Executive summary:

The development of information and communication technologies in the field of road transport provides drivers with access to various functions and services which, if designed ergonomically and used appropriately, have the potential to enhance driver safety, mobility, enjoyment and comfort. Little is known, however, about how drivers actually interact with most of these systems in everyday driving situations - where, when, how and why they interact with them - and about the effects of long-term system use on driver behaviour, performance and safety. INTERACTION aims to contribute to fulfil this knowledge gap.

The project started in November 2008 for 50 months under the co-ordination of ERT and the scientific supervision of IFSTTAR. The consortium gathered 8 other European partners and countries (CDV, CTAG, FACTUM, ADI, INTEMPORA, SWOV, TRL, and VTT) and collaborated with 2 Australian institutes.

Project main goals

The objective of the project was to identify the patterns of use of new technologies by European drivers and to analyse their effects on driver's behaviour and skills, to identify issues that may limit the adoption of IVT by drivers or induce unsafe use of these technologies, and to develop countermeasures to resolve them.

Project approach

The project meant to investigate differences and similarities of drivers regarding in-vehicle technologies at both micro and macro levels: i.e. at the individual and country level. For that, partners implemented a scientific approach associating self-report and observation of driver behaviour and qualitative and quantitative analysis. This was done through focus groups, questionnaire surveys, naturalistic and experimental observations.

The specificity and added value of the project came from this use of comparative and combined methodology, which allowed highlighting never approached individual and cross-country differences and enabling a holistic analysis of drivers' behaviour in relation to IVT use.

The project focused on a limited set of mature technologies, already available on a wide range of car models and already adopted by most of the European car drivers: cruise control, speed limiter, navigation systems and mobile phone.

Project results

Focus group sessions provided an overview of participants' feelings and attitudes regarding the use, safety and comfort of the systems. It was found that drivers admitted to engaging in potentially distracting and illegal activities with IVTs and misuse of IVTs was reported, which is indicative of behavioural adaptation.

Larger scale assessment of drivers' opinions was obtained in the questionnaire that surveyed more than 7,500 European drivers using IVT. It provided an estimate of the extent and type of IVT use across the studied countries and the frequency of some of the undesirable behaviours identified in the focus groups.

The naturalistic driving study resulted in the collection of data on the everyday driving and IVT use of nearly 100 participants from 30 different vehicles across 7 different countries with more than 3,000 hours of driving recorded. It identified key results such as the frequency, location and speed at which drivers choose to use the various IVTs.

The observational driving study, using the 'Wiener Fahrprobe', gave good insight over the influence of the IVT systems on the driving behaviour and especially on the communication behaviour (which cannot be registered nor analysed systematically with any other method).

Project impacts

The results of the INTERACTION project led to the development of recommendations and guidelines, covering methodological issues; design and engineering; education and awareness; and legislation and enforcement. They are relevant to legislative bodies, research institutes, driver training organisations, insurance companies and vehicle manufacturers alike.

Two main operational outcomes can be issued by stakeholders from these recommendations. They permit to define actions to strengthen drivers' awareness for the use of these technologies and for the consequences that such use has or may have. They also permit to better design future systems and appropriate instructions for drivers that will use them.

INTERACTION thus contributes to the reduction of the risks of systems misuses, of drivers' unsafe actions and in turn to increase the global benefits of in vehicle technology in enhancing road safety.

Project context and objectives:

The development of information and communication technologies in the field of road transport provides drivers with access to various functions and services which, if designed ergonomically and used appropriately, have the potential to enhance driver safety, mobility, enjoyment and comfort. Little is known, however, about how drivers actually interact with most of these systems in everyday driving situations - where, when, how and why they interact with them - and about the effects of long-term system use on driver behaviour, performance and safety.

If poorly designed and used inappropriately, in-vehicle technologies (IVT) have the potential to compromise safety. There are several key safety issues linked with IVT use:
- Risk of distraction
Use of the system may divert drivers' attention away from safety-critical driving tasks
- Over-reliance
Drivers may come to rely on systems that partially automate the driving task to the point that they fail to exercise previously learnt skills that are critical for anticipating and responding to hazards
- Comprehension of systems
A poor understanding of system operation may lead drivers to operate systems in a manner which increases the potential for high workload
- Confusion
The presence of numerous control interfaces operating a variety of in-vehicle systems may lead to confusion, particularly in high driver workload situations.
- Awareness of system limitations
Unless drivers understand the boundaries of system operation, they may expect systems to support them in situations for which they are not capable of doing so
- Interaction with displays and controls
Systems that do not allow the driver to control the pace of human-machine interaction may increase workload and compromise safety
- Negative behavioural adaptation
Drivers may, for example, go faster around a corner when cruise control is engaged than when it is not
- Workload

Unless the Human-Machine-Interface (HMI) through which the information is presented is ergonomically designed, it may overload and confuse the driver.

If the potential benefits of existing and emerging IVTs are to be realised, it is critical to understand the manner in which drivers use them. By doing so, the issues that have potential to comprise driver safety can be identified and countermeasures (e.g. better HMI design, training, education) can be developed to resolve them. This is the overall aim of the INTERACTION project.

INTERACTION started in November 2008 for 42 months and gathers 10 European partners from 8 countries and collaborated with 2 Australian institutes.

The objectives of INTERACTION are:
- To gain a better understanding of driver interactions with IVTs
- To focus on technologies already available on the European market

- To identify patterns of use of these systems by European drivers in everyday life
- To analyse their effects on driver's behaviour and skills, in normal and conflict situations;
- To highlight individual and cultural differences that influence the nature of driver interactions with IVTs, and the consequent outcomes of these interactions

Four types of IVT were studied. These were chosen to represent commonly used IVTs across Europe. They were:
- Cruise control (CC)
- Speed limiter (SL) or Speed Alert (SA)
- Navigation system (NS)
- Mobile phone (MP)

For this selected set of In-Vehicle Technologies (IVT), INTERACTION aimed to tackle the following dimensions of drivers' use of IVT:
- The identification of the population of IVT users.
- The drivers' motives to use or not IVT.
- The driving context where drivers use or not IVT.
- The drivers' patterns of IVT use, i.e. how drivers interact with their systems and configure them.
- The effects of IVT use on drivers' behaviour and road safety

The INTERACTION project has successfully investigated how drivers interact with IVT by applying four separate methodological approaches that address micro- and macro-level behavioural effects; encompass qualitative and quantitative data and include directly observed and self-reported behaviours.

Project results:

1.1.1 The scientific approach implemented by the project
Four methodological techniques were applied to address the project objectives:

1. Focus groups discussions of IVT use held in six countries
2. Web-based questionnaire on IVT use distributed to survey panels in nine countries
3. Naturalistic driving study of IVT use in seven countries
4. Observational driving study of IVT use in seven countries

1.1.1.1 Focus groups

A total of 111 drivers participated in focus groups (FG) that were carried out in 2009 across six countries: Austria, Czech Republic, Finland, France, Portugal and Spain. Drivers were recruited across two levels of age (under 24 years and 30 – 55 years) and three levels of driving experience.

FG sessions were held for the different IVTs with topics including:

- Learning to use the IVT
- Situations when drivers choose to or avoid use of the system
- Effects on speed
- Behaviour when using the IVT
- Knowledge of IVT functionality
- Advantages and disadvantages of using the system
- Suggested improvements for the system.

1.1.1.2 Web-based questionnaire

A standardised web-based survey was used as the research method for gathering information from a large (N=7677) group of drivers about their experiences of the use of in-vehicle technologies. The survey was carried out in 2010 in nine countries: Australia, Austria, Czech Republic, Finland, France, Netherlands, Portugal, Spain and United Kingdom. The questionnaire started with screening questions to select the target population (the participants had to be active drivers and users of at least one of the studied IVT systems). The characteristics of the target sample (e.g. gender and age groups) were not pre-defined because one of the aims of the study was to select a natural sample of the users of in-vehicle technologies. The background questions included socio-demographic topics and questions on driving behaviour. For each system, the questions covered usage of the system, the total time of use, frequency and average amount of use, contexts of use, and opinions about the system.

1.1.1.3 Naturalistic driving study

In total, 30 vehicles comprising thirteen different specific vehicle models were equipped with instrumentation to provide the video and driving data that would be used to study naturalistic driving behaviour. This aspect of the study was conducted in 2011/12 across seven countries: Czech Republic, Finland, France, The Netherlands, Portugal, Spain and the United Kingdom and a total of 92 participants were recruited to drive the vehicles as part of the project. At the end of each participant's study period, the driving data was downloaded and aggregated into a central data store. A total of 3,031 hours of driving data was collected, spanning 138,881km. After data collection had been completed, this data store was interrogated in order to test our hypotheses about drivers' use of IVT.

A data acquisition system (DAS) was fitted to study vehicles for the naturalistic driving study. The DAS used an array of different monitoring devices to capture information about the way the driver was controlling the vehicle and their use of IVT. It used cameras, GPS, accelerometers, infra-red sensors, GSM sensors and pressure sensors to monitor driver activity.

Input from all sensors was co-ordinated by software and recorded onto a PC, securely mounted in the boot of the study vehicles. The visible components of the DAS were designed to be minimally intrusive to encourage participants to engage in their normal driving activities. A few of the vehicles used for the study were already available from project partners' car pool. The majority of the vehicles were hired for the duration of this part of the study. The DAS was installed at the start of this period and removed at the end.

Participants were recruited from the general public in each country, organised by each partner. Before commencing their participation, each driver signed their agreement to the legal and ethical principles of the project. Each participant drove their study vehicle for a period of three to six weeks to enable collection of driving data for a range of different trips in which it was anticipated that IVT use would be observed. Participants were paid an amount (different in each country) for their time and expenses in taking part in the study.

A data analysis tool was developed to detect specific triggers in the data relevant to the study hypotheses. For example, sensors monitoring use of the NS would determine the specific regions of the data when the driver was interacting with the NS. This made the data analysis task significantly more efficient. Partners in each country running the naturalistic driving study had trained observers responsible for operating the analysis tool and coding specific items of interest within the recorded video and data materials.

1.1.1.4 Observational driving study

All partners completing the naturalistic driving study also conducted structured observations of two extended drives within each participant's time driving a study vehicle. Participants were asked to complete two drives on a pre-defined and standardised test route. Along this route, they would be asked to use the IVTs for a specific period. These drives were designed in accordance with the approach of the Wiener Fahrprobe Viennese Driving Test or VDT). This validated instrument for examining driver behaviour formed the basis of the observational driving study, enabling IVT use to be evaluated in more controlled situations. In each drive, the participants were observed by two observers with different responsibilities. The 'coding observer' concentrated on recording standardised errors with the help of an observation sheet. The 'free observer' recorded behaviour that could be foreseen systematically, and this included information about communication behaviour with other road users and conflicts.

In total 91 participants from, Czech Republic, Finland, France, the Netherlands, Portugal, Spain and United Kingdom participated in the driving behaviour observation study. The test route was divided into four main parts, one for each IVT system tested. During one of the drives drive the participants were asked to use the NS on one part of the test route and to answer some questions by phone on another part. During the other drive the participants had to use the CC system as well as the SL or the SA systems the other parts of the test route. On the sam e section of the route, participants were therefore observed using the IVT system once and without any IVT systems. The NS and the use of the MP were tested in all countries. The behaviour while using the CC were observed in six countries (all except the Netherlands). The SL was used in three countries (France, Portugal and Spain) and the SA in two countries (the Netherlands and United Kingdom).

1.1.1.5 Cross-country comparisons

In each of the study approaches described, results were aggregated across countries to determine whether any general trends in IVT use were observed internationally. Results were also compared between countries to investigate cross-cultural differences in IVT use.

1.1.2 Key results

1.1.2.1 Results from focus groups

Cruise control

Participants suggested that they use CC when traffic conditions are light, on motorways and on straight roads. When questioned about the circumstances in which they avoid activating the device, drivers mentioned specific situations, including: when driving in heavy traffic or a traffic jam and when driving in urban areas.

Despite the broad variety of answers regarding the choice of speed, participants reported driving at higher speeds when using CC, and also noted a tendency to exceed the speed limit when using CC.

Participants mentioned that the main advantages of CC were improved physical and mental comfort and increased safety since more concentration can be given to the road. In addition, some drivers viewed CC as a fun factor and this is considered an advantage of the system. Participants considered that the drawbacks of CC were: less efficient braking due to the foot being away from the pedals; and the monotony that the activation of the system can bring.

Participants also reported dangerous situations that can arise from use of CC: attention loss; speeds that feel too fast and uncomfortable for certain road configurations; and selection of the wrong pedal when attempting to brake while CC was active.

Standard drivers use CC in their own cars less than 50% of the time and more than 50% of the time in other vehicles. Young drivers use the CC in other vehicles more than 50% of the time and less than 50% of the time in their own car. This may mean that young drivers have more contact with this system when driving their parents' vehicle or in professional vehicles.

Participants felt that CC should incorporate the management of the headway distance to the lead vehicle, which would require a system upgrade, to Adaptive Cruise Control (ACC), instead of an improvement to CC.

Speed limiter

Compared with CC, fewer participants stated that they used the SL. The results of the FG discussions highlighted the importance of the effect that the situational context in which the SL is used has on driver behaviour, particularly regarding the regulation of speed according to the legal limits. Participants mentioned that urban areas and places with speed controls were the main situations in which the SL was used.

Non-use of SL was frequently reported. Some participants reported that they did not like the SL at all, some reported not feeling the need to use it and some stated not knowing how to use it. Apart from a lack of awareness of the general functionality of SLs, there was also ignorance of some specific functions such as activation of the last set speed and emergency deactivation of SL. Compared with CC, the speeds set on the SL were noted as being closer to the legal limit imposed on a particular section of road.

The most commonly stated advantages of using SL were the reduced risk of getting fined for speeding and avoiding driving too fast due to distraction. The main disadvantage considered was related to drawbacks regarding emergency deactivation.

Navigation system

Regarding the use of NS, it was pointed out that the driving context has a clear impact on its level of usage. The main use reported was the search for unknown locations, to a great extent during holidays and travelling abroad. Moderate utilisation was also stated by users to reach familiar destinations when seeking the best route or for alternative solutions to the usual one. A point of concern is the moment chosen by drivers to input the destination in the NS. In fact, during the FG sessions, it was mentioned that this operation is performed both before and during driving.

A relevant point for the discussion was also the mechanism selected by drivers for the delivery of the information provided by the NS. The most preferred solution was the combination of auditory and visual feedback. Auditory feedback only was favoured by some participants. Concerning the latter option, the time required for the drivers to look at the instructions can be different according to the driving context (unknown location, traffic conditions, etc.) and it can have, therefore, different consequences on the driving task.

Participants stated that dangerous situations were created by inaccurate information delivered by the system and by the distraction that the device could create.

The nomadic nature of NSs was for some drivers stated as a positive aspect because the device could be used in several cars and other modes of transportation. On the other hand, this portability was also considered as a drawback due to the need for a power connection and windscreen/dashboard mount plus the possibility of the device being stolen (especially if left visible in the car). Other stated disadvantages mainly related to the inaccurate, uncertain, and out-ofdate information that the some NSs can transmit. Moreover, when the surrounding environment is too complex, some drivers reported finding that the NS drew excessive attention, to the point that they would avoid using it.

Mobile phone

Drivers use MP in a variety of situations and for a variety of reasons. Even being conscious that some forms of interaction are forbidden, they recognize a number of advantages of using a MP while driving. During the FG sessions participants confirmed use of a MP when a hands-free system is not connected. Hand-held MP is prohibited in all countries where the FG sessions were conducted so it can be inferred that either drivers do not know the relevant law or are aware but choose not comply to with it. A result that supports this assertion is that a large group of participants suggested that the presence of a passenger influenced the way they interact with MP. Passengers can provide help while interacting with the MP in a handheld mode but would provide little assistance if they were using a hand-free system.

Besides phone calls, some drivers reported that they read and send text messages, even if only when the car is momentarily stopped. Sending text messages was considered more difficult than reading messages. It is important to consider that more than half stated to have dealt with text messages at least once in the preceding year.

In general, participants from all countries seemed to recognise that the MP induces distraction but not all participants felt that this caused their driving performance to be impaired. That they feel unimpaired may be due to lack of information about the subject and/or due to the way these drivers interact (or not) with the MP.

The suggestions for improvements indicated that drivers felt it important to make interaction with the device easier (this includes connection to the hands-free system as it was stated that this should be always automatic and require no additional tasks). Ways to reduce discomfort while interacting with the MP were discussed, such as the possibility of informing incoming callers that the MP owner is driving or a system that reads incoming text messages aloud on demand.

-verall comments on IVT use
Some common opinions and strategies were reported towards all systems in the study, across the different sessions. When asked about the way they learned to use IVTs, drivers frequently mentioned "learning by doing". Less commonly reported were learning with another user, with the car seller or consulting the vehicle owner's handbook.

In general terms, it was reported that passengers might influence the way in which drivers interact with IVT. While some stated to use the system to satisfy a request of a passenger (to control speed for example) others mentioned that passengers have no trust in the device or believe that it is a negative influence, and ask drivers not to activate it. Drivers may be deterred when it comes to the MP use, especially when the topic of conversation needs to be maintained undisclosed or when passengers represent somehow an authority (e.g. parents of young drivers).

1.1.2.2 Results from questionnaire survey

Cruise control

41% of the respondents reported that they use CC; 5% of these were users of Adaptive Cruise Control (ACC). The majority of users considered themselves to be regular users of CC – meaning that they use the system at least once a week. Based on the frequency of use of CC, it was estimated that the CC usage over time was approximately 46%. Men were typically regular or frequent users of CC, and women were most often regular or occasional users. Young drivers reported less frequent usage of CC than others.

-ver half of the respondents reported that when they use CC, they select the speed that is equal to the legal speed limit. 23% of all users of CC answered that they select a speed that is above the legal limit (most often 0-5 km/h over the limit), and 13% select a speed that is below the legal limit.

The main benefits of CC were that it helps to control speed and improves the comfort of driving. It was also considered useful in reducing speeding. The participants reported that CC was considered most useful on motorways, during long trips, in clear weather conditions, when there are speed checks by the police and in conditions of light traffic. On average, the usefulness of CC (calculated as an average of all ratings between '0' and '5' given to the system) was 2.7. Over 80% of the respondents agreed that the system is useful and easy to use and it functions logically. Most users were satisfied with the functioning of CC. The respondents agreed that CC helps to maintain constant speed, makes driving easier and allows the driver easily to regain the control over the car when they want to switch off the system. However, almost 30% of the users thought that CC is unreliable, causes driver distraction or takes the control of the car from the driver, and the same proportion of the users found it difficult to understand how the system works.

Speed limiter

SL was not commonly used among participants: 70% of all participants said that they didn't have SL. 18% of respondents indicated to be users of the system, and about 44% of those users had been using the system for less than 2 years. 38% of users reported that they used the system regularly, approximately 42% of driving time. 57% of the users were male and 43% female, which was the greatest difference between the genders in the usage rates of the systems studied. 59% of users belonged to the age group '26-45 years old'.

-ver half of the users of SL reported that they usually choose the speed equal to the legal speed limit when they are using the system. If setting the speed above the speed limit, most of the drivers set it 0-5 km/h over the limit.

The main benefits of the SL were that it helps to control speed and to reduce speeding. It was also considered as a system that improves the safety of driving. Some respondents thought that the system is good in improving the comfort of driving and reducing fuel consumption. The system was thought to be most useful when there are speed checks on the roads, in long trips, on motorways, in daytime and when the weather conditions are clear. Over 75% of the users thought that SL is useful, easy to use and functions logically and faultlessly, makes driving easier, makes it easier to concentrate on the driving task and they were satisfied with the functioning of the system. Respectively, less than 30% the users of the system thought that SLs were unreliable, cause driver distraction and take control of the car from the driver, and they also thought it is difficult to understand how the system works. The usefulness of the SL was 3.1 (calculated as an average of all ratings between '0' and '5' given to the system).

Speed alert

SA was not very commonly used in the countries participating in the survey. 32% of the respondents reported that they use SA. It was more often used as a function in NS than as an in-built system in the vehicle. 65% of the SA users reported that they used it as a function of their navigation device or MP, and 35% had a system that was installed in the car. 36% of the SA users used the system regularly. The estimate for the use of SA was that it is used approximately 40% of driving time.

-ver half of the users of SA reported that they usually choose the speed equal to the legal speed limit when they are using the system. The differences between the countries were similar than in the selection of speed while using SL or CC. If setting the speed for SL or SA above the speed limit, most of the drivers set it 0-5 km/h over the limit.

SA was considered to have the same benefits as SL and it was considered useful in reducing speeding and controlling speed. It was also thought to improve the safety of driving. The situations in which SA was considered most useful differed only a little from the situations in which CC and SL were considered useful. Most of the respondents thought that the SA was useful when they were driving at night-time, when there were speed checks, on long trips, on unfamiliar roads and on motorways. The usefulness of the SA was 3.5 (calculated as an average of all ratings between '0' and '5' given to the system).

Navigation system

81% of the participants reported that they use a NS. On average, they had been using the system for about 2.8 years. About 75% of the users answered that they had a portable navigation device. 13% of respondents were users of an in-built NS and 13% used a smart phone with a navigation function. These devices seemed to be used mostly occasionally (51% of all the respondents) and over 30% of the respondents reported that they use the system for the entire journey. 55% of the users of NS were female and 45% were male. This was an exception in the use of the systems: male respondents both had and used all the other systems more than female respondents. Men used navigation function of MP and in-built systems more often than women, and women preferred the usage of portable navigation devices. 56% of the users belonged to the age group '26-45 years old'.

The most common way of entering the destination in the navigation device was typing the town and street name. Selecting a pre-entered destination from the favourites or finding the address by entering a postal code were also common ways to enter the destination. The majority of the respondents avoided entering the destination in the NS when the car is moving, but quite a significant proportion of the drivers tended to do so.

The main benefit of the NS is that it gives good guidance information. The system also calculates good routes, and using the NS takes away the stress of finding the destination. The NS was considered most useful when the driver was lost, when the driver was driving on unfamiliar roads and when driving at night. Long trips and city roads were typical contexts for using the navigation. Navigation was also reported to be useful when the weather conditions are poor. The average usefulness of the NS was 3.3 (calculated as an average of all ratings between '0' and '5' given to the system). Over 75% of users of the NS agreed that the system is useful, easy to use, makes driving easier and provides clear and correct information. It was also notable that almost 25% of the users agreed with statements concerning unreliability of the NS and the difficulty in understanding how the system works.

Mobile phone

52% of the respondents reported that they have used a MP while driving. 61 % of them belonged to the age group '26-45 years old'. 37% of those who had used MP while driving indicated that they answer the phone calls while driving at least once a week; 26% also made phone calls at least once a week. The use of text messaging while driving was less frequent; however, 16% replied that they read text messages at least regularly, and 10% admitted sending text messages regularly while driving. 51% of the drivers reported that they use their phone only occasionally or rarely, and typically they use the phone for short phone calls while driving. 66% of the MP users had a hands-free system and about half of the respondents reported that they use the hands free system for all or almost all of their calls.

The users reported that they were more willing to use the MP when they were driving in familiar environments or on highways (nearly 40% or the users). The usage of MP was typically avoided in the following situations: when changing lane, overtaking or merging (71% avoided), when turning left or right or passing an intersection (70%) and in unfamiliar environment (70%).

1.1.2.3 Results from naturalistic driving study

Cruise control

The results of the naturalistic driving study revealed that CC was used in an appropriate driving context the majority of the time. When looking at the total participant sample, 66% of the time driving with CC engaged was on highways, 94% in weather not impacting driving behaviour and 89% in free flowing traffic. The rather substantial amount of time driven with CC on rural roads (25%) could be explained by the differences in road networks in different countries.

However, the results also indicate that CC was used in situations that are, according to the manufacturer specifications, inappropriate for CC; being used on urban roads for 9% of the time driven, 6% in weather impacting driving behaviour and 14% in constrained traffic.

Speed limiter

The results of the naturalistic driving study on SL are limited. The main reason for this is that partners had difficulties in finding participants that used SL (on a regular basis) and in finding B- or C-segment vehicles in their country that were equipped with the SL function. Two countries (France and the combined sample of Spain/Portugal) were able to include

SL in the naturalistic driving study. The share of time driven with SL on urban roads is slightly more than on rural roads or highways.

However, the amount of time driven with SL activated on urban roads might be an overestimate. During the data reduction phase of the analysis, it was observed that drivers often leave SL activated with an unchanged speed when changing to a lower order road category (e.g. SL was activated on the highway with a speed limit set at 130 km/h; when driving in an urban area, SL was still activated with this speed limit which is not relevant to the urban driving situation).

Drivers seem to differ in the way SL is used:
- Highway SL users: speed on highway is very homogeneous, 5 km/h above the legal speed limit. Not changing the speed limit when they change from highway to another road type.
- Rural roads SL users: Similar behaviour than the highway SL users. The speed limits are relevant for rural roads. No change in speed setting to the legal speed limit when driving from rural to urban area.
- Urban roads SL users: The entered speed fits the legal speed limit. Disengaging the SL when they leave urban area.

Navigation system

The NS was a commonly used in-vehicle system (IVS) in the naturalistic driving study. In the Dutch sample, 1% of all driving time was spent interacting with the navigation device. On average participants interacted:
- 12 times per hour when the vehicle was stopped
- 7 times per hour when the vehicle was driving slowly
- 2 times per hour when the vehicle was driving more than 10 kilometres per hour.

These results suggest that drivers strategically choose situations to engage a secondary task. These results show that although the intensity of interactions with the navigation device is highest when the vehicle is stopped, still half of all the interactions were performed when the vehicle was moving.

Mobile phone

The MP was a commonly used IVT in the naturalistic driving study. In the Dutch sample, 4% of all driving time was spent interacting with the MP and another 4.1% of all driving time was spent on MP conversations. The frequency of MP interactions was highest when the vehicle was stopped or driving slowly. When looking at the distribution of interactions over different speed categories however, the majority of the interactions with the MP (73%) were performed while the vehicle was moving. These results indicate that a substantial amount of driving time was spent interacting with the MP and talking on the MP in everyday traffic. Although the frequency of interactions with the MP is highest when the vehicle is stopped or moving slowly, the majority of all interactions were performed when the vehicle was moving.

1.1.2.4 Results from observational driving study

Cruise control

The CC was used on highways during the observation drives. After entering the highway the participants were asked to use the CC as much as possible and choose a speed for the CC on their own.

Most participants felt comfortable using the CC and had no problems using it (activating/deactivating, changing speeds with +/- buttons). Some of the participants who normally use another CC model in their own car claimed that they had problems using the system. Furthermore some of the participants complained about the user interface of the system. It was reported that a few participants selected a speed at the beginning of the CC section and hardly ever, or never, changed it till the end of the CC section. On the other hand some participants changed the speed in the CC quite often.

- Problems with handling the systems appeared when the user was not well acquainted with the system. The use of a CC type with functions and/or interfaces that differed from a participant's previous experience caused some discomfort.

The statistical analysis showed a significant difference between the drives with and without an active CC; participants drove too fast more often in the drives without using the CC. It was observed that one participant, even in the presence of the observer, set a much higher speed in the CC (up to 30 km/h higher) than the actual speed limit would allow. Due to the traffic situation, on some drives participants also selected speeds which were lower than the actual speed limit.

- The CC clearly helped the participants to keep the correct speed and avoid driving too fast. Participants also adapted their speed better to the traffic situation with the CC. However, CC did not prevent participants from driving too fast and to use the system in an undesirable manner.

With CC active, some participants adopted different feet positions. While some participants kept both feet on the pedals others put one foot or both feet away from the pedals, either near to the pedals (hovering over the pedals) or were resting them near to or under the driver's seat.

- The position of the feet while using the CC was not correct in all cases. Feet were taken away from the pedals and were even put under the seat. In emergency situations, when one would have to react quickly, such a position of the feet may inhibit timely and accurate response.

In most of the countries no major differences between the drives with and without an activated CC were observed. Only in the speed behaviour there was a significant difference between the drives with and without an active CC. However, in specific situations problems while using CC were recorded. In some of the observed overtaking manoeuvres participants aborted the manoeuvres as it took them too long to pass by another car and a faster car was coming from behind. Several overtaking manoeuvres took excessively long as the speed differences between the cars were not high enough.

- Especially towards the end of the CC section of the test route before leaving the highway, some participants had problems estimating the distance to the exit of the motorway which lead to late braking manoeuvres (even in the second lane), quick lane changes and late overtaking manoeuvres. In one case a participant even missed the exit.

Conflicts were only observed on the drives with CC activated and were all related to rear-end conflicts. Participants recognised unsafe closing speed to a vehicle ahead too late and had to brake hard in order to avoid an accident.

- In general only minor differences in driving behaviour with and without active CC can be reported. In addition, in specific situations (overtaking manoeuvres, exiting the highway, slower car in front) the participants either saw other cars too late or refused to deactivate the CC and to adapt their speed actively. On the other hand, speed behaviour according both to the limit and to the situation improved due to the system.

-verview of advantages and problems while using CC:

Advantages Problems
- System helps keeping the correct speed
- System prevents from driving too fast
- Good adaptation to the traffic situations - Problems using the system especially when it is not well known
- Problems with the interface of the system especially when the system is not well known
- Speed set in the CC depending on the driver ? higher speeds possible
- Position of the feet away from the pedals ? problematic in emergency situations
- Problems in specific situations when speed has to be adapted actively (overtaking situations, exiting the highway)

Speed limiter

The SL system was used on rural roads and in urban areas with different speed limits (30, 50, 70, 90 km/h). After entering the SL section the participants were asked to use the SL as much as possible and choose a speed for the SL on their own.

Generally, participants used the SL correctly and changed the SL threshold as soon as the speed limit changed. However, some situations occurred in which a participant stopped too close to the car in front as he took his attention away from the road while setting the speed on the SL. For another participant, the signal on the dashboard which indicated that the SL was active was mixed up with the fuel-status indicator.

- Some participants were confused using the SL, especially when the system was unfamiliar or had a different interface.

The speed set in the SL by participants was usually according to the actual speed limit. Although the hypotheses regarding speed behaviour when using the SL did not show a significant difference, more errors of driving too fast were observed on the drives without an active SL. In some cases it was observed that some participants, even in the presence of the observer, set a much higher speed in the SL (up to 30 km/h higher) than the actual speed limit would allow. Other participants either did not recognise the change of speed limit (e.g. from 70 km/h to 90 km/h) or set a lower speed than the actual speed limit. In fact, the standardised observation showed more errors regarding driving too slow. This leads to situations where car drivers from behind feel obstructed and sometimes overtake in an aggressive manner. Some participants only used one or two set speeds for the SL and did not change it to suit the speed limit that applied. Other participants used only two speeds, a higher one for rural roads and a lower one for urban areas.

- The SL clearly helped the participants to keep the correct speed and avoid speeding. The set speed for the SL was not always changed as soon as the speed limit changed. Furthermore, it did not keep participants from driving too fast or using the system in an undesirable way.

In most countries, no major differences in driving behaviour between the drives with and without an activated SL were observed, although more conflict situations were observed in the drive with an active SL. While 'only' one conflict with a cyclist was registered in the drive where the SL was disengaged, two right-angle conflicts, one rear-end conflict and one conflict with a car driver who suddenly opened the car door were observed on the drive with the SL active.

- An active SL neither positively nor negatively influenced the driving behaviour of the participants, although more conflict situations were observed while using the SL.
-verview of advantages and problems while using SL:
Advantages Problems
- System helps keeping the correct speed
- System prevents from driving too fast - Problems using the system especially when it is not well known
- Problems with the interface of the system especially when the system is not well known
- Speed set in the SL depending on the driver ? higher speeds possible
- Speed set in the SL depending on the driver ? change of speed limit not recognised (driving on with higher/lower speeds)

Speed alert

The SA system was used on rural roads and in urban areas with different speed limits. The SA function was used to warn participants when they were driving over the speed limit. On all drives with an active SA System the participants reduced their speed as soon as the system signalised that they were driving over the allowed speed limit.

- The use of the SA function seemed to have a good effect on the speed behaviour of the participants as an immediate reaction to the warning by adjusting speed was observed.
-only minor differences were observed by the free observer with regard to errors without the involvement of other road users on both drives, with and without an active SA System, but the statistical analysis showed a significant difference between the two drives with regard to longitudinal control. The participants were driving more often driving too close to the car in front when they were using the SA system.
- The SA system had a negative influence on the longitudinal control of the participants. A possible explanation could be that the participants intuitively expected that the system would warn them as soon as they drove too fast and therefore approached other cars faster, forgetting that SA would not react to situations, but only to the indicated limit.
-only minor differences between the two drives in the interaction with other road users were reported by the free observer. It was difficult to assign errors specifically to the use of the SA, except for the fact that the participants when using the SA system omitted the use the indicator much more often.

- The SA system had a negative effect in the sense that the participants much more often did not use the indicator in roundabouts and in turning situations.
-verview of advantages and problems while using SA:
Advantages Problems
- System helps keeping the correct speed
- System prevents from driving too fast - Problems in the longitudinal control
- Problems in the interaction, especially with use of indicator

Navigation system

The NS was mainly used in urban areas. On the drive with an active NS the participant had to follow the route guidance of the NS, while on the drive without the NS the participants had to find their way on their own.

One of the most common problems with and without the NS was that the drivers did not follow the correct route. With the NS this problem occurred especially at roundabouts; the participants often were not sure which exit to take. In other situations the route guidance was not clear enough so participants had to make late lane changes or merged at the last moment into another lane in order to follow the route correctly. Due to misinterpreting the guidance of the NS participants also missed the opportunity to turn. On the drives where the participants had to find the way on their own errors in the route finding were observed as well. Participants were driving slower on the drives when they had to find their way on their own, slowing to find and read direction signs. Some had to stop in order to consult the map once again. Also late lane changes were observed on these drives as participants were not sure where to go. However, the participants had to be corrected more often when they had to find their way on their own.

- Route finding with the help of the NS was better in comparison to when the participants had to find their way on their own. Searching for the correct way without route guidance is often combined to reducing the speed in order to have more time to find direction signs. The instructions given by the NS were not clear enough in all situations so that there were still some problems with route finding.

In other situations, participants were following the instructions given by the NS immediately, even when this was too early. This led to improperly early lane changes and erroneous use of the indicator before turning manoeuvres.

- In some situations the participants thought that an immediate reaction to the instruction by the NS was necessary. In some cases the guidance of the NS was not clear enough for an appropriate reaction of the drivers.

It was observed that the NS drew attention away from the road as the participants were checking the visual information provided by the NS display. In these situations the participants in some cases ignored yield or stop signs or waited at green lights, hindering others progress. Guidance information was also missed in situations when the participants were handling the NS.

- In some cases the NS was a source of distraction when participants were checking the visual guidance and were not looking on the road anymore. This can cause problems especially at intersections (stop signs etc.).

The conflicts (two rear-end and one right-angle conflict with a pedestrian) observed on the drive with NS active were clearly related to the use of the NS. In the rear-end conflict situations, participants were unsure about the route guidance and slowed down or were forcing their way into another lane in order not to miss the next turn. In both situations the car driver coming from behind had to brake hard. In the right-angle conflict the participant was looking at the NS and realised too late that the traffic light changed to red and forced a pedestrian to step back quickly.

- In general only minor differences in driving behaviour with and without an active NS can be reported. But the use of the NS created conflict situations either because the route guidance was not clear or the participants were checking the visual guidance, withdrawing their attention from the road.

-Overview of advantages and problems while using NS:

Advantages Problems
- System helps finding the correct route - Vocal guidance is not clear enough or misinterpreted (also leads to checking the visual guidance, thereby drawing attention away from the road)
- Vocal guidance is sometimes given too early and leads to an immediate (inappropriate) reaction
- Checking the visual display and handling the system draw attention away from road

Mobile phone

The MP was mainly used in urban areas during the observation drives. Most participants had no problems with driving and answering questions on the phone at the same time. Other participants stated that they felt uncomfortable having such kind of phone conversation while driving. It was also stated that this was a more difficult task than the use of the other IVT systems. A few participants also had to stop the phone conversation as they felt unsafe and wanted to concentrate on the traffic situation.

- It was not easy for all participants to have a phone conversation and to answer questions while driving. The conversation drew attention away from the road as the participants were concentrating on answering the questions. Especially in situation with higher traffic volumes this caused problems. Some even stopped driving in order to be able to talk on the phone.

Problems were also observed when the participants adjusted the hands-free kit of the MP. Some participants put both hands away from the steering wheel, others almost missed a turn.

- Handling the hands-free kit drew attention away from the driving task. The fact that two hands were used to adjust the kit whilst driving represents a clear safety risk. In emergency situations this could cause serious problems.

Some participants markedly reduced their speed due to the phone conversation. Participants had problems with keeping a constant speed while talking on the phone and lost awareness of the current speed limit.

- An influence of the phone conversation on the speed behaviour was registered. Participants had to concentrate on the phone conversation and compensated this by reducing speed. The additional task to talk on the phone led to the situation that participants had problems keeping their speed constant.

Route choosing errors were observed while participants were talking on the phone as they were distracted by the conversation. Participants missed turns, misunderstood the guidance of the observers and turned right instead of left or chose the wrong lane to drive on.

- The phone conversation also had the effect that participants did not follow the route correctly or misunderstood the guidance of the observers. It seemed that for some participants it was difficult to concentrate on the phone conversation and follow the guidance at the same time.

All conflicts observed during the drive with a phone conversation were caused by the driving behaviour of the participants while the conflicts on the drive without a phone conversation were caused by the behaviour of other road users.

- The additional task of having a phone conversation and being concentrated on answering questions caused critical situations during the observation drives. As the attention of the participants was on the phone talk they did not check enough if a lane change can be done in a save way or were driving too close to other cars and had to brake hard as the car in front slowed down. Furthermore they were ignoring the priority of other road users, who had to react to the participants in order to avoid an accident.

-Overview of advantages and problems while using MP:
Advantages Problems
- - Conversation draws attention away from the road leading to critical situations
- Handling the hands-free kit causes problems
- Speed behaviour while talking on the phone changes ? Slower, unsteady, sometimes also higher
- Problems in following the route guidance while talking on the phone

Cross country comparisons

The usage of CC varied quite a lot in the participating countries. 67% of the Australian drivers were using CC, but in Czech Republic usage rate was only 25%. The differences can be partly explained by the differences in the age of car fleet. In Australia, CC has been used for a longer time and by a larger proportion of respondents than in other countries of the survey. Almost 65% of the Australian respondents reported that they had used the system for more than 5 year (the average length of use was 7.1 years). Also in Finland both the usage rate (44%) and the length of use (4,9 years) were above the average. In UK and The Netherlands the usage rates of CC were below the average (31% and 30%); however, the system has been used for a long time in these countries (4.8 and 5 years). In Czech Republic both the usage rate (25%) and the length of use (3.2 years) were below the average. The proportion of frequent users (drivers reporting daily usage of the system) was highest in The Netherlands and lowest in France and Portugal. 55% of Finnish users of CC reported that they choose the speed above the legal limit, and about 25% of Czech and Spanish drivers choose the speed below the legal limit. These differences between the countries were statistically significant (p less than 0.01). In Portugal, Spain and UK also high exceeding of speed limits (over 16 or even 20 km/h) was reported. The assessed usefulness of CC varied between 2.5 (French) and 2.9 (Dutch); on average, the index was 2.7.

The proportion of SL users varied between 5% (Finland) and 36% (Spain). Users in Spain, Australia, UK and The Netherlands seemed to use the system more frequently than users in the other countries. The differences between the countries in speed selection for SL appeared to be similar than in the selection of speed while using CC. There were also drivers setting the system way over (more than 20 km/h) the speed limit: this was reported especially in UK and Spain. Automatic speed limit detection was used most often in The Netherlands. The British users of SL gave the highest ratings for the usefulness of SL, and the French and the Finnish gave the lowest. The values varied between 2.8 and 3.4.

The in-build SA was used mostly by Australian drivers (72%). In contrast to this, almost all (92%) of the Finnish users of SA were using it as a function of a NS or a MP. Dutch, British and Australian drivers gave more positive ratings for the usefulness of the system than drivers in other countries. The lowest ratings were given by the Finnish and French users. However, the differences between the countries were not substantial, the ratings varied between 3.2 and 3.6.

The proportion of drivers using a portable navigation device was highest in France, The Netherlands, and UK (above 80% in each of these countries). The use of a navigation function of a smart phone was most common in Portugal (20%), Finland (20%), and Czech Republic (18%). The use of in-built system was highest in Spain (19%). The proportion of respondents using NS frequently, at least once a day, was largest in Spain, (13%), Australia (11%) and The Netherlands (10%). Significant differences were found between the countries in the use of the system. Over 60% of the Dutch and about 50% of the Portuguese and UK drivers reported that they used the system for the entire journey whereas over 50% of the French and Austrian drivers used it for less than half of the journey. These results might also indicate that there are differences in the use of the system for different types of trips (long trips vs. short trips, trips to familiar vs. unfamiliar destinations, etc.); however, the question was asked in general level, therefore the results are only suggestive. Especially Finnish and French users of NS thought that the NS gave more accurate information about the driving speed than the speedometer of the car. Nearly 60% of the Finnish drivers preferred the speed information given by the NS.

MP usage varied a lot between the countries: 83% of Finnish respondents reported that they had used MP while driving. The percentage was lowest in UK (30%). Finland had the highest usage rates in voice calls, whereas Portuguese drivers reported sending/receiving text messages more frequently than other nationalities. More than one fourth of the respondents in Australia, France, Spain and UK reported that they never use their MP while driving. On contrary, even 13% of Austrian respondents reported that they typically use their phone for the whole duration of their journey. Although the use of the additional functions of MP was not very common among the respondents, the drivers in Czech Republic reported the usage of these functions more often than drivers in other countries. It needs to be kept in mind that Czech drivers were in general younger than the drivers in the other countries, and this naturally has effect on the usage of different MP features.

1.1.3 Recommendations and guidelines

Based on the analysis of the data collected, the following recommendations and guidelines have been produced.

1.1.3.1 Methodology: lessons learned and best practices (ME)

Approach

The FG interviews allowed researchers to have a rich overview about the ways in which drivers interact with the studied IVTs. However, the data collected was subjective and centred around participants' feelings, attitudes, opinions and beliefs about the systems which were based on their own experiences of using them. Therefore, recommendations that have been issued require confirmation from the results of the naturalistic driving study.

The internet survey was chosen as a data collection method because it is a more cost-effective method than traditional questionnaires and interviews. It was also considered an appropriate medium for reaching the target population: active users of new technology in general and, hence, IVTs. The chosen polling company worked as a subcontractor for VTT and in cooperation with participant panel organisations in the participating countries. One of the major disadvantages of the selected research method was that the national participant panels used for the drawing the samples were not identical in structure. For example, the size of the panel and the split of gender and age-groups were different in each country. Thus, the samples in the participating countries are not fully comparable to each other. However, the results can be used for comparing the user opinions on the studied systems, for designing the elements for the field tests and for planning further studies on the topic.

- ME1: Although each methodological approach had its own disadvantages, by drawing on the strengths of each approach, more holistic results could be obtained.

Car selection

A lot of the project time and resource in setting up the naturalistic driving study was spent in ensuring the DAS would successfully collect data from the thirteen different specific vehicle types selected across the project partners. Different models were selected to be most representative of vehicles from each country (Skoda for Czech Republic; Renault/Peugeot in France etc.). These differences created problems in the implementation of the DAS.

- ME2: Future naturalistic driving studies should either select the minimum number of vehicle models that is compatible with the purpose of the study and with the resources available to develop data acquisition systems appropriate for each vehicle.

Data collection and coding

Each partner was responsible for data collection, coding and analysis. The coding and analysis tools therefore had to be distributed by the lead partner and optimised to work on the computer systems used in each partner organisation. This created many compatibility issues. Similarly, video coding was performed by staff trained in each partner organisation. This possibly led to inconsistency in coding approach.

- ME3: It may be more efficient to have a single partner responsible for the data analysis and coding tasks following the data collection period in a collaborative naturalistic driving study.

1.1.3.2 Design and engineering (DE)

Different brands and models of vehicle use different interfaces to operate similar IVT functions. Conversely, sometimes different IVT functions are controlled by similar interfaces across vehicle models.

- RDE1: The design of the user interfaces for CC and SL should be standardised amongst car brands and models. This could improve ease of use of the systems. The functionalities of the systems should be explained in a more understandable and user-friendly way. Careful user-centred design is necessary for reaching this objective.

Issues were observed where IVTs designed to provide speed assistance could be improved by having greater awareness of the driving situation and by providing feedback in a more helpful and intuitive manner.

- RDE2: The following improvements for both CC and SL could improve safety and increase driver comfort:
  Detection of the changes of legal speed limit should be automated which could allow for speeds set for CC and SL to be adjusted accordingly. Information about the legal speed limit could be provided by NS if used.
  The systems should be made easier to use to reduce the danger of driver inattention and distraction.
  The different functions of the systems should be more logical to use.
- RDE3: The following interface improvements should be made for NS:
  The connection to satellites should be improved to allow for more accurate information and guidance.
  Information should be provided in an appropriate timescale to allow the driver to make decisions.
  Whether it is nomadic or not, the NS should be located in a position that allows for an easy and fast visual perception of the information presented.
  Vocal feedback should be provided when speech inputs are made.
  The user interfaces should be designed according to the needs of the ageing population (e.g. size of displays, clearness of visual and audio information, and comprehensibility of information).

A small but significant number of participants performed manual interactions with the NS system whilst the vehicle was moving at speed.

- RDE4: In order to prevent the driver from setting up the NS during driving, the system should be impossible to interact with while the vehicle is in motion or when stopped in traffic. A visual or vocal message should be presented to inform the driver about this. Although navigation systems provide warnings about this behaviour, it is easy to ignore these warnings.

Many drivers admit to using handheld MPs when driving in countries where this practice is outlawed.

- RDE5: The use of a speech recognition system incorporated into the hands-free system should be the only way the driver is able to make a phone call or send/receive text messages while driving. Using this function would prevent the driver from physically interacting with the MP. Vocal feedback should be provided in response to speech inputs.
Many MPs have the ability to detect motion or be configured in a 'Driving' mode – this could enable them to help the driver by managing incoming contacts.
- RDE6: When receiving a phone call while driving, an automatic voice message or text message should be sent to the inbound contact telling them that the recipient is driving.
Similarly, many MPs have location awareness through GPS. Linking this to a database of road/traffic complexity may enable the MP to manage the level of functionality available to a driver at any time.
- RDE7: Development of a system which takes into account the traffic and road situation and gives the driver a recommendation if it would be advisable or not to make a phone call.

1.1.3.3 Education and awareness (EA)

All the methodological approaches revealed significant numbers of drivers who were unaware of how to use IVT appropriately.

- REA1: Awareness campaigns should be developed, highlighting situations in which IVTs should and should not be used. This could include:
- Different speed limit zones
- Different traffic environments or driving conditions (average speed of the traffic flow, traffic density etc.)
- Different weather conditions
- REA2: Car dealers should provide information to buyers on the appropriate use of both CC and SL. However, the complexity of modern vehicles means that this is likely to be impractical. A built-in tutorial mode using the in-vehicle screen and accessible only improving drivers when stationary may be a good solution for use of IVT.

Typical driver training and testing regimes across Europe do not include components related to IVT use.

- REA3: Driver training for licence acquisition should include the use of IVT, which requires equipped cars to be available. This will allow drivers to have experience of using the systems from the beginning of the learning process. Learner drivers would also be able to get advice on how to use the systems safely.

The scope of the INTERACTION project was limited by the available resources but has provided useful insights into IVT use across Europe. Further work could strengthen these results and examine issue relating to the introduction of new IVTs in the latest vehicle models (e.g. collision warning/full auto brake systems; blind spot warnings etc.).

- REA4: The long term effects of the use on driver behaviour, performance, and traffic safety should be studied further. The INTERACTION project has provided a brief insight into driver behaviour with in-vehicle technologies, supported by focus group and questionnaire results. Further research is required to strengthen the results of the study and to take into account the continual progress of technology that is available to drivers. Based on the results of this study it is recommended to further investigate the use of IVT while driving and the risks involved. To study risk, a larger sample size is required and the relation with safety critical events need to be made. To study safety effects of interactions with navigation system and mobile phone, it would be of major interest to study glance behaviour and investigate differences in glance behaviour while operating such a system or having a phone conversation compared to baseline driving behaviour.

Many of the problems observed with IVT use related to misplaced trust in the technology.

- REA5: Awareness should be raised that the guidance of the NS might not always be accurate and that it would be better to miss a turn and allow the system to recalculate the route than to check the visual display for too long and risk a collision.

1.1.3.4 Legislation and enforcement (LE)

Vehicle manufacturers are making rapid progress in introducing IVTs that they believe make their vehicles safer, more comfortable and ultimately more appealing. However, the pace of this change makes it difficult to for legislation to cover all the systems and functionality that is introduced. Driver training, licensing and insurance regimes could be changed to manage drivers' exposure to IVT in a safer manner.

- RLE1: National and European laws regarding the use of IVT should be reviewed.
- RLE2: Training, licensing and insurance processes need consider the benefits and disbenefits that IVTs introduce into driving behaviour. Understanding driver risk through 'black box'/telematics systems in association with IVT use may provide insight into how this may be achieved.

1.1.4 Conclusions

The project has benefitted from the advantages of each approach, enabling a holistic analysis of drivers' behaviour in relation to IVT use.

Focus group sessions provided an overview of participants' feelings, attitudes, opinions and beliefs regarding the use of the targeted systems and the related safety and comfort issues. It was found that drivers admitted to engaging in potentially distracting and illegal activities with IVTs and misuse of IVTs was reported. This is indicative of behavioural adaptation – where a system provided for safety and/or comfort (e.g. CC) is misused resulting in adverse unintended consequences (e.g. taking corners too fast).

Larger scale assessment of drivers' opinions on IVT use was obtained in the questionnaire that surveyed opinions of more than 7,500 European drivers who used IVT. It provided an estimate of the extent and type of IVT use across the participating countries and the relative frequency of some of the undesirable behaviours identified in the focus groups.

These focus group and questionnaire approaches provided insights that helped in the formulation of the hypotheses that would be tested in the naturalistic and observational driving studies, carried out in seven countries: Czech Republic, Finland, France, The Netherlands, Portugal, Spain and United Kingdom.

The naturalistic driving study was the most challenging and complex part of the project resulting in the collection of data on the everyday driving and IVT use of nearly 100 participants from 30 different vehicles across seven different countries with more than 3,000 hours of driving recorded. It identified key results such as the frequency, location and speed at which drivers choose to use the various IVTs – for example, how drivers typically interact with their MP four times per hours when travelling at more than 10km/h and the majority of MP use is while the vehicle is travelling at speed.

The observational driving study observations with the help of the 'Wiener Fahrprobe' gave insight into the behaviour of the participants while using different IVT systems. Specific results for each system could be reported. Especially the descriptions of the free observers showed how the participants were handling the systems, how the driving and interaction behaviour changed while using it and how the participants acted in the frame of communication processes ranging from friendly interaction to severe traffic conflicts. Thus it seems legitimate to say that the observations give a good overview over the influence of the IVT systems on the driving behaviour and especially on the communication behaviour. These aspects of behaviour – interaction with others – cannot be registered nor analysed systematically with any other method. The results of the driving behaviour observation could therefore provide information in order to develop the above mentioned guidelines.

The results of the INTERACTION project led to the development of the recommendations and guidelines. They cover methodological issues; design and engineering; education and awareness; and legislation and enforcement. The recommendations are relevant to legislative bodies, research institutes, driver training organisations, insurance companies and vehicle manufacturers alike.

Potential impact:

1.4.1 Main dissemination activities

General dissemination

- The website is at http://interaction-fp7.eu
- The first issue of the project newsletter has been published in February 2011. The final issue will be published in March 2013.
- Interaction is presented on CORDIS, the European Commission's official information service for Research & Development, since the 15/04/2011. The project has been selected to have its research results published on the website. It has also been selected for special promotion on Technology Marketplace.

http://cordis.europa.eu/fetch?ACTION=D&SESSION=&DOC=1&TBL=EN_OFFR&RCN=6527&CALLER=OFFR_TM_EN

Special session

- INTERACTION Special session (Milestone 12)
- ETC 2010, Glasgow, 11-13 October 2010

A special session named 'Understanding driver interactions with In-Vehicle Technologies: Mid-term results of INTERACTION FP7 project' was organised with the support of the European Conference of Transport Research Institutes (ECTRI). Interaction was registered for the special session on month 18.

The aim was to promote the project objectives, to present and discuss the intermediate results based on self-reported behaviour analysis and to get stakeholder feedback on the coming investigations based on the observation of In-Vehicle Technologies use behaviour. The exchanges with the audience were extensive and fruitful. The operational outcomes of INTERACTION for the automotive sector have been highlighted by the attendees.

- Presentation of INTERACTION during special sessions
1. Presentation of INTERACTION methodology during the session "Ongoing Naturalistic Driving projects in Europe", Organized by SWOV, at the European ITS congress, Lyon, 6-9 June 2011.
2. INTERACTION results concerning drivers' interactions with mobile phone have been presented at the 19th ITS World Congress, in Vienna, Austria, in October 2012, during the session SIS86 - Cognitive Load and In-Vehicle Human-Machine Interaction.

Papers

INTERACTION was presented by Ralf Risser of FACTUM, during his presentation on 'Behaviour observation in order to explain automatically collected data' at the 22nd ICTCT workshop 22/23 october 2009 in Leeds, U.K.

INTERACTION was presented by INRETS at the PROLOGUE and DACOTA workshop, on the 26th of october 2009, in Brussels

Human Centred Design for Intelligent Transport Systems conference, Berlin, 29-30 April 2010

Three papers were presented at the second HUMANIST conference and published in the proceedings of the conference:
1. 'The reality of in vehicle technology European market and its impact on research investigations', by Arnaud Bonnard et al.
2. 'A focus group approach towards an understanding of drivers' interaction with in-vehicle technologies', by Marta Pereira et al.
3. 'A comprehensive approach to investigate the patterns of use of in-vehicle technologies' , by Corinne Brusque et al.

Tenth Spanish congress on Intelligent Transport System, 11-13 May 2010. (CTAG)
'Analisis de los efectos en el comportamiento del usuario derivados del uso continuado de sistemas ITS en vehículo. Proyecto INTERACTION', by CTAG.

2nd International Conference on Driver Distraction and Inattention, Gothenburg, September 2011
Simultaneous use of in-vehicle technologies: what is happening in real-life situations? Pereira M., Bruyas M.-P., Kaufmann C., Britschgi V., Diez Gil J.-L., Zaoral A.

6th Workshop of ICTCT 'City Traffic and ITS: Commitment of Authorities', Companies and Citizens, Tokyo-Chiba, May 2011
The use of Intelligent Driver Support Systems. Empirical results from the EU-project INTERACTION. Risser R., Kaufmann C.

24th ICTCT workshop in Warsaw, Poland on 27th & 28th October 2011
'The use of different IVT-systems – results from focus-group interviews from the EU-project INTERACTION' Clemens Kaufmann
The workshop topic was "Traffic safety management - Tackling the problems in urban areas and at other hot spots".

World congress on ITS 'Keeping the economy moving', Orlando, October 2011
Use and Potential Safety Effects of In-Vehicle-Technologies. Penttinen M., Rämä P., Britschgi V.

Five conference presentations related to INTERACTION project was prepared by VTT, IFSTTAR, ADI and FACTUM for the HUMANIST conference that was held in Valencia, Spain, June 14-15 2012. The four first papers were also published in the conference proceedings.

1. Britschgi, V., Rämä, P., Penttinen, M. (2012). Finnish drivers and the use of in-vehicle technologies – .comparison of the results of the focus group study and the internet survey. In P. Valero Mora & J.-F. Pace (Eds.), Proceedings of European Conference on Human Centred Design for Intelligent Transport Systems. (pp. 29-37).HUMANIST VCE.
2. Brusque, C., Bonnard, A., Hugot, M., Lancelle, Valérie, & Tattegrain, Hélène. (2012). Using naturalistic driving data to estimate speed behaviour indicators: methodological issues. In P. Valero Mora & J.-F. Pace (Eds.), Proceedings of European Conference on Human Centred Design for Intelligent Transport Systems. (pp. 209-216). HUMANIST VCE.
3. Ferreira, A., Piccinini, G., Rôla, S., Simões, A. (2012). Perceptions of Portuguese drivers about the usage of mobile phone while driving. In

P. Valero Mora & J.-F. Pace (Eds.), Proceedings of European Conference on Human Centred Design for Intelligent Transport Systems. (pp. 131-137). HUMANIST VCE.

4. Christoph, M. van Nes, N., Wesseling, S. (2012). The effect of auditory route instructions of navigation systems on glance behaviour of drivers driving on the motorway. In P. Valero Mora & J.-F. Pace (Eds.), Proceedings of European Conference on Human Centred Design for Intelligent Transport Systems. (pp. 113-120). HUMANIST VCE.

5. Kaufmann, C. & Risser, R. (2012). The Interaction with IVT-systems – Preliminary results of driving behaviour observations from the EU-project INTERACTION. Oral communication in the European Conference on Human Centred Design for Intelligent Transport in Valencia, Spain on 14th & 15th June 2012.

Ferreira, A., Piccinini, G., Rôla, S., Simões, A. (2012).The influence of Speed Regulating Systems on speed compliance in a sample of Portuguese drivers: A naturalistic driving study. Oral communication in 4th Internacional Applied Human Factors and Ergonomics Conference in San Francisco.

SWOV presented a paper entitled Manual interactions with its while driving: naturalistic driving observations on mobile phones and navigation system at ITS World congress in Vienna on October 2012.

Clemens Kaufmann gave a presentation with the title 'The Interaction with IVT-systems – Results of driving behaviour observations from the EU-project INTERACTION' at the 25th ICTCT workshop in Hasselt, Belgium on 8th & 9th November 2012. The workshop topic was 'Road safety in a globalised and more sustainable world - current issues and future challenges'.

Papers published in a book

Huth, V., Lancelle, V., Gabel, C., Bonnard, A., & Brusque, C. (2012). Exploring mobile phone usage and its context with naturalistic driving observations. In D. de Waard, K. Brookhuis, F. Dehais, C. Weikert, S. Röttger, D. Manzey, S. Biede, F. Reuzeau & P. Terrier (Eds.), Human Factors: a view from an integrative perspective, on the occasion of the Human Factors and Ergonomics Society Europe Chapter Annual Meeting in Toulouse, France, October 2012. (pp. 16). Available from http://hfes-europe.org.

Papers to be published in a scientific journal

Ferreira, A., Bianchi Piccinini, G., Rôla, S., Simões, A. (2013). Gender and age-related differences in the perception of in-vehicle mobile phone usage among Portuguese drivers. IET Intelligent Transport Systems. Special issue in Human-centered design (accepted).

Pereira, M., Bruyas, M.-P., Kaufmann, C., Britschgi, V., Diez Gi, J.-L. and Zaoral, A. (under correction). Reported use of speed control systems: cruise control and speed limiter. IET Intelligent Transport Systems journal.

Presentations of the project

Half-yearly follow-up meeting of the research program for transport telematics, Finland (VTT), December 3rd 2010.

Prologue stakeholder meeting, Rotterdam November 23rd 2010, (SWOV) (around 60 attendees from NL and Belgium).

UK Department for Transport presentations on current EC projects, August 12th 2010. (TRL).

FotNet meeting, presentation by SWOV (Orlando, 2011)

Presentation at the final Workshop of PROLOGUE, Vienna, Austria, 22nd June 2011

Presentation of the project to the HMI group of the French automotive cluster Mov'eo, by ERT, on 17 May 2011

Presentation of the behaviour observation platform at the IFSTTAR Booth (Posters and DVD) at the European ITS congress, Lyon, 6-9 June 2011.

During NVVC-Dutch Road Safety conference, 19th April 2012, both presentation of the Interaction instrumented vehicle at the SWOV booth and in the short movie from SWOV to be presented at the plenary session of the conference.

Pre-sales meetings: various mentions of the INTERACTION system setup and functionalities by Intempora.

The new INTEMPORA company website will be more modular and will allow presenting more easily particular products or project achievements next to the main generic commercialized product. The INTERACTION project achievements concerning the DAS acquisition software and the video made by IFSTTAR will be presented there as well.

A poster on 'Personality of the driver in the context of improving traffic safety' was presented by CDV on 7.Dec 2012 at the Palacký University of Olomouc, Czech Republic

CDV presented the experimental car used in the Naturalistic driving studies during a Workshop and exhibitionat on the 5. June 2012 at the INSTITUTE of TRANSPORT of Czech Republic.

CDV presented the Progress and methodology of INTERACTION project during a Workshop on Human factors at Honeywell on 11. May 2012.

Articles in newsletter

FOT-NET newsletter - INTERACTION has reached its mid-term
An overview of international Naturalistic Driving Studies and Naturalistic FOTs was given in the issue 6 of the FOT-NET newsletter published in December 2010. INTERACTON was one of the projects presented.

PROLOGUE newsletter – INTERACTION, naturalistic driving activities to start in spring
The issue 3 of the PROLOGUE newsletter published in January 2011 announced the launch of the Naturalistic Observation of INTERACTION in Spring 2011.

FOT-NET newsletter (September 2011)

IFSTTAR has an article about INTERACTION to be published in the TRAJECTOIRE MAGAZINE, n°5 of April 2013.

Media performances on television (SWOV)

http://www.rtl.nl/components/actueel/rtlnieuws/miMedia/2010/week26/za_1930_camera_in_auto.avi_plainml

http://www.eenvandaag.nl/binnenland/36489/sms_en_is_dodelijk

1.4.2 Exploitation of results

In conducting the INTERACTION project there has been various foreground produced by each of the work packages:
- Methodologies
- Scientific productions
- Aggregated and segregated data
- Experimental device

The Consortium has defined the strategy and measures regarding the management of the project's intellectual property in a dedicated milestone document, which is binding for each partner.

It details the knowledge and intellectual property produced in the project, as well as the use of the project results from when they are produced and after the end of the project, particularly in terms of further research and commercial exploitation, between partner and between partners and stakeholders. It will facilitate further collaboration between partners on the same topic INTERACTION focused on.

Rules for the exploitation of the foreground:

The use of the results will vary according to the nature of IP produced and to its ownership, as follows:

Raw data:
- from the focus groups, the naturalistic observations and the experimental observations
- single ownership
- Each partner is responsible for its exploitation and protection

Aggregated data

- from the focus groups, the naturalistic observations and the experimental observations
- joint ownership
- A common aggregated database created
- Free access rights to all INTERACTION partners
- opened to others than Interaction partners, with public access, for free and one year after the end of the project on the website of the project

Hardware and software solutions

- CTAG's Event manager, INTEMPORA's Software and IFSTTAR's Video coding software and GSM sensor
- single ownership

- Paying access to the Event manager and Intempora's software, with better prices for INTERACTION partners
- Free access to IFSTTAR's devices

Common ownership

- documents leading to the production of the foreground in WPs 1 to 5
- no further exploitation of these documents is planned

Possible further exploitation of the foreground

Additional studies using the existing datasets are planned by partners, exploiting the information gathered within the project to investigate other interesting facets of driver behaviour and IVT use. Furthermore, there will be publicly available version of the aggregated INTERACTION data issued in 2014. This resource will enable researchers across Europe (and the world) to interrogate the data and evaluate different hypotheses about driver behaviour.

Partners have taken advantage of INTERACTION project and the data collection done to launch additional analysis in the framework of PHD thesis at SWOV and FACTUM, of Post(-doc works at IFSTTAR and of Master thesis at ADI.

Besides, the IP produces in WP3 by CTAG and INTEMPORA will lead to commercial exploitation, i.e. Event manager, Zigbee module and Power module of CTAG and Software Licenses of INTEMPORA.
The IP produced by IFSTTAR in WP3 will serve to the general advancement of knowledge. Indeed, the video coding software and GSM sensor will be available for future research.

1.4.3 Potential impact

INTERACTION developed recommendations and guidelines regarding use if IVT, covering methodological issues; design and engineering; education and awareness; and legislation and enforcement. They are relevant to legislative bodies, research institutes, driver training organisations, insurance companies and vehicle manufacturers alike.

Two main operational outcomes can be issued by stakeholders from these recommendations. They permit to define actions to strengthen drivers' awareness for the use of these technologies and for the consequences that such use has or may have. They also permit to better design future systems and appropriate instructions for drivers that will use them.

INTERACTION thus contributes to the reduction of the risks of systems misuses, of drivers' unsafe actions and in turn to increase the global benefits of in vehicle technology in enhancing road safety.

The results of the INTERACTION project led to the development of the recommendations and guidelines. They cover methodological issues; design and engineering; education and awareness; and legislation and enforcement. The recommendations are relevant to legislative bodies, research institutes, driver training organisations, insurance companies and vehicle manufacturers alike.

List of websites:

http://interaction-fp7.eu/