speed limit. However, representatives of the operator indicated that an additional vehicle control system such as ISA could be perceived to be as “negative” by the professional driver. This concern corresponds to the view of the sole participating truck driver in this trial.

Certainly there were negative responses elicited here. The driver was an experienced truck driver with a pre-determined route schedule who was asked to trial an unfamiliar concept system in his normal working routine. Questionnaires were administered pre, during and post trial. Perceptions of “usefulness” and “satisfaction” of ISA became increasingly negative as the trial progressed. Consistently negative views were expressed concerning ISA impacts on “joy of driving”, “ease of overtaking” and “keeping to the speed limit”. Perceptions of where ISA could be applied focussed on perceived risk groups such as novice drivers. In contrast, actual impacts on driving with the ISA truck were limited. The trial driver was mainly compliant with ISA control and there was only a minimal use of ISA override during the trial. Despite the reported negative perceptions, there was a carry-over effect after ISA system experience in urban environments, which undoubtedly delivers positive implications to road safety.

5. CONCLUSIONS

A number of conclusions can be drawn from the ISA truck trial. The first is that, in terms of vehicle design, there is little difficulty in adapting an ISA system that is targeted at the passenger car environment into one that it suitable for a truck. The adapted system fulfilled safety (such as electro-magnetic compatibility) and other operational requirements and was suitable for reliable operation in commercial service. Indeed, there were a number of feasible alternatives available in terms of interface between ISA system and truck.

The trial was conducted with one driver in a short-haul parcel delivery operation. Caution should be used in extrapolating the results obtained to any generalised conclusions. In terms of the relationship between attitudes and behaviour in this trial, the results reveal a substantial mismatch between attitudes and behaviour. The driver was generally hostile to the ISA concept and experience with the system did not help to change his view. However, the behavioural data reveal a high level of compliance with ISA when the system was active, and this greater speed compliance persisted during the post-ISA phrase, in comparison with the pre-ISA phase. In addition, the participant's negative opinion towards the ISA system would perhaps have been changed, had more fellow drivers been participating. Certainly in the car trials there were strong indications of a "fleet effect" in that the fleet motorists tended to be more compliant with the ISA system than the private motorists. This prompts a need for further research into how the fleet environment could be used to promote ISA among employees in the goods vehicle context.

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