ADASE

Advanced driver assistance systems in Europe

ADASE 2 Expert Workshop on effects of ADA systems on safety, throughput and comfort

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1.0	01.07.2004	Final version, TNO, AVV & CETE

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Executive summary

On May 17-18, 2004 the fifth and final workshop of ADASE II took place at the properties of DaimlerChrysler in Stuttgart, Germany. The topic of the workshop was on ADAS effects on safety, throughput and comfort. The workshop was organized by the Dutch Rijkswaterstaat (AVV) and the French Ministry of Transport (CETE). The objectives of the workshop were:

- Disseminate the results of the previous ADASE 2 expert workshops on sensor technology, overall technology architecture, infrastructure design and communication systems, human machine interfaces and legal aspects within the research community.
- Provide a forum where a preliminary assessment of the effects (on safety, throughput and comfort) of ADA systems as mentioned in the deployment roadmap will be discussed. Moreover the workshop will deal with the needs, limits and barriers influencing the effects of these systems are identified.
- Focus on a policy framework, based on the overview of policy processes and priorities of the member states that are most actively involved in ADAS deployment. A vital goal is to find a common framework between public authorities and the automotive industry with concrete proposals for effective ADAS deployment.

The workshop started with a keynote speech of the European Commission, a presentation on the re- and preview perspective of European initiatives on ADAS and presentations on the previous ADASE II workshops. Next, the introduction on the impact assessment was given by a presentation of the ADASE II Roadmap and the presentation of the Introduction Paper. During an active part of the session, all participants have given their input on the impact assessment of six specific systems in the Roadmap. The first day was concluded by a discussion on the impact assessment.

The second day lead off with the presentation of the State of Policy. In two successive panel sessions, the points of views on ADAS from the National Policies and the Automotive Industries were presented and discussed.

Results from the workshop

Effects on safety, throughput and comfort

It is remarkable to see that the experts from the automotive industry, suppliers, policy people from national governments, researchers and consultants overall have a fairly common opinion on the effects of the presented ADA systems. The attendees of the workshop filled in pretty similar effects estimations. Although the automotive industry merely promotes their ADA systems as comfort improving systems, positive effects on mostly safety and also throughput are expected.

The Safe Speed and Following systems (with functionalities of Stop&Go, ACC/Stop&Go with Foresight and Curve & Speed limit info) are expected to have a very positive safety effect and also (but slightly lower) positive throughput effect. Effects on safety are here mainly on decreasing head-tail accidents. Safe Speed and Following systems have a very positive effect on comfort.

The Lateral Support systems (with functionalities of Lane Keeping Assistant, Lane Departure Warning and Lane change assistant) have mainly very positive effects on safety. These effects are mainly on decreasing singular and aside accidents.

To improve the knowledge on accidentology and the effects of ADA systems, harmonized accident numbers are needed to make good comparable assessments on the same information level.

ADA systems thus seem to have potential benefits on safety, throughput and comfort. Although the assessment is not a scientific one, the input of more then 60 European experts from several professional backgrounds has proven to deliver a worthwhile contribution to knowledge on effects of ADA systems.

Requirements and barriers regarding ADAS implementation

The main requirements that are needed for implementation of ADA systems are to give attention to the functionality (not everyone agrees if this should be 100% or not) and the user acceptance. The driver should be educated so they understand what the systems do and that the driver stays responsible for it's drivers task. Furthermore there are external information needs, such as route information or other information from road authorities and there are requirements for the infrastructure (such as good markings).

Looking at the barriers of market introduction, it is often mentioned that there should be more standardisation in technology and the price/value ratio should be more positive. How to deal with driver attentiveness, wide scale introduction in medium sized (and prized) cars, harmonization of ADA policies in Europe, liability issues and the availability and quality of data from external sources are also often mentioned as barriers.

Policy issues

The initial motivation of governments and automotive industries in relation to ADA systems is different. Most car manufacturers promote ADA systems because it improves comfort of the customer and the policy makers are interested in these systems because of the expected positive impact on road safety and throughput (and also environmental effects). ADA systems are not very high on the policy agenda across Europe. Nevertheless governments have intentions to promote these systems when effects have been proven, on the other hands effects cannot be proven if there is no (large scale) deployment of these systems.

The visions amongst the delegates of the EU member state countries Sweden, Germany, the Netherlands, the United Kingdom, France concerning road safety are different and so is the usefulness of ADA systems for road safety. Less accidents and better safety (with better throughput) is the main objective in several countries, the means how to get there can be different.

Technology can help there, it should be problem solving for governments. There is for instance a difference in the way speed enforcement should be used to reach these goals. ADA systems can be beneficial, as long as the effects can be proven. Automotive industries see the comfort aspect of ADA systems as a selling point, due to liability issues it is not favourable to sell them as safety systems (although they can help for that matter). If ADA systems also are implemented with communication aspects (vehicle to vehicle or vehicle to infrastructure) it would be wise to have a European wide understanding and agreements on ADA visions between the EU countries. Also the common goals of the governments and automotive industry can be stimulated by setting up common frameworks for research and implementation and experience more with Field Operational Tests in order to let people experience the ADA systems and better estimate effects.

Overall recommendations

Standardized and harmonized methods of accident causation analysis should be based upon an agreed European accident database.

Concerning liability issues it seems wise to let the driver always be responsible for it's driving and not let the driver be completely out of the loop.

Regarding the safety and comfort motivations of ADA systems governments and automotive industries should try to reach a common understanding and strengthen each other with their goals. It is interesting to find out if comfort improving systems in itself have also a positive effect on safety.

Field Operational Tests (FOT's) can have a lot of benefits for awareness and expectation management of the benefits of ADA systems for society. In order to reach each others goals the organization of Field Operational Tests can be a good way in which the governments and (automotive) industry can create more knowledge.

Establishing an European governmental platform on Intelligent Vehicles would be helpful to let EU governments learn from each other, develop, create and interact with their visions on intelligent vehicles and be a EU wide counterpart for the European Commission and automotive industries. Especially when more systems with communication applications (for instance between vehicles and infrastructure) are being developed, this is a efficient way to interact and harmonize between each other and with the automotive industry to strengthen the potential of ADA systems.

1 Introduction

Advanced Driver Assistance systems in a road vehicle (also referred to as active safety systems) are systems that support a driver in his driving tasks, e.g., to maintain appropriate speed, headway or heading or to prevent accidents. ADA systems are believed to have a strong potential to improve traffic safety. For the introduction of ADA systems, a holistic approach is needed, integrating different R&D disciplines and integrating the interests of the different stakeholders that are involved.

ADASE-II is an EC IST funded thematic network that will help to introduce and implement active safety systems by offering a platform to achieve the required holistic process and therefore to have all major players in the ADASE II environment involved. Partners in this project are a cross-section of the European automotive industry, suppliers as well as government representatives. To achieve its aim ADASE-II covers a comprehensive range of activities. One of the activities is organising workshops, to meet and discuss with relevant players and main actors about the latest developments, gaps, bottlenecks and opportunities for ADA systems around key issues.

The fifth and final workshop of the ADASE-II project was held in Stuttgart, Germany on May 17-18, 2004. It dealt with the impact assessment of ADA systems. The aim of the first day of the workshop was to obtain consensus about the effects of ADA systems on traffic safety, traffic efficiency and comfort. These results are integrated into the ADASE-II roadmap. Based on the results, also the 'white spots' in knowledge on effects are identified. The second day of the workshop focuses on the Policy Framework and leads to more insight in the relation between (potential) effects of ADA systems and policy issues in EU countries.

Moreover, on the first day an introduction was given by a keynote speech of the European Commission, a presentation on the re- and preview perspective of European initiatives on ADAS and presentations on the previous ADASE II workshops.

The workshop was characterized by plenary presentations, active input by all participants and panel sessions with discussion.

All items of the workshop will be presented in this report. The presentations are also available on www.adase2.net.

2 Keynote speech

Presented by Mr. Francisco Ferreira (European Commission)

Mr. Ferreira presented the eSafety Initiative of the European Commission. The eSafety Initiative aims to accelerate the development, deployment and use of new technologies for increasing road safety in Europe. It was launched in April 2002 and is a joint industry and public sector initiative. The presentation showed an overview of the planned meetings, the new working groups, the planned communication and the future intentions of the Initiative. The existing working groups are:

- Accident Causation Analysis WG
- The eCall Driving Group
- Human Machine Interaction WG
- Implementation Road Maps WG
- Real-Time Traffic and Travel Information WG
- Research and Technological Development WG
- International Co-operation WG

The new working groups in 2004 are:

- Heavy Duty Vehicles Working Group
- User Awareness

3 History – now – future perspective

Presented by Mr. Berthold Ulmer (DaimlerChrysler) and Didier Wautier (Renault).

Mr. Ulmer and Mr. Wautier gave a reflection on previous projects related to the ADASE issues. Mr. Ulmer showed the growing consciousness that technology is not the only issue in the development and implementation of ADA-functions. Also the mutual dependencies between the various actors (suppliers, public parties, car manufacturers and consumers) require attention. Therefore platforms are needed to facilitate the interaction between these actors and to develop a common understanding. PROMETHEUS was one of the first projects in which attention was paid both to the functionality of the systems and the technology in the system. This facilitated the interaction between the developers (interested in the technology) and the policy (interested in the functions). The ADASE I and II platform moved forward in the development of the holistic approach. By means of the developed roadmaps, architectures and standards, ADASE creates a solid basis for the required common understanding. Moreover, based these products and the organized cluster meetings, the platform is able to identify the (technology) gaps. These gaps are taken into account in the development of the next generation collaborations: in the integrated project PReVENT.

Mr. Wautier showed the change in the focus of the development of ADA systems; regarding the attention that was paid to the triptych "driver, vehicle and infrastructure/environment". The first systems focused on the driver or the vehicle; to assist the driver in it's driving task. Currently it is seen that also the infrastructure is taken into account to improve the performances. Mr. Wautier stated that attention should be paid to the business models and that all three elements of the triptych should be regarded. Moreover he stated the main lessons from the past regarding:

- Technology: a) intersystem requirements and b) use of fusion for low cost sensors
- Infrastructure: a) cooperation needed and cost to be shared, b) service models for introduction (since there is no business model for private vehicles) and c) information from the road needed.
- Driver: a) how to escape from "no extra payment for safety", b) define the rules for the actors and c) liability issues (legal frame for safety applications, since the liability is currently the biggest barrier for the introduction of innovative systems in vehicles).

4 Previous ADASE workshops

4.1 HMI and legal aspects

Presented by Mrs. Luisa Andreone (CRF)

The workshop on Human Machine Interaction and Interface, held in Brussels on October 28th 2002, has been organized by Centro Ricerche Fiat, and it has been hosted in the facilities of the European Commission.

The objectives of the workshop were to identify the research needs in the area of Human Machine Interface for Advanced Driver Assistance Systems (ADAS) and to identify technical and scientific gaps to be filled with respect to the current and expected R&D activities in this field. The three main clusters, identified within a brainstorming, indicate clearly the needs within the three relevant steps of the HMI research and development:

- the design and the integration phase (where an HMI is designed, developed and integrated into the vehicles);
- the evaluation phase (where the methods to assess both the usability and the acceptability of an HMI are applied);
- the supporting measures (which are related to the actions according to which the laws, the standards, the code of practices, etc. can tailor and handle the HMI design, development and test phases).

The collection of these needs will be then considered within the ongoing initiatives to build up a Human Machine Interface

Integrated Project (AIDE, coordinated by Volvo) that belongs to the initiatives organized by EUCAR in the Integrated Safety Program.

This workshop therefore represents a significant step to promote and focus the future HMI R&D activities in Europe.

4.2 Architecture and technology roadmap

Presented by Mr. Alain Servel (PSA)

According the transport white paper on road safety in Europe the number of 40 000 fatalities and 1.6 million injuries should be halved in the next 10 years.

Given the fact that vehicle safety in Europe is already on highest level this cannot be achieved by further improvement of board autonomous systems only. So we have to optimise the systems in a holistic consideration:

- the driver,
- the vehicle, and
- the road infrastructure.

Major benefits might be achieved by the interaction of all three of these components as such as: driver-vehicle, vehicle-vehicle and vehicle-infrastructure interactions.

This requires an ADASE architecture supporting in an evolutionary way the stepwise introduction of functions which lead to higher system performance and in the same way to an increase in road safety! First spin-offs of these functions are promoters for the future products and at the same way guarantee a quick win by scaling effects.

In the past electronic throttle enabled cruise control functions and together with electronically controlled brakes including the communication bus systems provided the introduction of adaptive cruise control systems. This led to early onboard architectures including the appropriate standards which not only enabled increased functionality, but also led to test and diagnostic capabilities as spin-offs.

In the present ADASE architecture workshop an extensive state of the art overview regarding the different onboard architectures and on board communication systems was given. Further needs regarding the reliability and handling of the safe development of such complex systems were identified.

On the other side ADASE activities regarding roadside equipment were presented and further functions for roadside based information- warning and traffic control systems were presented.

By their very nature Advanced Driver Assistance Systems (ADAS) have to be inter-operable across Europe (or even across the World). The combination of all components leads to an complex system approach were some of the critical boundary conditions (design, reliability, political, marketing etc.) aspects for the early product introductions were discussed. Especially the lack of public awareness has to be overcome in order to prepare the introduction. This also eases the preparation of the required standards.

As a consequence the European thematic Network ADASE 2 has as its objective to address the co-ordination and dissemination of Advanced Driver Assistance Systems that range from pure driver assistance functions to the integration of telematics services and infrastructure-vehicle interaction like applications.

One important tool to achieve the objectives is given by setting up European ADASE expert workshops managed by the partners of ADASE 2.

As one of the clearly identified needs for the future the extension of the ADASE road map regarding telematic and communication requirements was formulated. Therefore special requirements of communication will be discussed in the subsequent workshops. Together with this results a first concept on a ADASE open architecture will be developed.

This holistic ADASE approach as a fusion of the intelligent vehicle with the intelligent road and the intelligent driver-vehicle-interface by use of an globally interoperable open ADASE architecture will lead to a significant increase of traffic safety in Europe.

4.3 Infrastructure and communication

Presented by Mr. Guy Fremont (CofiRoute)

On February 5-6 2003, the third workshop of ADASE II took place in Paris France. The topic of the workshop, organized by Cofiroute, was Vehicle to Vehicle and Vehicle to Infrastructure communication. The objectives of this workshop were:

- Present the state of the art of:
  - Current communication technologies
  - Possible Architectures
  - Possible Services and Applications
- Establish the needs of Advanced Driver Assistance Systems (ADAS)
- Determine future actions and co-operative measures

The following conclusions were drawn:

- Applications providing informational content such as AIDA, RTA, or AHS are foreseeable in the near future. Probably based on DSRC (which benefits from the strong standardization and interoperability effort that have been made recently), these early cooperative driving systems will attempt to increase the driver's awareness, and therefore anticipation, or the road conditions.
- The widespread use of global positioning system is also another foreseeable trend.
- Cooperative ADAS probably need more maturing. Some interesting technological breakthrough have been made

with the appearance of high data rate medium and long range communication medium adapted to high speed mobile applications. Standardization of the communication media, protocols, behaviours and the development of a common telematics platform are precursors to many commercial telematics applications. The development of CALM is a major step in this direction.

- The legal framework for many of the active (directly effecting vehicle functions) driving assistance system, such as speed management or blind merging, is too uncertain for these systems to be realized any time soon.
- The work to be completed is mostly one of standardization and mutual agreement amongst the different parties involved on the use, behaviour and dissemination of these systems.

Based on these conclusions is the following white spots and needs were identified:

Standardisation needs

- The communication medium, to ensure that all vehicles and infrastructure can communicate together
- The behaviour of the communication, to prevent the saturation of communications
- A dictionary of traffic events and conditions, to ensure the right treatment by all systems

Actions .

- Set up a co-operation between ADASE and CALM
- Extend the roadmap for communication systems
- Standardise the inter vehicles communication
- Develop a business model prior to market introduction
- Focus on legal issues

4.4 Sensor Technologies

Presented by Mrs. Gloria Pellischek (CLEPA)

Industry is committed to support the European Commission in reaching their ambitions objective of cutting the number of road victims by half from today's approximately 40.000 per annum until 2010. Advanced technology will help to implement the functionalities required to reach that goal.

The aim of the ADASE expert workshop on Sensors & Actuators Technologies was to get an overview on presently available systems and the future trends. The contributions from all those involved to this workshop demonstrated impressively, that enormous efforts are taken throughout the whole supply network and the OEM's to

- develop new technologies, which support the functions needed;

- overcome obstacles and bottlenecks to market introduction;
- strive for customer acceptance and the most appropriate regulations.

Strong focus was laid on optical sensor technology and systems, the functionalities which they support, and the sensor data fusion leading to HMI issues. A novel actuator technology was presented with the capacity to reduce requisite motors by 50%.

Actual achievements in technologies were presented, limits and problems discussed openly, bottlenecks and obstacles mentioned, as well as possible road maps for market introduction identified.

Both an encouraging political address from a vehicle manufacturer, as well as a competent final round table discussion complemented the technological contributions from the automotive suppliers.

5 Impact assessment

5.1 Preliminary ADASE II roadmap

Presented by Mr. Dirk Ehmanns(BMW)

Mr. Ehmanns showed that the research Roadmap is one of the core products of the ADASE-II platform. The roadmap describes the possible line in the research of the ADA systems. Moreover it shows the complexity in the various relevant aspects of these ADA systems; the complexity in the system aspects, in the sensor aspects, the infrastructure, the communication, the HMI, degree of driver assistance, the legal aspects and the political and societal aspects. The roadmap is based on a broad input from concertation meetings, expert workshops, the roadmap task force, the ADASE-I Roadmap and internal ADASE discussions. Based on the results of the workshop on effects, a final column is added to the roadmap, to describe the contribution of the systems to safety enhancement.

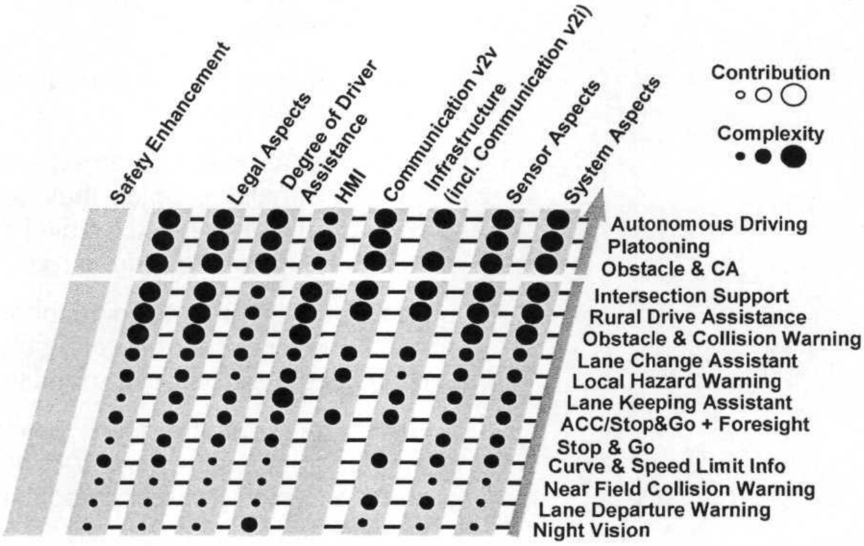


Figure 5.1: ADASE II Roadmap

5.2 Introduction paper; preliminary assessment of effects

Presented by Mrs. Lieke Berghout (TNO)

An introduction paper is drawn up as a preparation for the workshop (see annex 3). It aims to focus the discussion and offers the participants a starting point for the discussion on effects. The paper is included in the annex.

The main objective of the paper is to offer the framework for the assessment of the effects. The framework is shown in figure 5.2.

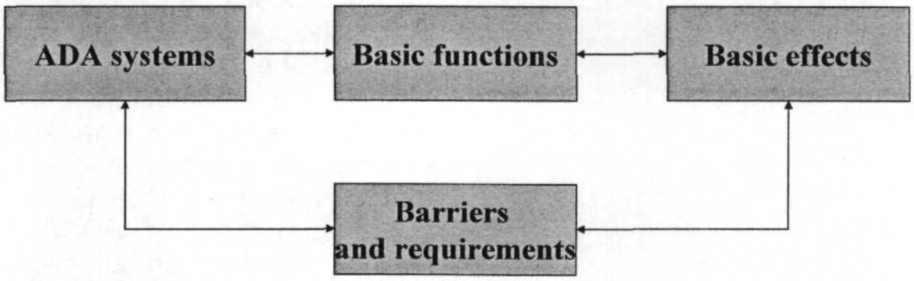


Figure 5.2: Framework for the impact assessment

Given this framework, the paper aims to facilitate the active input of the participants during the workshop. The framework defines the ADA systems and classifies them in five types of functions:

- Safe speed & Safe Following (ACC/Stop&Go + Foresight, Stop&Go, Curve and speed limit info)
- Lateral support (Lane change assistant, Lane keeping assistant, Lane departure warning)
- Obstacle detection and collision warning (Obstacle & collision avoidance, Obstacle & collision warning, Near field collision warning)

- Intersection Safety & Complex Situations (Intersection support, Rural drive assistance, Local hazard warning, Night vision)
- Autonomous driving (Autonomous driving, Platooning). Due to it's far end position in the roadmap, this function is not discussed in the workshop.

Regarding the effects it was presented in the state of the art deliverable that although most of the there considered ADA systems have their main potential in the *safety* improvement, they can also have impact on the *traffic efficiency* and *comfort*.

The effects of ADA systems on traffic safety can be seen in the reduction in the number of accidents in combination with the reduction of the severity of the accidents/injuries. In general there can be seen three different location scenarios: City traffic, Rural traffic and Motorway traffic. The safety problems differ in the location scenarios; both the share of the three scenarios and the type of fatal accidents are different. The types of accidents are classified as:

- Accidents from aside
- Frontal accidents
- Head-tail accidents
- Accidents with vulnerable road users
- Singular accidents

For each function, a brief and general assessment of the effects is given and serves as a starting point for the discussions in the workshop:

Safe Speed & Safe Following

- Intimate relation to risk and severity of the crash
- Decrease of mean speed and variation leads to decrease in accidents
- Decrease of accidents leads to prevention of congestion and associated costs

Lateral Support

- Reduction of unintentional lane departures,
- Possibly leading to decrease of side impact collisions
- Potential side effects: over reliance and reduced alertness (depending on degree of support)
- Decrease of accidents leads to prevention of congestion and associated costs
- Possibilities for increased traffic efficiency if narrowed lanes are possible

Obstacle Detection & Collision warning

- Mainly traffic safety effects due to timely warning and/or interference.

- Decrease of accidents leads to prevention of congestion and associated costs

Intersection Safety & Complex Situations

- Vision enhancement can reduce the number of accidents during unfavourable situations
- Potential side effects: over reliance and increased exposure in unfavourable conditions
- Strong potential expected from in complex urban and rural intersections
- Only possible increase in traffic efficiency on congested roads

5.3 Rules of the game for interactive session on effects

Presented by Mr. Joachim Irion (Irion Management Consultancy)

All attendees are asked to give active input to the workshop by including their opinion on the impact assessment. They were asked

- Give their estimation on the impact of 6 ADA systems for each type of effect in a given format (using a sticker)
- To indicated the certainty of their impact assessment (very certain or less certain) by means of the colour of their sticker (green for certain impact, yellow for less certain).
- To indicate the requirements for the stated impact (degree of penetration, max. headway, ...)
- To indicate the barriers for the introduction (marketing, legal, policy, technical, financial, HMI, infrastructure, communication, ...).

The information is structured by the use of templates. These templates are shown in figure 5.3 and figure 5.4.

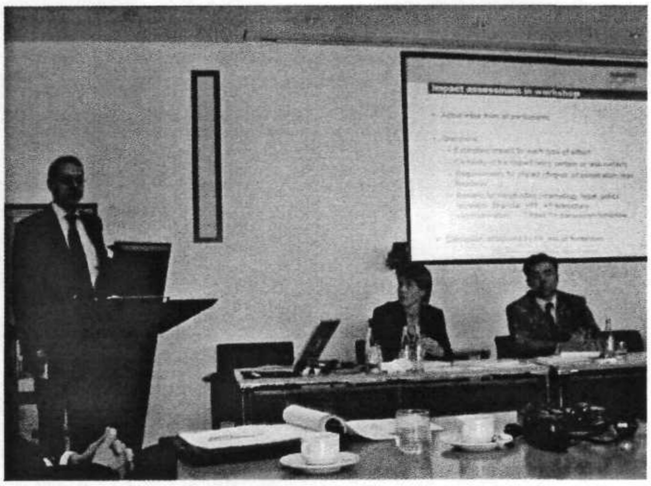
	Effect on Safety					Effect on traffic efficiency	Effec com
Impact	Decrease of 'aside' accidents	Decrease of 'frontal' accidents	Decrease of 'head-tail' accidents	Decrease of accidents with vulnerable road users	Decrease of 'singular' accidents		
++ (very positive)							
+ (positive)							
0 (neutral)							
- (negative)							
-- (very negative)							

Figure 5.3: Template for the impact assessment

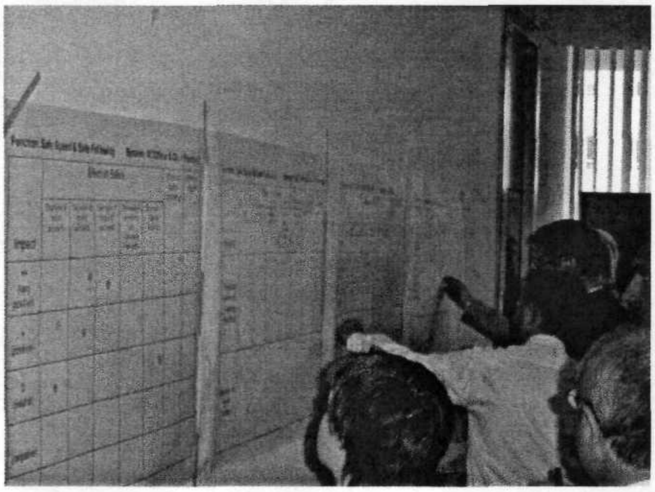
	Effect on Safety					Effect on traffic efficiency	Effect on comfort
	Decrease of 'aside' accidents	Decrease of 'frontal' accidents	Decrease of 'head-tail' accidents	Decrease of accidents with vulnerable road users	Decrease of 'singular' accidents		
Requirements for reaching the effects							
Barriers for introduction							

Figure 5.4: Template for the indication of the requirements and barriers.

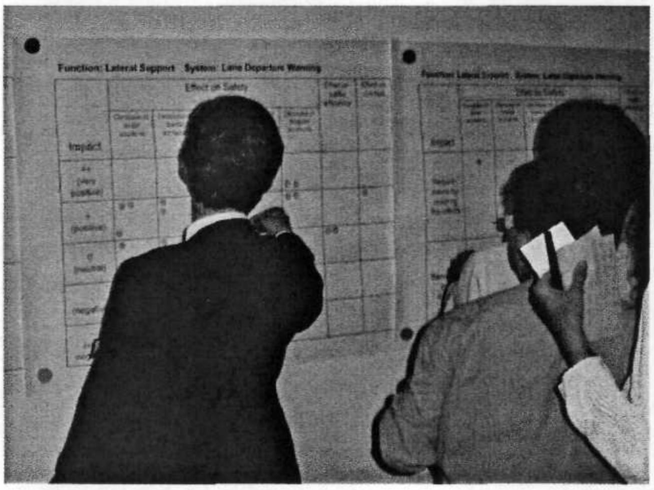
Due to time constraints and practical matters not all systems from the roadmap could be discussed during the workshop. The functionalities safe speed & safe following and Lateral support were completely discussed by approximately 60 experts. The remaining systems from the functionalities obstacle detection and collision warning and intersection safety & complex situations have been rated and discussed by the ADASE 2 core team members.



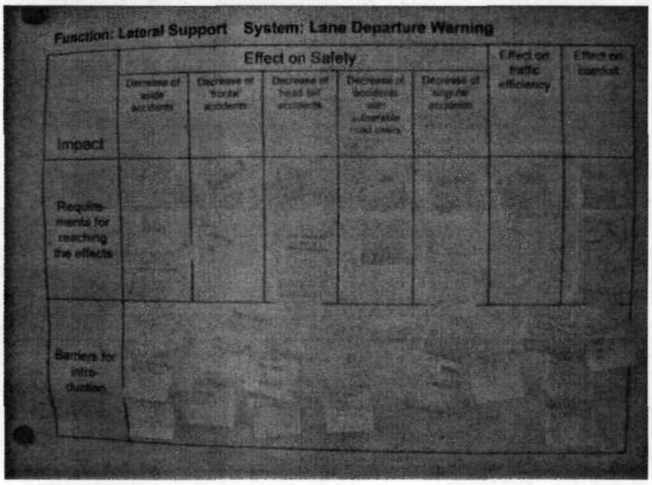
picture 1; rules of the game explained by mr. Irion



picture 2; effect's assessment by workshop participants (1)



picture 3; effect's assessment by workshop participants (2)

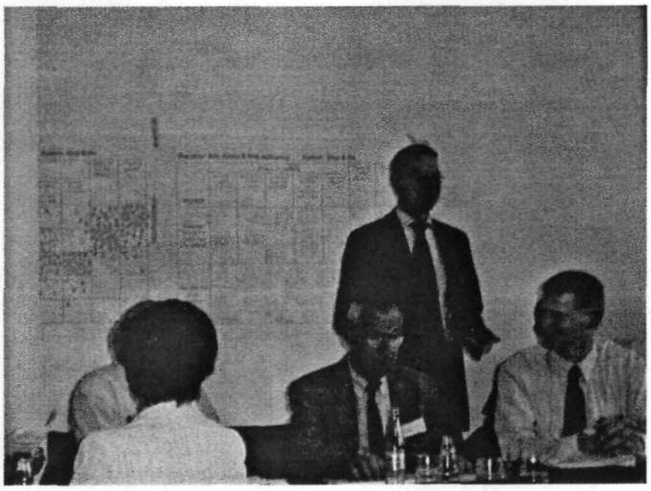


picture 4; remarks on requirements and barriers by workshop participants

picture 5; effect's assessment by workshop participants (3)

5.4 Results of interactive session on effects

Moderated by Mr. Joachim Irion (Irion Management Consultancy)



picture 6; discussion on basis of results workshop

After the "rules of the game" were explained by Mr. Joachim Irion, all attendees actively participated in the workshop by putting their opinion, in the form of stickers and post-its, on the large sheets which were mounted on the wall (see pictures 3 and 4). Within a relatively short time period the accumulated knowledge of the present experts, regarding effects of ADA systems, became visible and could easily be used for a constructive discussion.

For each system the moderator summarized the results by looking at the emerged pattern of green and yellow dots. Also the post-its were scanned and several remarks that were written down on them were presented to the audience. A brief discussion regarding these results followed.

In this chapter you will find the results of the workshop session categorized per functionality and per ADA system.

5.4.1 Safe speed & following

Stop & Go

During stop & go traffic situation the longitudinal control of a vehicle will be partly carried out by a system. Therefore it is necessary to detect the traffic in front even in the near field. In extension to an ACC the detection of this area is necessary to react on other cars swerving into the near field.

Safety

Regarding the expected potential of Stop & Go to increase traffic safety the majority of the participants believe the only type of accidents to be prevented are head-tail collisions. 70% of the participants is very certain that the impact of Stop & Go is very positive which they indicated with green stickers (see figure 5.5). In the discussion it is mentioned that Stop & Go is not a safety function but a comfort function.

Throughput/traffic efficiency

Almost all attendees are sure that Stop & Go has a positive effect on traffic flow throughput.

Comfort

Regarding the effect of Stop & Go on comfort the participants are again very positive, even more so than regarding throughput.

Requirements for stated effects

Amongst all the remarks written down on the post-its and mentioned in the discussion, the requirements for the stated effects regarding a decrease in head-tail accidents are: wide scale introduction, 100 % functionality, vehicle to vehicle communication, driver education and improved HMI usability. A relatively low penetration of Stop & Go should be enough to create a substantial effect (approximately 30%) through harmonization.

Barriers for introduction

Mentioned barriers for introduction of Stop & Go are predominantly financial and legal matters: cost of system and the price / value ratio, liability, frequency allocation.

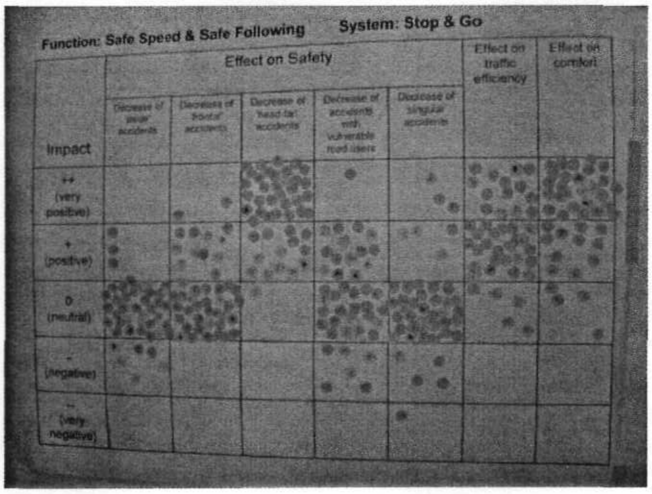


Figure 5.5

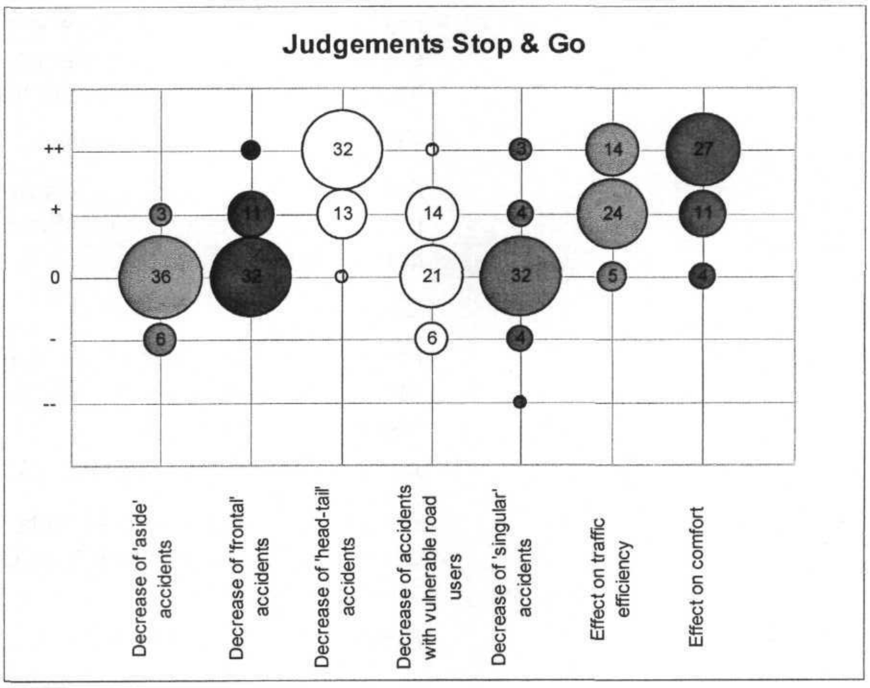


Figure 5.6

ACC-Stop & Go + Foresight

The ACC and Stop & Go function can be extended to a traffic related system by the means of communication. Far away driving vehicles will be involved into the longitudinal control. Thus, an end of a traffic jam can be included into the longitudinal control, before a driver is able to see it e.g. in a curve. Thus the traffic flow and the safety can be increased.

Safety

The results for ACC-Stop & Go + Foresight are similar to the results of Stop & Go. Once again the majority of the participants believe the main type of accidents to be prevented are head-tail collisions. 75% of the participants is very certain that the impact of ACC-Stop & Go + Foresight is very positive. In the discussion it is mentioned again that ACC-Stop & Go + Foresight is not a safety function but a comfort function and that it will not be put on the market as a safety function because of liability issues. This is a marketing issue. Also, in general, when systems are sold as safety systems (like ABS for instance) people want to use them and are thus prone to be in more critical situations.

Throughput/traffic efficiency

Almost all participants are sure that ACC-Stop & Go + Foresight has a positive effect on traffic flow throughput although a majority is not very positive.

Comfort

Regarding ACC-Stop & Go + Foresight and it's effect on comfort the participants are again very positive, even more so than regarding throughput.

Requirements for stated effects

Remarks on the requirements for the stated effects regarding a decrease in traffic safety are: Communication with other vehicles, 100 % functionality,

Barriers for introduction

Mentioned barriers are again predominantly financial and legal matters: cost of system and the price / value ratio, liability. But also Technical aspects play a role such as reliability and frequency allocation.

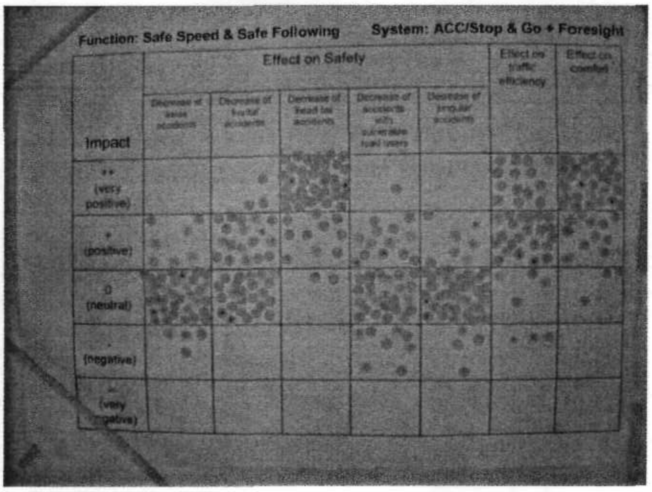


Figure 5.7

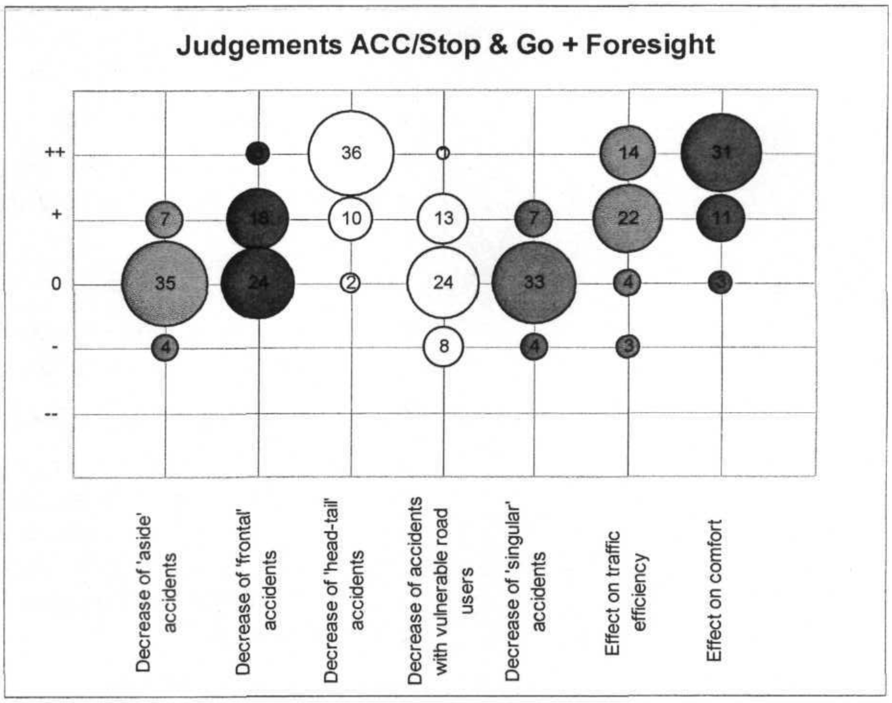


Figure 5.8

Curve speed limit info

When driving is not adapted to traffic signs or curvature, these systems inform the driver about his speed and the recommended speed by e.g. an optic or haptic (at the accelerator pedal) feedback. Possibly the necessary information can be taken from digital maps, image processing or communication systems between vehicles and infrastructure. The drivers always have to be aware of the problems arising from the actuality of the information e.g. from digital maps.

Safety

The expected potential of curve speed limit info to increase traffic safety is not restricted to one category of incidents according to the participants. A majority is very sure that singular, frontal and head-tail accidents can be reduced by curve speed limit info. Less certain but still sure is a majority regarding the positive impact of curve speed limit info on aside accidents and accidents that involve vulnerable road users.

Throughput/traffic efficiency

Almost all participants are sure that curve speed limit info has a positive effect on traffic flow throughput although not as much as other systems.

Comfort

Regarding the effect of curve speed limit info on comfort the participants are again positive but also less than for other systems.

Requirements for stated effects

Amongst all the remarks written down on the post-its and mentioned in the discussion, the requirements for the stated effects regarding an increased traffic safety are mainly HMI related. Also mentioned is that it's better to give information about a situation rather than a speed advice, since safe speed might be driver dependent.

Barriers for introduction

Mentioned barriers for introduction of curve speed limit info are predominantly liability issues.

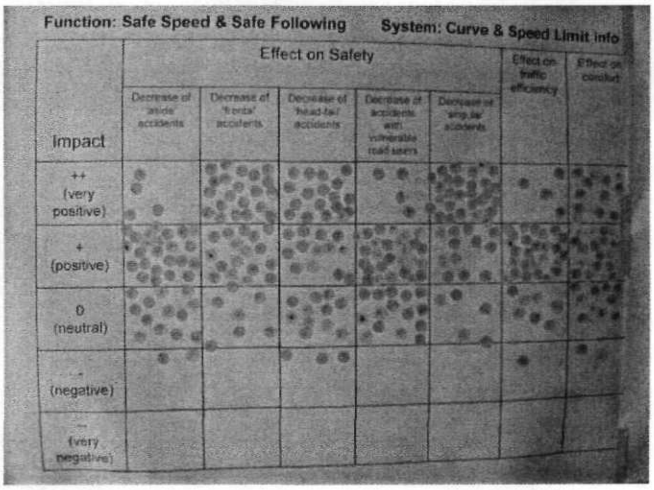


Figure 5.9

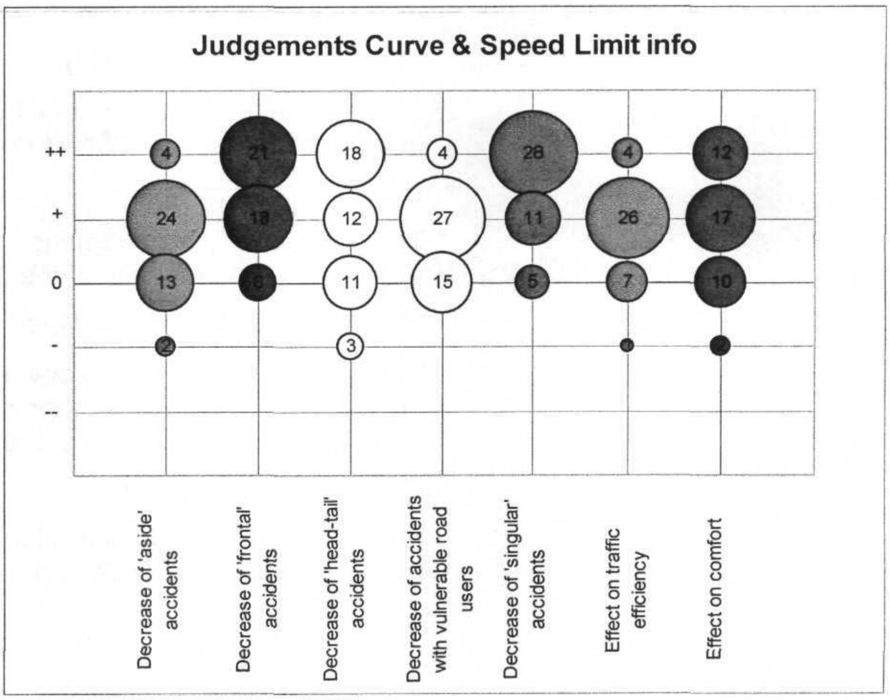


Figure 5.10

5.4.2 Lateral support

Lane keeping assistant

The function of a lane keeping assistant system includes the lane detection and the feedback to the driver if he is leaving a defined trajectory within the lane. An active steering wheel can help the driver with a force feedback to keep on this trajectory. The lane is detected by a video image processing system.

Safety

Regarding the expected potential of lane keeping assistant to increase traffic safety the majority of the participants believe the only two types of accidents to be prevented are aside accidents and singular accidents. In the discussion it is mentioned that when driver's rely on such a system for lane keeping they can pay more attention to the traffic.

Throughput/traffic efficiency

Almost all attendees are not sure that lane keeping assistant has a positive effect on traffic flow throughput.

Comfort

The effect of lane keeping assistant on comfort is positive according to the majority of the participants.

Requirements for stated effects

Amongst remarks written down on the post-its and mentioned in the discussion, requirements for the stated effects are: combination with active steering, reliability and user acceptance.

Barriers for introduction

Mentioned barriers for introduction of lane keeping assistant are mainly infrastructure related or technical.

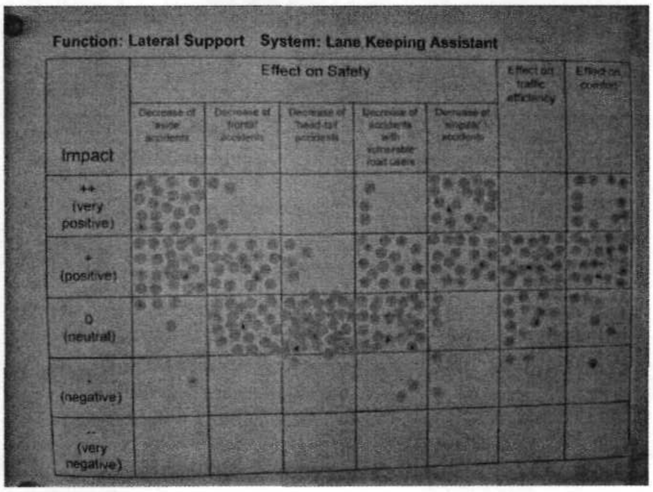


Figure 5.11

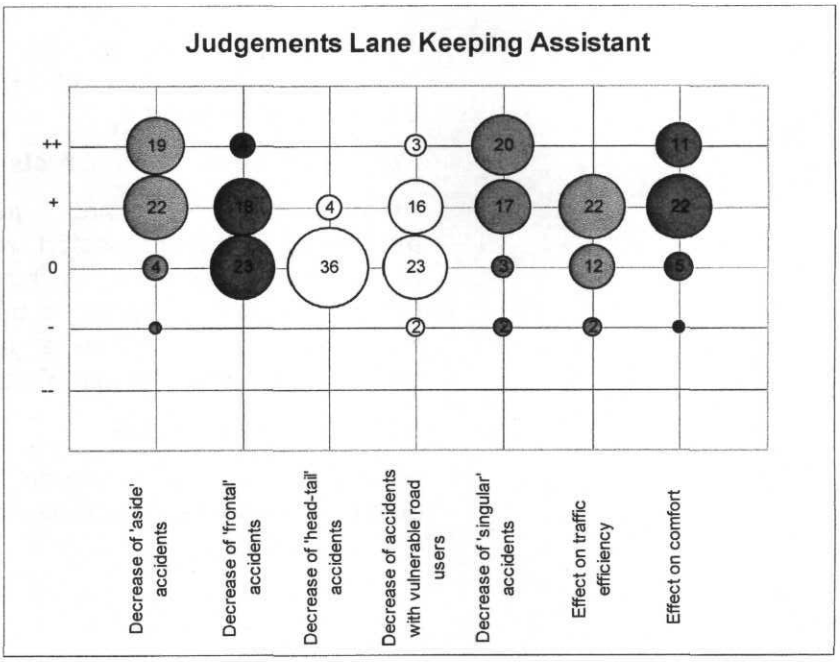


Figure 5.12

Lane departure warning

If certain thresholds (like distance, time to lane crossing) allow a prediction of a lane departure this system warns the driver by means of acoustic, optic or haptic feedback. The detection of the lane markings results from e.g. video image processing.

Safety

Regarding the expected potential of lane departure warning to increase traffic safety the picture is pretty much the same as for lane keeping although a little less pronounced. Again the majority of the participants believe the only two types of accidents to be prevented are aside accidents and singular accidents.

Throughput/traffic efficiency

Almost all attendees are not sure that lane keeping assistant has a positive effect on traffic flow throughput.

Comfort

The effect of lane keeping assistant on comfort is positive according to the majority of the participants, although slightly less than for lane keeping.

Requirements for stated effects

Amongst all the remarks written down on the post-its and mentioned in the discussion, requirements for the stated effects regarding a decrease in singular and aside accidents are: Cooperative environment in terms of: quality of lane markings, standard of lane markings all over EU, a combination with active steering, extended domain of operation.

Barriers for introduction

Mentioned barriers for introduction of lane departure warning are also predominantly infrastructure related and legal matters.

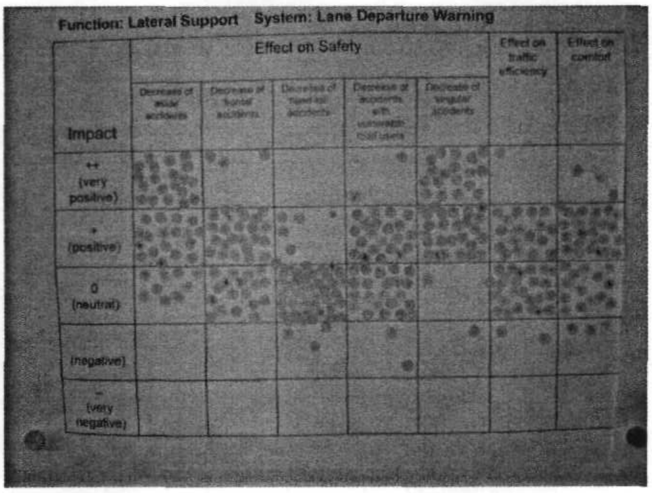


Figure 5.13

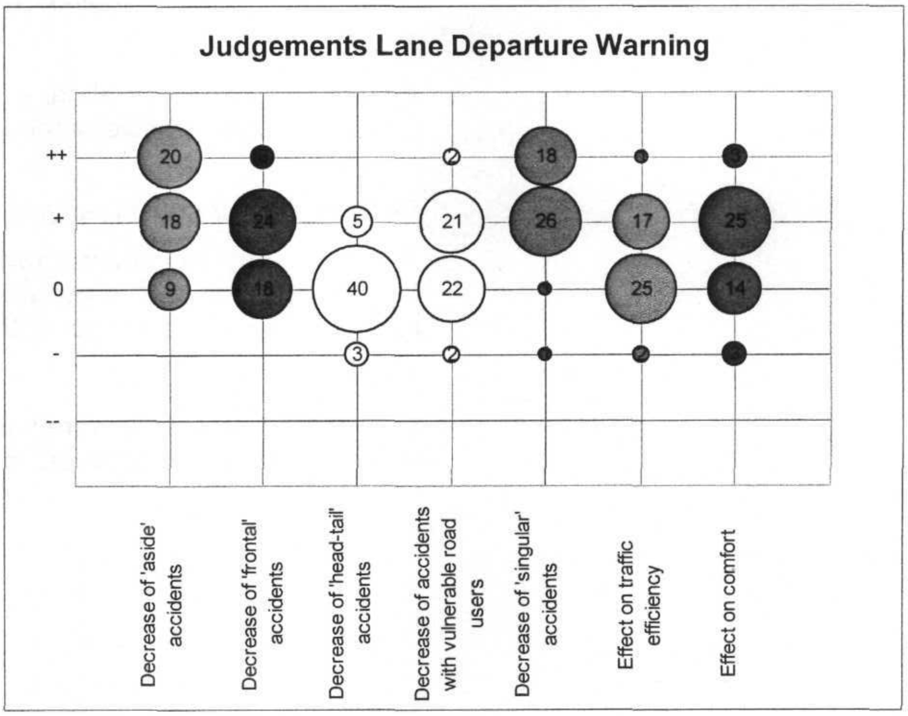


Figure 5.14

Lane change assistant

Before and during a dangerous lane change process, the lane change assistant will warn the driver. Several stages of such a system are possible from pure warning systems to even haptic feedback at the steering wheel to help the driver following a lane change trajectory. The detection of all vehicles around the own car is necessary as well as the detection of the lane.

Safety

Regarding the expected potential of lane change assistant to increase traffic safety, the majority of the attendees believe the only type of accidents to be prevented are aside accidents. 60% of the participants is certain that the impact of lane change assistant is positive and 40% is very positive.

Throughput/traffic efficiency

Halve the number of attendees think that lane change assistant has a positive effect on traffic flow throughput, the other halve thinks there is neither positive nor negative effect.

Comfort

Regarding the effect of lane change assistant on comfort the participants are positive, although most of them are not very sure about it.

Requirements for stated effects

Amongst remarks written down on the post-its and mentioned in the discussion, the requirements for the stated effects are reliability and a combination with blind spot detection.

Barriers for introduction

Mentioned barriers for introduction of lane change assistant are mainly financial and technical matters.

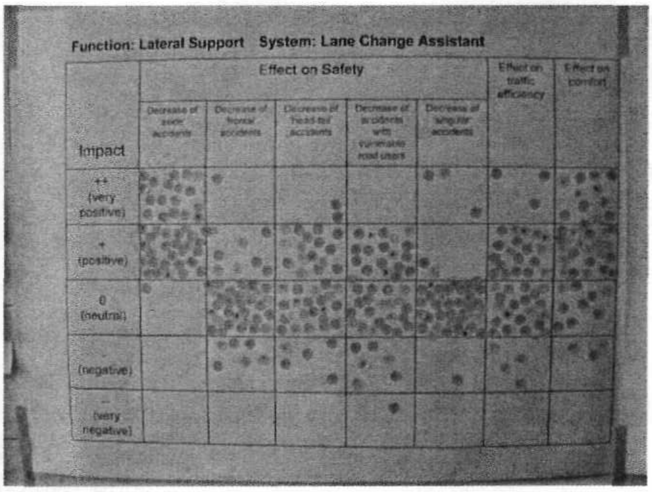


Figure 5.15

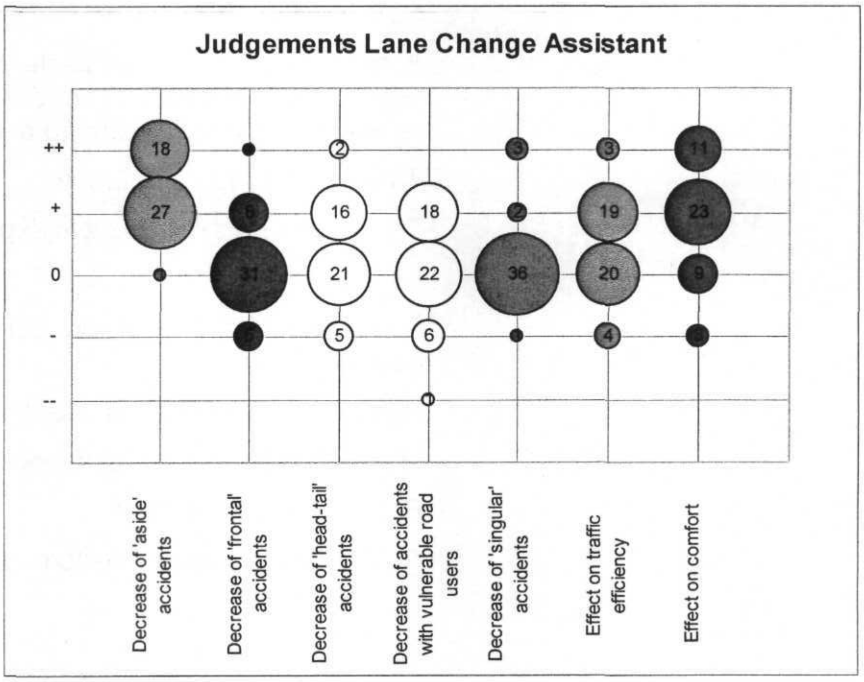


Figure 5.16

5.4.3 Obstacle detection and collision warning

Due to time constraints and practical matters not all systems from the roadmap could be discussed during the workshop. Therefore the functionalities obstacle detection and collision warning and intersection safety & complex situations have been rated and discussed by the ADASE 2 core team members instead of the approximately 60 experts.

Obstacle & collision warning

The driver will be warned if a potential collision is detected with e.g. another car or obstacle. This warning can be for example acoustic or visual. Complex scenarios like evading can be included as well as warn breaking, which is a very short brake in order to give a kinestetic feedback.

Safety

A positive impact of obstacle & collision warning is expected in nearly all categories. The degree of certainty of these effects varies, especially concerning accidents with vulnerable road users

Throughput/traffic efficiency

The impact on throughput is expected to be neutral to positive.

Comfort

Regarding the impact on comfort expectations are neutral to positive.

Requirements for stated effects

Minimize false alarm rates, good sensor performance.

Barriers for introduction

Costs, liability, sensor performance.

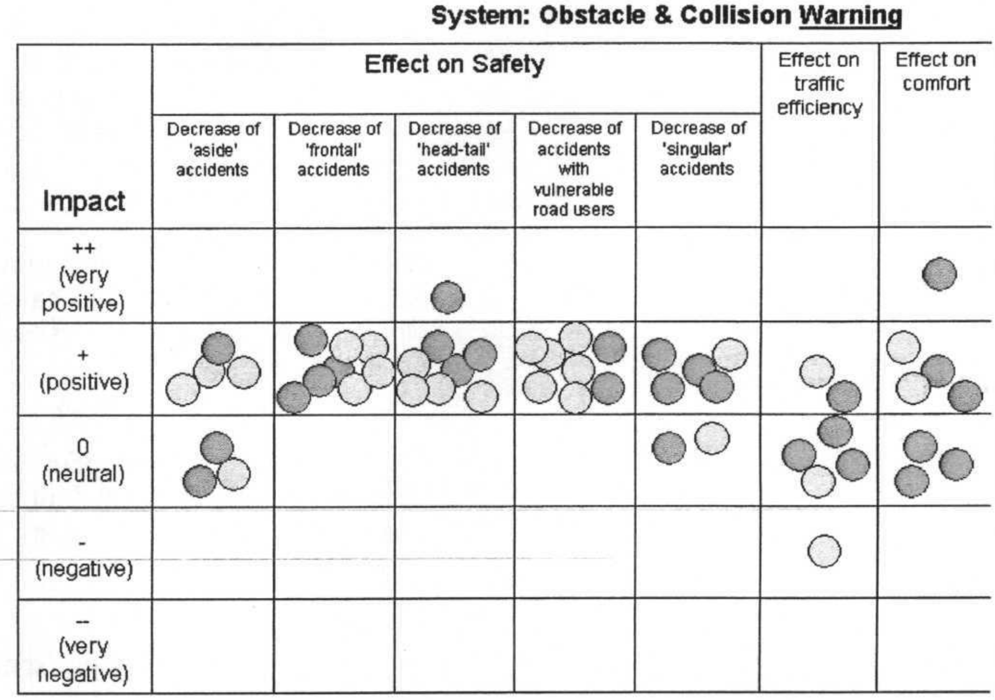


figure 5.17

System: Obstacle & Collision Warning

	Effect on Safety					Effect on traffic efficiency	Effect on comfort
	Decrease of 'aside' accidents	Decrease of 'frontal' accidents	Decrease of 'head-tail' accidents	Decrease of accidents with vulnerable road users	Decrease of 'singular' accidents		
Require-ments for reaching the effects	•Efficiency? •Early detection •False alarms rate •False alarms are not that critical but decrease drivers acceptance •Good sensor technology	•False alarms rate •Early detection False alarms are not that critical but decrease drivers acceptance •Driver does not speed-up because he relies on the system •Good sensor technology	•False alarms rate •Early detection False alarms are not that critical but decrease drivers acceptance •Driver does not speed-up because he relies on the system •Good sensor technology	•False alarms rate •Early detection •False alarms are not that critical but decrease drivers acceptance •Vulnerable road users must be detected by the front looking sensor •Good sensor technology	•False alarms rate •Early detection •False alarms are not that critical but decrease drivers acceptance •Good sensor technology	•Should prevent many accidents •Appropriate penetration	•HMI •Good HMI •Design of MMI •avoid false alarms
Barriers for intro-duction	costs, liability, physical outline of the function (should not be irritating), user acceptance Cost of the front looking sensor HMI aspects: the warning must be given in a way that is easily recognized and accepted by the driver 24 GHz – Sensor-Systems Liability legal aspects, liability issues, performance (accuracy, range, costs etc.) of sensors, Reaction time of the driver and MMI costs						

figure 5.18

Obstacle & Collision Avoidance

This system has an extended functionality compared to the Obstacle and Collision Warning. An autonomous intervention overtakes partly the control of the vehicle in critical situations in order to avoid an accident. Longitudinal and lateral control will be done by the system.

Safety

A positive to very positive impact of obstacle & collision avoidance is expected in nearly all categories. The degree of certainty of these effects varies, especially concerning accidents with vulnerable road users

Throughput/traffic efficiency

The impact on throughput is generally expected to be mildly positive due to accidents that can be prevented which leads to less congestion. But opinions vary on this topic from negative to very positive.

Comfort

For comfort slightly higher expectations can be noted.

Requirements for stated effects

Minimize false alarm rates, good sensor performance.

Barriers for introduction

Costs, liability, sensor performance.

System: Obstacle & Collision Avoidance

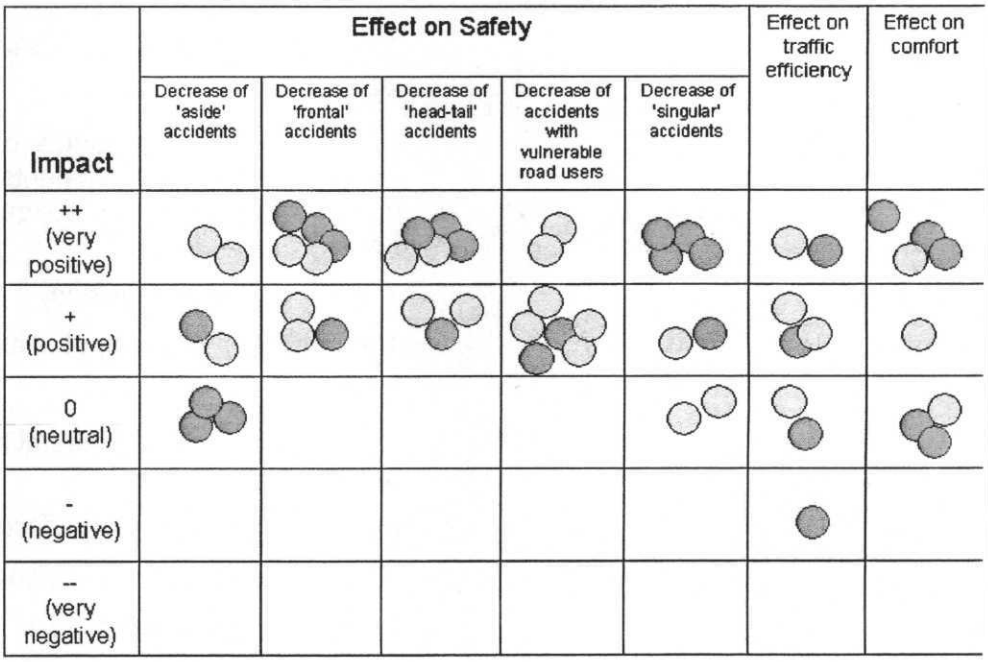


figure 5.19

System: Obstacle & Collision Avoidance

	Effect on Safety					Effect on traffic efficiency	Effect on comfort
	Decrease of 'aside' accidents	Decrease of 'frontal' accidents	Decrease of 'head-tail' accidents	Decrease of accidents with vulnerable road users	Decrease of 'singular' accidents		
Require-ments for reaching the effects	•Efficiency? •Early detection •Right interaction •Far range sensing from fast approaching vehicles from behind in adjacent lanes • good sensor technology	•No false alarms •Avoid False alarms, •Early detection •Relevance of the objects to be avoided (with own lane etc) •object recognition in complex scenarios • good sensor technology	•No false alarms •No false alarms •Avoiding false alarms •Early detection • good sensor technology	•No false alarms •No false alarms •Early detection Robust pedestrian protection •Detection of pedestrian intention • good sensor technology	•No false alarms •Early detection •Robust lane marking recognition • good sensor technology	•Should prevent many accidents •Moderate equipment rate	•HMI •user acceptability •Reliable and systems with high availability
Barriers for intro-duction	costs, liability, user acceptance, realizable? Detection and interpretation of scenario legal aspects, liability, certification issues, performance (accuracy, range, costs etc.) of sensors, conflicts and lags in the situation interpretation, Establishment of conflict free trajectory for collision avoidance Safety aspects for possible incorrect behavior of the system are too heavy. I think this kind of system cannot be introduced on the market for a long time.						

figure 5.20

Near field collision warning

The near field collision warning includes the detection of especially vehicles in the near field like in the blind spot area. Suitable sensor systems for the detection of other cars are radar, lidar or vision based sensors. The warning can be acoustical, haptical or optical.

Safety

A positive to very positive effect is expected in the categories aside accidents and accidents with vulnerable road users. Overall the opinions seem to be quiet scattered between neutral and positive.

Throughput/traffic efficiency

The impact on throughput is expected to be neutral.

Comfort

For comfort higher expectations can be noted, positive to very positive.

Requirements for stated effects

Minimize false alarm rates, good sensor performance.

Barriers for introduction

Costs, liability, frequency allocation.

System: Near Field Collision Warning

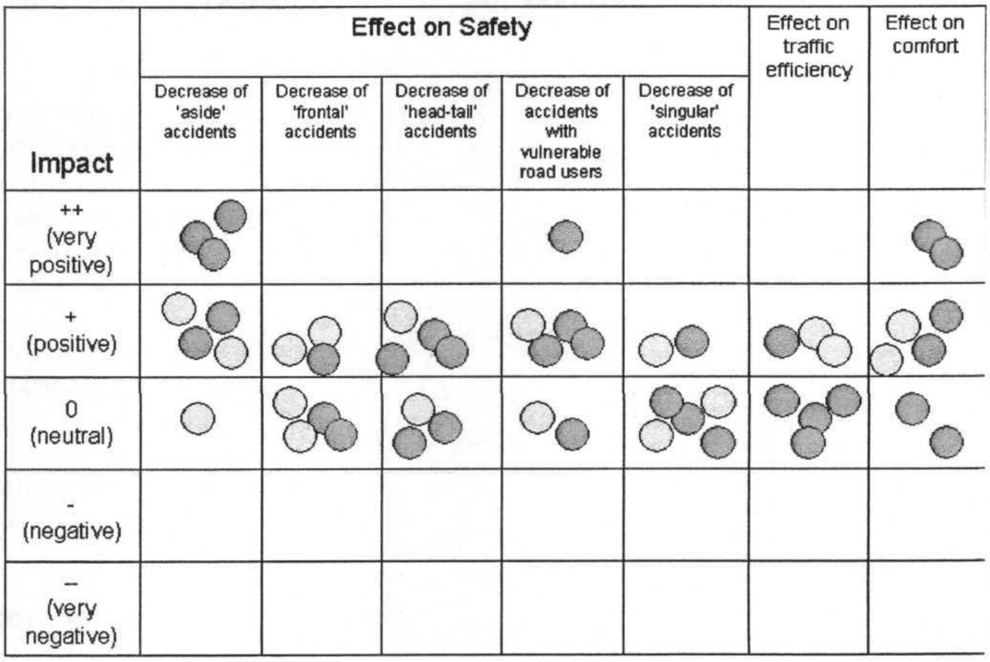


figure 5.21

System: Near Field Collision Warning

	Effect on Safety					Effect on traffic efficiency	Effect on comfort
	Decrease of 'aside' accidents	Decrease of 'frontal' accidents	Decrease of 'head-tail' accidents	Decrease of accidents with vulnerable road users	Decrease of 'singular' accidents		
Require-ments for reaching the effects	•Detection of relevant objects in complex scenarios •The system must be designed in such a way that the driver still has to look at the side mirror •Good sensor technology	•False alarms rate •See coll warning •Good sensor technology	•False alarms rate •See coll warning •Good sensor technology	•False alarms rate •See coll warning •Good sensor technology	•False alarms rate •See coll warning •Good sensor technology	•Should prevent many accidents •See coll warning	•HMI •user acceptability •See coll warning
Barriers for intro-duction	costs, liability Safety aspects: danger of accidents when the system is not perfoming as the driver would expect 24 GHz – Sensor Systems liability, frequency allocation Standardization Frequency						

figure 5.22

5.4.4 Intersection safety and complex situations

Intersection support

In an intersection situation especially in cities a driver has to fulfil several tasks in parallel. Thus the potential for information overload is given. In order to assist the driver in such situations it is necessary to support certain tasks like approaching a stop sign / traffic light or right of way of crossing traffic.

Safety

Regarding the safety impact of intersection support the core team members seem not very certain about a positive to neutral effect.

Throughput/traffic efficiency

Correspondingly the effect on traffic efficiency is expected to be neutral.

Comfort

Also the effect on comfort is regarded to be neutral.

Requirements for stated effects

Good human machine interface.

Barriers for introduction

Costs, liability, good sensor performance, communication.

System: Intersection Support

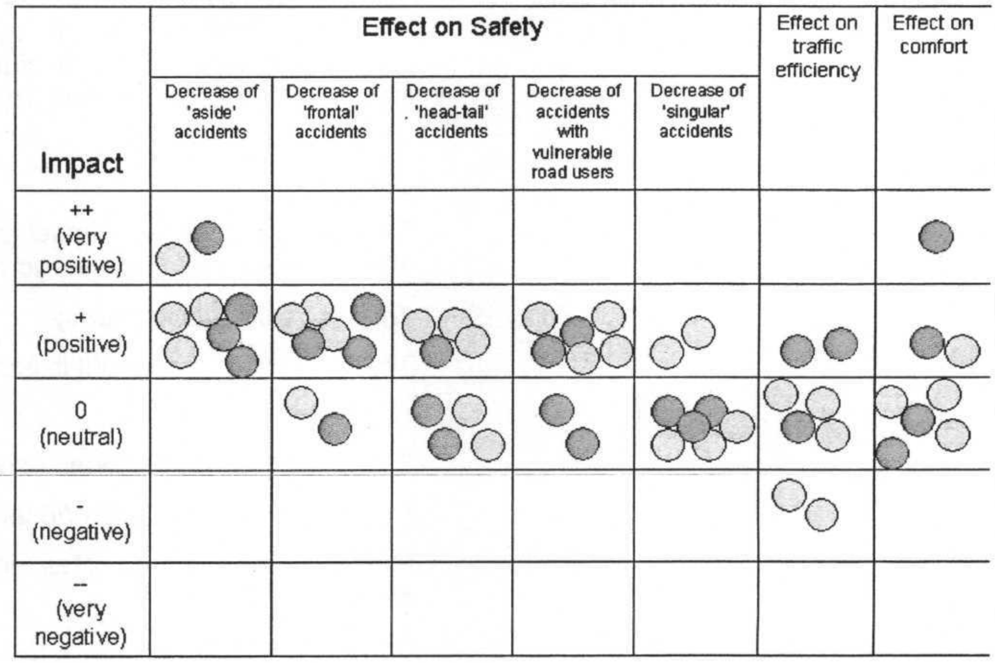


figure 5.23

System: Intersection Support

	Effect on Safety					Effect on traffic efficiency	Effect on comfort
	Decrease of 'aside' accidents	Decrease of 'frontal' accidents	Decrease of 'head-tail' accidents	Decrease of accidents with vulnerable road users	Decrease of 'singular' accidents		
Require-ments for reaching the effects	•Functionality should not be confusing for driver •Providing information for safe left/right turns •To avoid driver compensation effects, the system has to inform the driver about presence of the road structure (traffic sign, crossing, priority) and not incoming vehicles	•Functionality should not be confusing for driver • Providing information for safe left/right turns Cooperation sensors	Functionality should not be confusing for driver Cooperation sensors	Functionality should not be confusing for driver Cooperation sensors	Functionality should not be confusing for driver Cooperation sensors	Should prevent many accidents Mod roadside equipment	HMI Mod roadside equipment
Barriers for intro-duction	costs, liability, user acceptance Standardization of communication side effects ? Sensor technology Vehicle to Infrastructure Communication Infrastructure financial issues for extending the road side equipment User acceptance						

figure 5.24

Rural drive assistance

Most of the systems are developed for the use on highways. Between cities a lot of co called rural roads exist. The requirements compared to highways are higher e.g. because of closer curves or sight obstructions in combination with oncoming traffic.

Safety

Regarding the safety impact of rural drive assistance a positive effect is expected in all categories.

Throughput/traffic efficiency

The impact on throughput is expected to be neutral to positive.

Comfort

Slightly higher expectations exist for the effect on comfort

Requirements for stated effects

Minimize false alarm rates, interaction with environment, good sensor performance.

Barriers for introduction

Costs, liability, sensor performance, availability of road map data.

System: Rural Drive Assistance

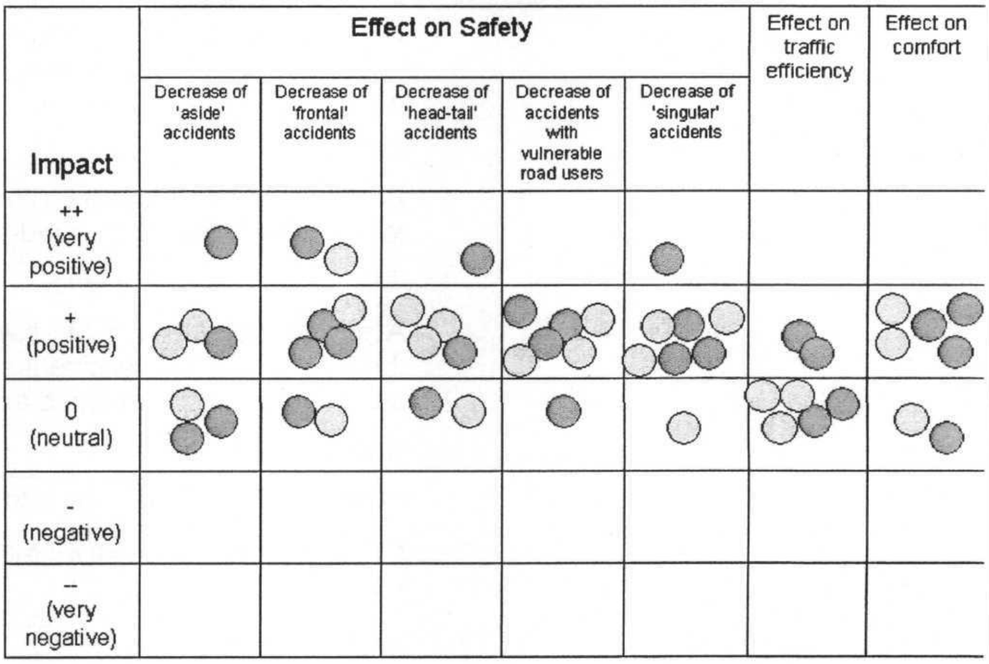


figure 5.25

System: Rural Drive Assistance

	Effect on Safety					Effect on traffic efficiency	Effect on comfort
	Decrease of 'aside' accidents	Decrease of 'frontal' accidents	Decrease of 'head-tail' accidents	Decrease of accidents with vulnerable road users	Decrease of 'singular' accidents		
Require-ments for reaching the effects	•False alarms rate •Interaction with environment well detailed •Far range and Robust sensing for overtaking support	• False alarms rate •Interaction with environment well detailed • Far range and Robust sensing •Wide field of view for front looking sensor	•False alarms rate •Interaction with environment well detailed •Far range and Robust sensing •Wide field of view for front looking sensor	•False alarm rate •Interaction with environment well detailed •complexity and robust pedestrian recognition esp. in night time •Vulnerable road users must be detected by the front looking sensor	•False alarms rate •Interaction with environment well detailed •Robust lane marking recognition •Use of map database	•Should prevent many accidents •Mod penetration • effects increase if intensity on roads is high	•HMI •user acceptability •App. Design of system and MMI
Barriers for intro-duction	Costs, liability, complexity of the system Availability of accurate road maps for rural roads Cost and complexity of the system deployment on rural netwoirk Sensor technology / detection of scenario legal aspects, liability, perfomance (accuracy, range, costs etc.) of sensors Infrastructure data User acceptance						

figire 5.26

Local hazard warning

If a hazard occurs far away in front of the vehicle, so that the driver cannot see it, this system will warn him. By the means of communication it is possible, to transfer this information over long distances.

Safety

Positive safety effects are expected from local hazard warning due to a decrease in frontal, head-tail and singular accidents

Throughput/traffic efficiency

A positive effect on traffic flow throughput is expected based on the mechanism that accident scenes can be avoided if alternatives are available and prevented accidents that lead to less congestion.

Comfort

Regarding comfort a neutral to positive effect is expected.

Requirements for stated effects

Good communication.

Barriers for introduction

Penetration rate, frequency allocation, standardization.

System: Local Hazard Warning

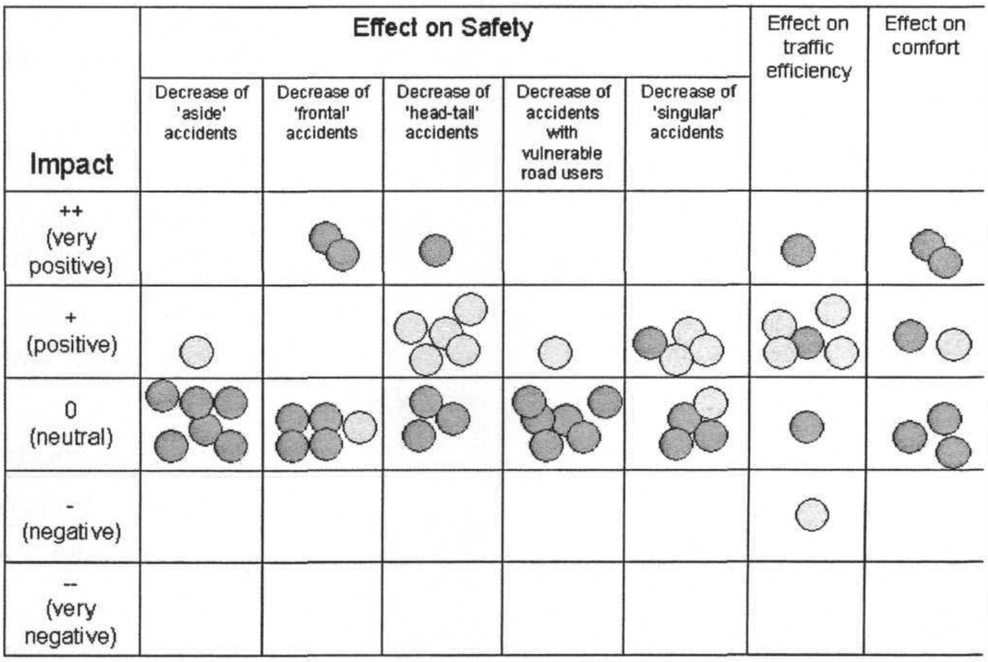


figure 5.27

System: Local Hazard Warning

	Effect on Safety					Effect on traffic efficiency	Effect on comfort
	Decrease of 'aside' accidents	Decrease of 'frontal' accidents	Decrease of 'head-tail' accidents	Decrease of accidents with vulnerable road users	Decrease of 'singular' accidents		
Require-ments for reaching the effects	Communication working for right users	Communication working for right users	•Communication working for right users •Providing the information chain between accident and following vehicles	Communicatio n working for right users	•Communication working for right users •The information is clear to the driver: where and what is the hazard	High penetration grade	HMI
Barriers for intro-duction	system standardization, sufficient equipment rate Standard protocol for data exchange Penetration Frequency allocation and communication standardization acceptance due to low starting penetration, might be increased by promotion and also used by construction sides and ambulances! Low price						

figure 5.28

Night vision

Based on camera techniques like near or far infrared it is possible to enhance the perception of the driver in dark light conditions. The picture of the camera will be shown to the driver by monitors or head up displays.

Safety

The positive impact of night vision is mainly related to an expected decrease of accidents with vulnerable road users. For the other categories a neutral to positive effect is expected.

Throughput/traffic efficiency

A neutral impact on traffic flow throughput is expected.

Comfort

Regarding comfort the expectations are positive.

Requirements for stated effects

Good human machine interface.

Barriers for introduction

Costs, unexpected side effects.

System: Night Vision

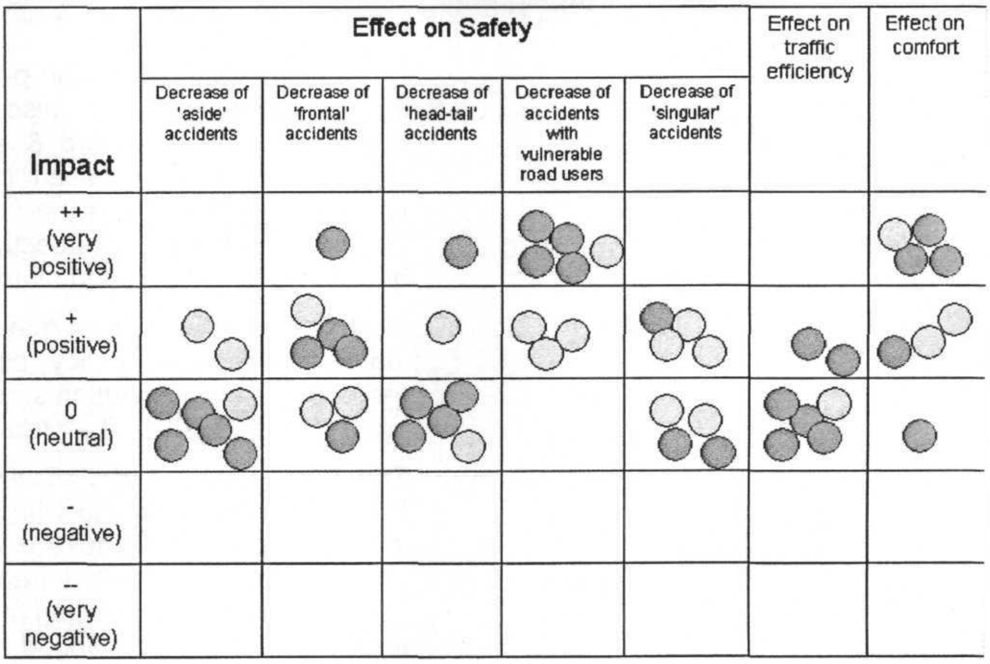


figure 5.29

System: Night Vision

	Effect on Safety					Effect on traffic efficiency	Effect on comfort
	Decrease of 'aside' accidents	Decrease of 'frontal' accidents	Decrease of 'head-tail' accidents	Decrease of accidents with vulnerable road users	Decrease of 'singular' accidents		
Require-ments for reaching the effects		•Correct detailed information •Both equipped cars should not interfere with each other •image easy to see	•Correct detailed information •Detection in long distances •image easy to see	•Correct detailed information •Should be detected independent on their dress •image easy to see	Correct detailed information	•High penetration grade •Mod penetration	•User acceptability, human machine interface, integration into the vehicle •Better perception
Barriers for intro-duction	System costs HMI aspects: it has to be clarified the fact that an extra image can be seen easily by the driver without causing overload or distraction side effect : driver behavior (drive faster ?) *cost of the systems, certification of adapted illumination, cost of IR sensors, liability* MMI+Driver attentiveness issues						

figure 5.30

5.4.5 Conclusions

Due to time constraints and practical matters not all systems from the roadmap could be discussed during the workshop. The functionalities safe speed & safe following and Lateral support were completely discussed by approximately 60 experts. The remaining systems from the functionalities obstacle detection and collision warning and intersection safety & complex situations have been rated and discussed by the ADASE 2 core team members.

It is remarkable to see that the experts from the automotive industry, suppliers, policy people from national governments, researchers and consultants overall have a fairly common opinion on the effects of the presented ADA systems.

The Safe Speed and Following systems (with functionalities of Stop&Go, ACC/Stop&Go with Foresight and Curve & Speed limit info) are expected to have a very positive safety effect and also (but slightly lower) positive throughput effect. Effects on safety are here mainly on decreasing head-tail accidents. The effects on throughput of Safe Speed and Following systems can be considered a primary effect in addition to secondary effects because of different headways, less shockwaves and smoother traffic flow. Safe Speed and Following systems have a very positive effect on comfort.

The Lateral Support systems (with functionalities of Lane Keeping Assistant, Lane Departure Warning and Lane change assistant) have mainly very positive effects on safety. These effects are mainly on decreasing singular and aside accidents. The effects on throughput are also positive for lateral support systems, but only as a secondary effect due to the mechanism that prevented accidents lead to less congestion. The effects on comfort regarding to lateral support systems are positive, but less obvious then for Safe Speed and Following systems.

The safety potential for the obstacle detection and collision warning functionality is regarded to be positive to very positive. Concerning throughput these systems have a secondary effect due to the mechanism that prevented accidents lead to less congestion. The effects on comfort for obstacle detection and collision warning systems are positive, but less obvious then for Safe Speed and Following systems. The obstacle and collision avoidance system however has a slight more positive expectation towards comfort.

For the intersection safety and complex situation function also a positive effect is expected on safety, although not as high as for the other functionalities. Regarding throughput only a mildly positive to neutral effect is expected. The effects on comfort for intersection safety and complex situation systems are positive, but less obvious then for Safe Speed and Following systems. The night vision functionality however is considered to have a very positive effect on comfort.

To get the aforementioned results the attendees of the workshop believe the following requirements are necessary and several barriers (mentioned below) need to be overcome.

Requirements

- Reliability of the ADA system (100% functionality/accuracy)
- User acceptance (e.g. also in relation to false alarms)
- Need for driver education
- High detection rate (e.g. vulnerable road users like motorists)
- Functionalities should not confuse the driver
- Good sensor technology (e.g. for range, cooperation between sensors and good object recognition)
- External information needed (e.g. road authorities)
- Requirements quality of infrastructure (e.g. lane marking)

Barriers to overcome

- Standardisation (e.g. Frequency)
- Price/value (costs)
- Wide scale penetration of system (not only luxurious cars)
- Overlap business case versus policy case
- Driver attentiveness issues (overload, underload)
- 24 GHz sensor systems
- Performance of sensors (accuracy)
- Conflicts and lags in situation interpretation
- Communication standards veh-veh and veh-infra (depending on functionality)
- Liability issues (clear legal issues)
- Data availability and data validation from external sources

Discussion

- Selling point ADA systems for industry to customers: comfort *versus* acceptation point road authorities: safety, throughput, environment
- Introduce simple systems. Acceptance increases with experience.
- Systems have limits, driver stays in control
- Focus on low cost systems for everyone, not only exclusive systems on luxurious vehicles
- Focus also on integrated systems

- Agreement and cooperation needed; what can industry do and what can road authorities do to help and convince each other?

6 State of Policy

6.1 Introduction

Presented by Mr. Gerben Bootsma (Dutch Ministry of Transport, AVV)

During the first day, dedicated to the effects, ADAS experts focused on the expected effects of ADA systems on safety, throughput and comfort. This question is one of the most important for the public authorities. Environmental effects, traffic efficiency effects and road safety effects are the most relevant for transport ministries. Accompanying measures from public authorities depend first on expected or proven effects. Furthermore Advanced Driving Assistance systems deployment does not call for a priority intervention of national governments.

That's why strengthening relations between public authorities and the automotive industry, and above all reaching a consensus on the sought objectives, are key to the success for deployment ADA systems

This chapter is intended to give the process, the results and major conclusions achieved in the expert workshop day 2 focused on policy.

6.2 Objectives

The objectives of the policy part of workshop were :

- Meet the Ministries of transport and public agencies, as well as the major industrial stakeholders about ADAS.
- Give the policy of several European public authorities
- Give the point of view of the automotive industry on measure and rules expected from public authorities
- Find a common framework and reach a consensus and between public authorities and the automotive industry with concrete proposals for effective ADAS deployment

The policy framework discussed is based on the overview of policy processes and priorities of the member states that are most actively involved in ADAS deployment.

The policy workshop was divided in three parts :

- Presentation of the state of policy of ADAS: An overview of different European policy perspectives
- First panel session: Governments' points of view statements and discussion with the audience
- Second panel session: industries' points of view statements and discussion with the audience

6.3 State of policy in EU members

Presented by Mr. Gilles Ostyn (French Ministry of Transport, CETE)

At the end of 2003, a survey was launched and used by the ADASE 2 project as input for a state of policy regarding the national position and strategies of the member states on Advanced Driving Assistance system

This state of policy gives a global perspective on

- Political awareness
- Proposed solutions
- Identification of national requirements

Key messages given during the presentation are the following

Member state position

- ADAS deployment is rarely high on the national policy agendas
- Members state are more observers than actors on this subject
- Priorities are on Safe speed and pedestrian and two wheeled vehicle protection

What countries are doing:

In terms of organisation

ADAS issues are often handled by the National ITS platform. Technological support comes from the Automotive industry and more marginally from public R&D institutions (e.g. LIVIC in France).

In Sweden, Finland, the Netherlands and the UK, the benefits to expect from ADAS are cited in their road safety programmes

In terms of financial measures

Only the Netherlands propose tax incentives for systems that contribute to road and/or environmental safety.

In terms of evaluation of ADA systems

A premature question for most of countries, nevertheless for the Netherlands an overall evaluation will take place at the end of 2006; acceptance studies and post deployment evaluations are being undertaken in the UK and France. The Swedish administration evaluates the results by the degree of implementation and the potential safety benefits in real life traffic (Vision Zero)

European Commission ADAS policy

A joint initiative of the EC, industry and other stakeholders called "eSafety" was launched to promote Intelligent Vehicle Safety Systems, adapt the regulatory and standardisation provisions and remove the societal and business obstacles.

Barriers and difficulties to implement ADAS policy

Organisational issues

- Lack of a national organisation which could establish a link between national objectives and those of the automotive industry
- Lack of integration and coordination on ADAS field.
- Lack of evaluation and communication on the expected benefits

Technical issues

- Lack of standards (incl HMI)
- Lack of allocated spectrum or frequency
- Lack of cooperation with infrastructure (road) managers

Other important issues

- Privacy and liability problems
- Legal framework not adapted
- Lack of funding

Recommendations for national governments on improving implementation of ADA systems

- Improve institutional coordination and cooperation in the field of ADAS, find the ADAS "champion" who will:
    - Establish a supportive national policy framework
    - Encourage effective participation of all stakeholders, partnerships and communication
- Provide a legal and regulatory framework
- Provide fiscal and financial support

- Provide safety indicators for proper system evaluation
- Provide suitable infrastructures for the innovative systems using road-vehicle interactions.

7 1st Panel session: National Policies

Five representatives from public authorities (France – Gérard Gastaut, The Netherlands – Martin Van Gelderen, Germany – Roland Niggestich, Sweden – Anders Lie and the UK – Ian Yarnold) chaired by the EU and ADASE 2 project officer – Fabrizio Minarini, have gathered under the title "*The priorities of ADAS deployment, strategy and accompanying measures*" with the following in mind:

- Main objectives of the national safety program (focus on adas)
- Priorities, possible accompagning measures regarding the expected effects of ADAS systems
- Futur common framework with the automotive industry, concrete proposals for ADAS deployment, white spots

7.1 Presentations

Gerard Gastaut (CGPC – French Ministry of Transport)

Priority programme road safety:

- Near zero tolerance policy enforcement on the following items:
  - Speed
  - Alcohol
  - Seat belt
  - Cell phone
  - Lights
  - Interdistance between vehicles
- Automatic enforcement

Measures regarding the expected effects of ADAS systems:

Regarding the priorities detailed above, ADAS could help the drivers to comply with the rules of enforcement. Automated enforcement could be create a market for Intelligent speed limiter in the short term.

Future common framework

Cooperation with all stakeholders and specially with car manufacturers (PSA and Renault) should be pursued in order to develop a step by step progress towards 20 year vision and on the followings items:

- From incitation to regulation with developing onboard, modulable and voluntary speed limit system and basic accident data recorder.
- Develop a common format for Veh-Veh, Veh-Road communications, frequencies and ITS architecture
- Develop multilateral R&D

Roland Niggestich (Head of Division – Federal Ministry of Transport, Germany)

Priority programme road safety:

Germany supports the eSafety initiative and the integration of driver, vehicle and infrastructure.

The main task of German Road safety programme is to make traffic space available and protect the vulnerable road users.

Measures regarding the expected effects of ADAS systems:

- Promotes primarily systems for road safety (e.g 24Ghz short range radar)
- PPP issues : provision of correct digital road data

Future common framework

- Set objectives (incl. Framework law) by paying attention not to obstruct the innovation
- Provide support by making funds available for research, with a close coordination with international research.
- Focus must be on assisting the driver in performing his driving task with in mind that the driver has to remain responsible (driver in the loop).

Ian Yarnold (Head of Primary and eSafety branch Vehicle Technology & Standards Division Dept of Transport, UK)

Priority programme road safety:

- Road safety, casualty reductions with safer Vehicles and HMI targets
- Network efficiency, reducing congestion with Travel information and comfort and accessibility targets.

Measures regarding the expected effects of ADAS systems:

Develop research topic on :

- ISA with the drivers behaviour issues in mind, short term :
- CVHS program : Cooperative Vehicle Highway Systems (automated highways), long term

Future common framework:

In order to concretise the concept of CVHS, The DfT study objectives are the following:

- Determine if CVHS is a viable strategic concept
- Develop an over-arching strategy for implementation and business cases for each stage
- Develop stakeholder engagement

Martin van Gelderen (Dutch Ministry of Transport, The Netherlands)

Priority programme road safety:

The vehicle technology and the active safety systems can help the policy Plan mobility to reach his targets, especially on the mains items:

- Increasing road capacity with using ADA/AVG systems (Lane Keeping systems and smaller lanes)
- Reducing number of accidents with active safety, HMI, driver monitoring, lighting
- Improving use of network with dynamic traffic information

Measures regarding the expected effects of ADAS systems:

- Stimulate the development by participation in EU projects
- Help implementation by reducing legal barriers and provide suitable infrastructure
- Stimulate sales with consumer test (Euro NCAP), tax breaks, Field Operational Tests (FOTs). Dutch field operational test with lateral support systems has been carried out in 2003

Future common framework:

For the Netherlands it's necessary to agree first upon basics: effects of and needs for ADA technologies, fill gaps and set up a common agenda for research and implementation

Anders Lie (Swedish National Road Administration, Sweden)

Priority programme road safety:

Vision ZERO

- It is not the human being which must adapt to the road traffic but the system of circulation which must be adapted to the human being
- No fatalities – no long term impairments
- Shared responsibility

In the past, it was the road user which, normally was criticized after an accident. "Vision Zero" estimates that the responsibility must be shared between the three following actors:

- the organisation which builds and maintains the roads, fixes the traffic regulations and buys the means of transport
- each road user which must conform to the traffic regulations and act in a responsible way, including in situations which are not formally regulated, and which must make pressure on the authorities and industry
- the industry which produce the vehicles and which buy and sell the means of transport

The responsibility first falls on the authorities

Model for safe traffic

- characteristics and limits of the human behaviour
- limits of the human body to resist the violence of the accidents
- the problems not being able to be taken into account by the preventive action must be solved by measurements aiming at decreasing the number of accidents

Measures regarding the expected effects of ADAS systems:

- Start from problem and not from the Technology to develop new systems (e.g. Seat belt, speed, alcohol...)
- Assessment of new technologies
- System effectiveness=Safety problem*Risk reduction*Side effects
- Work on DATA: A better diagnostic system with using of indicators of performance as regards road safety.

Future common framework

- Give ADAS a common “safety language”
- Consumer rating of new technologies by Euro NCAP, European Road Assessment Programme, Business Travel International (BTI)

8 2nd Panel session: Automotive Industries

This second panel session was dedicated to the Automotive Industry point of view.

Five representatives from Automotive Industry (PSA – Alain Servel; Renault – Didier Wautier; FIAT – Louisa Andreone; BMW Joachim Scholten and DCAG Gerhard Rollmann) chaired by Joachim Irion gave feedback, background on political issue discussed during the first panel session and presented the actual barriers and the political issues (legislation, intellectual property, ...) derived

8.1 Presentations

Joachim Scholten (BMW) gave a talk on the state of the activities and the difficulties encountered

- For the activities which are in the stage of research, FP6 helps to answer some open questions; further research has to be done.
- Final assessment of driver assistance systems is not possible without having detailed accident data on a common European basis
- Increase of traffic safety is a common task of several parties (industry, public authorities, infrastructure operator, ...)
- RTTI is an important issue to be used with navigation, traffic management, road safety and convenience R&D effort may be in vain and no mid term improvements may be gained, if no frequency is available

Gerhard Rollmann (Daimler Chrysler as SARA member) gave a talk on the SSR (Short Range Radar) using 24 GHz and the concrete difficulties to have the support from France due to the existing utilisation of this frequency by the Police radar.They have requested the support of France to make it possible at the same time to answer a benefit of safety and the protection of the existing systems.

Didier Wautier (Renault) gave a talk on the priorities of research

- Make the innovation available on all the range and work on the business model
- understand the behaviour and develop the most relevant ADAS
- have an approach step by step
- Mutual functions and fusion of information

Alain Servel (PSA) confirm the priorities of PSA

- Progressive generalization of equipment ADAS

- Implementation on all the range

For the two French manufacturers, the Public authority will have to animate the policy of ADAS deployment and prepare the framework necessary to facilitate the deployment.

Luisa Andreone (CRF Fiat)

The research and development focuses on:

- Driver behaviour when interactions with the advanced systems
- Development of the HMI
- Evaluation method for adaptive integrated interface

Open discussion:

Anders Lie remarks that for the users it's difficult to understand the safety market

About ACC, Martin Van Gelderen mentioned if systems sold as "comfort", it have to be paid by the customers. The support of the public authority focuses on "safety" systems.

9 Main conclusions for policy framework

- Policy case starts from traffic problem (IV where cost-effective)
- Industry business case starts from comfort, with safety applications
- Liability; sell systems on basis comfort to drivers. Safety is main focus of governments. Marketing mix.
- Need for accident causation analysis (all EU)
- Need for clear effects of functionalities and systems (all EU)
- Need for standards and frequency allocations (all EU)
- Holistic approach from problems; what with enforcements, what with infrastructure, what with technology and IV?

Contrast on ADAS approach still exists:

- between ADAS policy vision among members state
    - safe speed focus, limits of the enforcement policy (holistic approach), vision Zero
- between public authority vision (safety) and technical vision (comfort) on road safety

    - work on the approach Problem⇨Technology as in Sweden and give ADAS a safety language

Nevertheless, there is a consensus to continue to develop the research area

- Develop a multilateral R&D
- Identify and fill gaps and set up a common agenda for research

Short-term actions being able to be implemented

- Assessment of new technologies
    - Through Euro NCAP with common participation of all stakeholders
- Technical issue
    - Digital map, DATA availability, provide suitable infrastructure
- Legal issue
    - Availability of the frequencies
- Accident causation analysis

Questions still open, at least:

- Responsibility
    - Contrast with German and Sweden position on responsibility
- Standardisation, Implement scenarios, business cases, existing cars
    - the legal aspects must be thorough

10 Overall conclusions

Presented by Mr. Gerben Bootsma (Dutch Ministry of Transport, AVV)

Effects on safety, throughput and comfort

It is remarkable to see that the experts from the automotive industry, suppliers, policy people from national governments, researchers and consultants overall have a fairly common opinion on the effects of the presented ADA systems. The attendees of the workshop filled in pretty similar effects estimations. The same can be said for the assessment on the more complex systems that the ADASE core team has done. Although the automotive industry merely promotes their ADA systems as comfort improving systems, positive effects on mostly safety and also throughput are expected.

Safety

Regarding the expected effects of ADA systems on safety the results are positive to very positive. For the safe speed and following function this positive result is largely due to the expected reduction in head-tail accidents. For the lateral support function aside and singular accidents are expected to be influenced substantially. The safety potential for the obstacle detection and collision warning functionality is regarded to be positive to very positive. For the intersection safety and complex situation function also a positive effect is expected, although not as high as for the other functionalities.

Throughput

The expected effects on throughput are positive. However, there is a difference between the results for the different functions. For the lateral support function and obstacle detection & collision warning only a secondary effect on throughput is expected due to the mechanism that prevented accidents lead to less congestion. For the safe speed and following functions also primary effects are expected because of different headways, less shockwaves and smoother traffic flow. This is in addition to secondary effects. Regarding intersection support and complex situations only a mildly positive to neutral effect is expected.

Comfort

The impact of the safe speed and following systems and night vision is believed to be larger than that of the other systems. The overall expectations regarding the effect on comfort are predominantly positive.

Overall

ADA systems thus seem to have potential benefits on safety, throughput and comfort. Although the assessment is not a scientific one, the input of more then 60 European experts from several professional backgrounds and the assessment of the ADASE core team has proven to deliver a worthwhile contribution to knowledge on effects of ADA systems.

To improve the knowledge on accidentology and the effects of ADA systems, harmonized accident numbers are needed to make good comparable assessments on the same information level.

Requirements and barriers regarding ADAS implementation

The main requirements that are needed for implementation of ADA systems are to give attention to the functionality (not everyone agrees if this should be 100% or not), the user acceptance and technological (mainly sensor) requirements. The driver should be educated so they understand what the systems do and that the driver stays responsible for it's drivers task. Furthermore there are external information needs, such as route information or other information from road authorities and there are requirements for the infrastructure (such as good markings).

Looking at the barriers of market introduction, it is often mentioned that there should be more standardisation in technology and the price/value ratio should be more positive. How to deal with driver attentiveness, wide scale introduction in medium sized (and prized) cars, technological barriers, integration barriers (mainly concerning communication), harmonization of ADA policies in Europe, liability issues and the availability and quality of data from external sources are also often mentioned as barriers.

Policy issues

The initial motivation of governments and automotive industries in relation to ADA systems is different. Most car manufacturers promote ADA systems because it improves comfort of the customer and the policy makers are interested in these systems because of the expected positive impact on road safety and throughput (and also environmental effects). ADA systems are not very high on the policy agenda across Europe. Nevertheless governments have intentions to promote these systems when effects have been proven, on the other hands effects can not be proven if there is no (large scale) deployment of these systems.

The visions amongst the delegates of the EU member state countries Sweden, Germany, the Netherlands, the United Kingdom, France concerning road safety are different and so is the usefulness of ADA systems for road safety. Less accidents and better safety (with better throughput) is the main objective in several countries, the means how to get there can be different. Technology can help there, it should be problem solving for governments. There is for instance a difference in the way speed enforcement should be used to reach these goals. ADA systems can be beneficial, as long as the effects can be proven.

Automotive industries see the comfort aspect of ADA systems as a selling point, due to liability issues it is not favourable to sell them as safety systems (although they can help for that matter). If ADA systems also are implemented with communication aspects (vehicle to vehicle or vehicle to infrastructure) it would be wise to have a European wide understanding and agreements on ADA visions between the EU countries. Also the common goals of the governments and automotive industry can be stimulated by setting up common frameworks for research and implementation and experience more with Field Operational Tests in order to let people experience the ADA systems and better estimate effects.

Overall recommendations

This ADASE II effect assessment has been a good start for analysing and comparing the effects of the ADA systems that have been dealt with. Nevertheless a more thorough and in-depth study on effects is recommended based on modelling studies, results of field operational tests and monitoring driver behaviour of ADA systems that are already on the market. Standardized and harmonized methods of accident causation analysis and effect assessment should be based upon an agreed European accident database and agreed method(s) of effect assessment. International differences in driver behaviour should be considered.

Concerning liability issues it seems wise to let the driver always be responsible for it's driving and not let the driver be completely out of the loop.

There's a great need for better standardisation and harmonization between systems requirements (technological) and policies between the automotive industries, suppliers and governments. Taking part in projects like ADASE II is a good way of creating common understanding amongst each other. However more efforts are needed to create a "common language".

Regarding the safety and comfort motivations of ADA systems governments and automotive industries should try to reach a common understanding and strengthen each other with their goals. It is interesting to find out if comfort improving systems in itself have also a positive effect on safety.

Field Operational Tests (FOT's) can have a lot of benefits for awareness and expectation management of the benefits of ADA systems for society. In order to reach each others goals the organization of Field Operational Tests can be a good way in which the governments and (automotive) industry can create more knowledge.

Further technological improvements are needed to increase the performance, accuracy and reliability of the ADA systems.

Establishing an European governmental platform on Intelligent Vehicles would be helpful to let EU governments learn from each other, develop, create and interact with their visions on intelligent vehicles and be a EU wide counterpart for the European Commission and automotive industries. Especially when more systems with communication applications (for instance between vehicles and infrastructure) are being developed, this is a efficient way to interact and harmonize between each other and with the automotive industry to strengthen the potential of ADA systems.

11 Final note

As a final note, the organizing team of the workshop would like to thank the speakers and all the participants for their active input and making the final workshop of the ADASE consortium a success meeting.

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Annex 2 Agenda

Agenda – day 1 (Effects)

Hours		
1.00 PM	• Welcome • Introduction to the workshop, Day 1	• Mr. Berthold Ulmer (DaimlerChrysler) • Mr. Gerben Bootsma (Dutch Ministry of Transport, AVV)
1.10 PM	• Keynote speech	• Mr. Francisco Ferreira (European Commission)
1.25 PM	• History – now- future perspective (PROMETHEUS, ADASE, PREVENT)	• Mr. Berthold Ulmer (Daimler Chrysler) • Mr. Didier Wautier (Renault)
1.45 PM	Previous ADASE workshops; main lessons learned • HMI and legal aspects • Architecture and technology roadmap • Infrastructure and communication • Sensor technologies	ADASE Core team members: • Mrs. Luisa Andreone (CRF) • Mr. Alain Servel (PSA) • Mr. Guy Fremont (CofiRoute) • Mrs. Gloria Pellischek (CLEPA)
2.45 PM	• Presentation of the ADASE 2 preliminary roadmap • Presentation of introduction paper; preliminary assessment of ADAS effects • Explanation of the rules of the game for the next session	• Mr. Dirk Ehmanns (BMW) • Mrs. Lieke Berghout (TNO-INRO) • Mr. Joachim Irion (Irion Management Consulting)
3.15 PM	Break	
3.30 PM	Session with discussion on effects of systems split up in functions concerning: 1) Safe speed & Safe following (ACC/Stop&Go + Foresight, Stop&Go, Curve and speed limit info) 2) Lateral support (Lane change assistant, Lane keeping assistant, Lane departure warning) 3) Obstacle detection and collision warning (Obstacle & collision avoidance, Obstacle & collision warning, Near field collision warning)	All participants, moderated by Mr. Joachim Irion (Irion Management Consulting)
5.00 PM	Break	
5.30 PM – 6.00 PM	• Overall conclusions • Consensus, discussion points and white spots • Closing and invitation to the reception	• Mr. Gerben Bootsma, (Dutch Ministry of Transport, AVV) • Mr. Joachim Irion (Irion Management Consulting) • Mr. Berthold Ulmer (Daimler Chrysler)
6.00 PM – 8.00 PM	Reception	

Agenda – day 2
(Policy Framework)

ADASE
Advanced driver assistance systems in Europe

Hours		
9.00 AM	• Welcome • Introduction to the workshop, Day 2	• Mr. Berthold Ulmer (Daimler Chrysler) • Mr. Gerben Bootsma (Dutch Ministry of Transport, AVV)
9.10 AM	Presentation of the State of Policy of ADAS - an overview of different European policy perspectives	• Mr. Gilles Ostyn (French Ministry of Transport, CETE) • Mr. Patrick Gendre (French Ministry of Transport, CETE)
9.30 AM	1st Panel session: • Points of view ADAS from National Policies • Governments point of view statements & discussion with the audience	Panel speakers from Transport Ministries of several EU Countries: • France: Mr. Gerard Gastaut • Germany: Mr. Roland Niggestich • UK: Mr. Ian Yarnold • Netherlands: Mr. Martin van Gelderen • Sweden: Mr. Anders Lie Moderated by Mr. Fabrizio Minarini (European Commission)
10.30 AM	Break	
10.45 AM	2nd panel session: • Points of view ADAS from the automotive industries • Industries point of view statements & discussion with the audience	Panel speakers: The ADASE 2 Core Team (automotive & supplier partners)
11.40 AM	Break	
12.00 – 12.30 PM	• Wrap up and overall conclusions	• Mr. Gerben Bootsma, (Dutch Ministry of Transport, AVV)

Annex 3 Introduction paper

A3.1 Introduction

Advanced Driver Assistance systems in a road vehicle (also referred to as active safety systems) are systems that support a driver in his driving tasks, e.g., to maintain appropriate speed, *headway or heading or to prevent accidents*. ADA systems are believed to have a strong potential to improve traffic safety. For the introduction of ADA systems, a holistic approach is needed, integrating different R&D disciplines and integrating the interests of the different stakeholders that are involved.

ADASE-II is an EC IST funded thematic network that will help to introduce and implement active safety systems by offering a platform to achieve the required holistic process and therefore to have all major players in the ADASE II environment involved. Partners in this project are a cross-section of the European automotive industry, suppliers as well as government representatives. To achieve its aim ADASE-II covers a comprehensive range of activities. One of the activities is organising workshops, to meet and discuss with relevant players and main actors about the latest developments, gaps, bottlenecks and opportunities for ADA systems around key issues.

The final workshop of the ADASE-II project deals with the impact assessment of ADA systems. The aim of the first part of the workshop is to obtain consensus about the effects of ADA systems on traffic safety, traffic efficiency and comfort. These results will be integrated into the ADASE-II roadmap. Based on the results, also the 'white spots' in knowledge on effects will be identified. The second part of the workshop focuses on the Policy Framework and should lead to more insight in the relation between (potential) effects of ADA systems and policy issues in EU countries.

This paper aims to focus the discussion and to offer the participants a starting point for the discussion on effects. The main objective is to offer the framework for the assessment of the effects. Given this framework, the paper aims to facilitate the active input of the participants during the workshop. In the next paragraph, the framework is described. It defines the ADA systems and their functions and shows the possible types of effects. For each function, a brief and general assessment of the effects is given and serves as a starting point for the discussions in the workshop. As a result of the workshop there should be consensus, on a general level, on the potential effects. The workshop does not aim at discussions about effects on a percentage-level, since this imposes a shared impact assessment framework and an accuracy level that is not yet available. Therefore, this paper deliberately does not go more deeply into detailed effects found in the literature.

A3.2 Framework for assessment of effects

A3.2.1 The framework

The workshop "Effects of ADA systems on traffic safety, traffic efficiency and comfort" will address the potential of ADA systems in three areas. These potentials should be found in the reduction of the safety problems, the (in)direct effects on traffic efficiency and the effect on comfort. These potentials can be based on estimations in desk research, based on modelling studies, based on field studies or seen as long term effect after the market introduction.

The framework offers a structure to position these potentials for each ADA system. These systems are taken from the ADASE-II Roadmap [1]. Annex 2 gives the definitions of these systems. To structure the systems, each system is categorised in one or more functionalities. These functionalities describe which driving task the systems support or in which situation the systems offer their support. Based on this categorisation of functionalities, the current knowledge on effects and potentials is described in this position paper.

Figure 1 shows the framework.

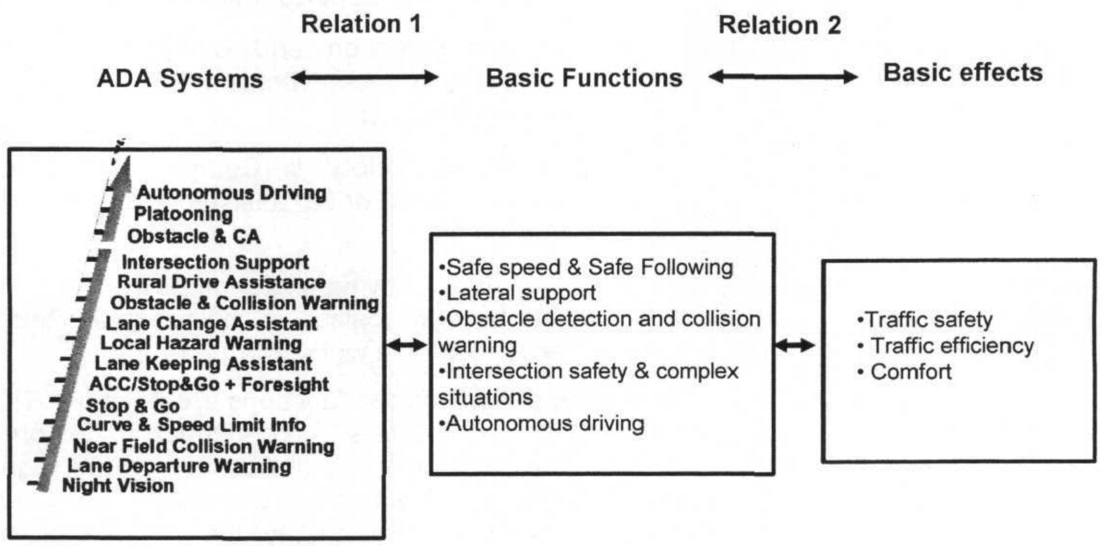

Figure A3.1: The framework

A3.2.2 ADA Functionalities

In order to adequately perform the driving task a driver must perceive the environment, process his or her observations, take a decision on what action to perform, and – finally – to actually carry out the action, by means of controlling the vehicle, in such a way that the driver's goals will be attained without endangering himself or other road users. These actions can be categorised by:

- perception of the environment, which permits a safe and desirable:
- choice of speed
- choice of headway (following)
- position on road and movement in traffic and
- control of vehicle.

The number of accidents on Western roads proves that the surrounding traffic and environment is a complex system which makes it difficult to make safe choices of speed, headway and lateral position. Advanced Driver Assistant Systems (ADAS) help the driver to accomplish this.

Related to the assisted tasks, the ADA systems can be classified in the following types of functions.

- Safe speed & Safe Following (ACC/Stop&Go + Foresight, Stop&Go, Curve and speed limit info)
- Lateral support (Lane change assistant, Lane keeping assistant, Lane departure warning)
- Obstacle detection and collision warning (Obstacle & collision avoidance, Obstacle & collision warning, Near field collision warning)
- Intersection Safety & Complex Situations (Intersection support, Rural drive assistance, Local hazard warning, Night vision)
- Autonomous driving (Autonomous driving, Platooning). Due to its far end position in the roadmap, this function is not discussed in the workshop.

Several variations on the functions are possible. The complexity of the functions differs, concerning performance/technical requirements and organisation, as well as the required social and industrial support. Variation is possible in the degree of support, the degree of vehicle autonomy, the use by specific target groups and users, the applicability to different road types and conditions, the type of vehicle and the level of integration of two or more functions.

A3.2.3 Basic effects

There are several types of effects and these effects are seen in various levels. This paragraph describes the part of framework about effects.

Although most of the ADA systems have their main potential in the safety improvement, they can also have impact on the traffic efficiency and comfort.

The effects of ADA systems on traffic safety can be seen in the reduction in the number of accidents in combination with the reduction of the severity of the accidents/injuries. In general there can be seen three different location scenarios: City traffic, Rural traffic and Motorway traffic. The safety problems differ in the location scenarios; both the share of the three scenarios and the type of fatal accidents are different. When the distribution over the location scenario's and the type of accidents is shown (figure 2, based on Dutch data), it is seen that singular accidents and accidents between vehicles from aside form the majority of the accidents. It is expected that the general distribution of the type of accidents for other EU-countries will be alike, although there will be slight differences.

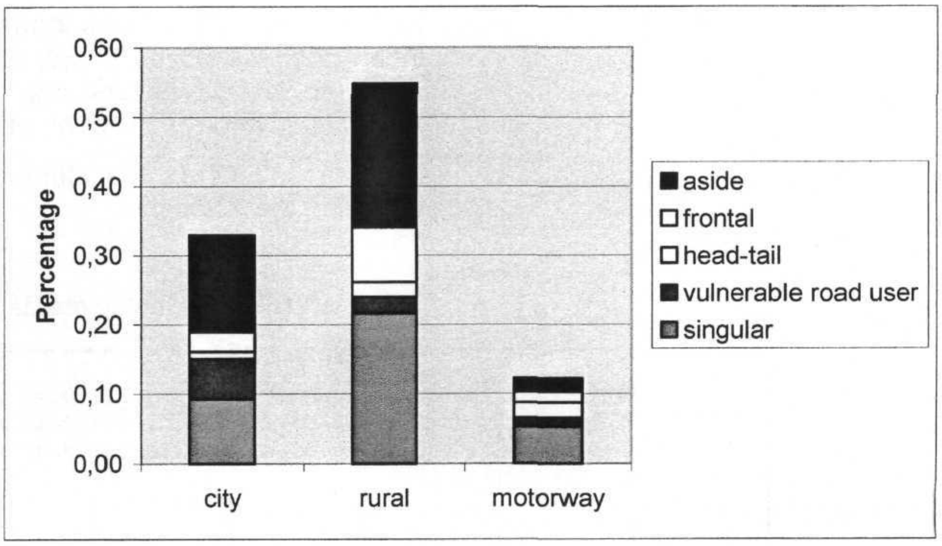

Figure A3.2: Distribution of the three scenarios divided into the types of accidents.

From these figures it should not be concluded that problems on motorways are minor. It should be kept in mind that the most car-kilometres are driven on the motorways. So, if a motorway is congested due to an accident, this has a major impact on the throughput and the possible driven car-kilometres. Moreover, congestion itself leads to an increased risk of accidents.

There is a primary effect of ADA systems on traffic efficiency if the number of cars that can pass a certain road at a certain time increases due to the ADA system. For example, these systems could make traffic flow more smoothly and relieve traffic jams. There is also a secondary effect on traffic efficiency; if there is a reduction of accidents, this will decrease the inconvenience and traffic delays due to accidents.

Note that the technology is continuously improving. This implies that the effects of one technology is not equal to the effects of it's successor.

Little knowledge is found on the effects on comfort. Therefore, these effects are not addressed in this position paper. During the workshop, attention will be paid to these effects as well.

A3.3 Effects

The workshop aims to gather the current knowledge about the effects of the ADA-functions on safety, traffic efficiency and comfort. Moreover it aims to gather the barriers and needs for the introduction of the systems (like marketing, policy, legal, technical, financial, HMI, infrastructure, communication).

Based on the discussions in the workshop table 1 should be filled in as good as possible. So, it will indicate the knowledge (and white spots) on effects and the barriers and needs for the introduction and reaching the effects.

Paragraph 3 offers the starting point on the discussion on the effects of the functions.

Tabel A.3.1: Format for the results of the workshop

Function	Effect on Safety					Effect on traffic efficiency	Effect on comfort	Requirements reaching the effects and barriers for introduction
	Decrease of 'aside' accidents	Decrease of 'frontal' accidents	Decrease of 'head-tail' accidents	Decrease of accidents with vulnerable road users	Decrease of 'singular' accidents			
Safe speed & Safe Following								
Lateral support								
Obstacle detection and collision warning								
Intersection Safety & Complex Situations								

A3.3.1 Safe speed & Safe Following

Speed is intimately related to the risk and severity of a crash. A review of international research on the relationship between speed, speed limits and accidents came to the conclusion that a decrease in the mean speed of traffic produces a decrease in injury accidents ([3] derived from [4]).

Other studies show the contribution of speed variance: vehicles moving much slower or much faster than the median speed are over-involved in accidents ([5], [6], [7], [8], all derived from [4]).

Traffic efficiency is also influenced by traffic safety through the mechanism that prevented accidents lead to less congestion and associated benefits for throughput [2].

A3.3.2 Lateral support

These systems can decrease the number of unintentional lane departures, possibly leading to a decrease of side impact collisions. Potential side effect however are over reliance on the system and reduced alertness depending on the degree of lateral support (warning or keeping).

Traffic efficiency is also influenced by traffic safety through the mechanism that prevented accidents lead to less congestion and associated benefits for throughput.

Traffic efficiency can also be increased when a combination of lane keeping systems and narrow lanes is introduced [9]

A3.3.3 Obstacle detection & Collision Warning

Effects of this functionality are mainly traffic safety effects due to timely warning and/or interference. Indirect related traffic efficiency benefits are expected due to a reduction in incident related congestion.

Traffic efficiency is also influenced by traffic safety through the mechanism that prevented accidents lead to less congestion and associated benefits for throughput.

A3.3.4 Intersection Safety & Complex Situations

Vision enhancement can reduce the number of accidents by improving the driver's visibility during unfavourable situations. By doing so, valuable reaction time can be gained versus situations were visibility is poor. Possible side effects are an over-reliance on system, an increased exposure in unfavourable conditions (darkness) and new cohorts of less qualified drivers attracted. Strong potential is expected from intersection collision avoidance in complex urban and rural intersections

Traffic efficiency in complex situations is not influenced significantly by traffic safety through the mechanism that prevented accidents lead to less congestion and associated benefits for throughput, because in these situations there is usually not much traffic around (because of the time (night) and / or the location (urban, rural)). Of course when accidents are prevented on congested roads there are positive traffic efficiency effects to be found.

A3.4 Used literature and references

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A3.5 ADA systems

The systems shown in the ADASE-II roadmap represent the research topics of ADAS. The detailing of the system description depends on the complexity of the addressed functionalities. In order to give an impression which systems functionality is mentioned the systems are defined below. The definitions derived from the roadmap [1].

Night vision Based on camera techniques like near or far infrared it is possible to enhance the perception of the driver in dark light conditions. The picture of the camera will be shown to the driver by monitors or head up displays.

Lane departure warning If certain thresholds (like distance, time to lane crossing) allow a prediction of a lane departure this system warns the driver by means of acoustic, optic or haptic feedback. The detection of the lane markings results from e.g. video image processing.

Near field collision warning The near field collision warning includes the detection of especially vehicles in the near field like in the blind spot area. Suitable sensor systems for the detection of other cars are radar, lidar or vision based sensors. The warning can be acoustical, haptical or optical.

Curve & speed limit info When driving is not adapted to traffic signs or curvature, these systems inform the driver about his speed and the recommended speed by e.g. an optic or haptic (at the accelerator pedal) feedback. Possibly the necessary information can be taken from digital maps, image processing or communication systems between vehicles and infrastructure. The drivers have to be always aware of the problems arising from the actuality of the information e.g. from digital maps.

Stop & Go During stop & go traffic situation the longitudinal control of a vehicle will be partly carried out by a system. Therefore it is necessary to detect the traffic in front even in the near field. In extension to an ACC the detection of this area is necessary to react on other cars swerving into the near field.

ACC/Stop & Go + Foresight The ACC and Stop & Go function can be extended to a traffic related system by the means of communication. Far away driving vehicles will be involved into the longitudinal control. Thus, an end of a traffic jam can be included into the longitudinal control, before a driver is able to see it e.g. in a curve. Thus the traffic flow and the safety can be increased.

Lane Keeping Assistant The function of a lane keeping assistant system includes the lane detection and the feedback to the driver if he is leaving a defined trajectory within the lane. An active steering wheel can help the driver with a force feedback to keep on this trajectory. The lane is detected by a video image processing system.

Local Hazard Warning If a hazard occurs far away in front of the vehicle, so that the driver cannot see it, this system will warn him. By the means of communication it is possible, to transfer this information over long distances.

Lane Change Assistant Before and during a dangerous lane change process, the lane change assistant will warn the driver. Several stages of such a system are possible from pure warning systems to even haptic feedback at the steering wheel to help the driver following a lane change trajectory. The detection of all vehicles around the own car is necessary as well as the detection of the lane.

Obstacle & Collision Warning The driver will be warned if a potential collision is detected with e.g. another car or obstacle. This warning can be for example acoustic or visual. Complex scenarios like evading can be included as well as warn breaking, which is a very short brake in order to give a kinestetic feedback.

Rural Drive Assistance Most of the systems are developed for the use on highways. Between cities a lot of co called rural roads exist. The requirements compared to highways are higher e.g. because of closer curves or sight obstructions in combination with oncoming traffic.

Intersection Support In an intersection situation especially in cities a driver has to fulfil several tasks in parallel. Thus the potential for information overload is given. In order to assist the driver in such situations it is necessary to support certain tasks like approaching a stop sign / traffic light or right of way of crossing traffic.

Obstacle and Collision Avoidance This system has an extended functionality compared to the Obstacle and Collision Warning. An autonomous intervention overtakes partly the control of the vehicle in critical situations in order to avoid an accident. Longitudinal and lateral control will be done by the system.

Platooning Several cars are connected electronically (e.g. by the means of communication) and follow themselves in a platoon. An example is the connection of trucks in order to save space, fuel and to increase the traffic flow.

Autonomous Driving This is the theoretical highest level of driver assistance. The vehicle drives controlled by an algorithm in each situation. It is predictable that this stage assistance cannot be reached in the actual roadnet.

Annex 4 Barriers and requirements

Stop & Go

Barriers for introduction

Financial	Cost of system
Financial	Price/value ratio
Financial	No profit yet for OEM
Liability/Legal aspects	Reliability of system; liability
Liability/Legal aspects	Liability issue clear
Liability/Legal aspects	Clear legal conditions
Other	Frequency allocation
Other	M/T operation with S & G
Other	Standards to be made
Other	Unusual behavior in comparison to human drivers
Other	Drivers to understand limitations
Other	Public education
Other	Frequency assignment for short range radar
Other	Waiting for the ultimate sensor prevents solutions
Other	Autonomous braking? Risk compensation
Other	SRR frequency allocation
Other	Frequency allocation 24 GHz
Other	Ensuring it works + convincing motorists
Other	Risk of slower response by driver -> more accidents?
Other	MT market in EU
Technical	Reliability?
Technical	Reliability

Requirements for a decrease of 'aside' accidents

Do it

Fast introduction of systems

Requirements for a decrease of 'frontal' accidents

Positive effects for driver and traffic

100 % functionality

Requirements for a decrease of 'head-tail' accidents

100 % functionality

Driver education + HMI

Improved HMI usability

Communication with vehicles ahead

Requirements for a decrease of accidents with vulnerable road users

Detection of VRU's

Detection of small obstacles must be possible

Keep driver in 'the control loop'

Don't forget other 'objects'

Requirements for a decrease of 'singular' accidents

-

Requirements for a positive effect on traffic efficiency

Wide scale introduction

Longitudinal control algos

No increase of congestion

100 % functionality

Requirements for a positive effect on comfort

Adjustable dynamic by driver

Very reliable and smooth working system

Wide scale introduction

100 % functionality

ACC-Stop & Go + Foresight

Barriers for introduction

Financial	Cost
Financial	System cost
Financial	Costs; reliability
Financial	No profit for OEM's
Financial	Additional costs
Liability/Legal aspects	Liability + reliability of tech.; S & G costs
Liability/Legal aspects	Liability issue clear
Liability/Legal aspects	Information security of V2V communication -> liability
Liability/Legal aspects	Reliability, liability
Liability/Legal aspects	Clear legal conditions
Other	Frequency allocation (24 Ghz)
Other	Acceptance of drivers (some have, some not)
Other	Need good planning of ideal demanded speed possibly based on more preceding vehicles
Other	Frequency allocation
Other	Public education
Other	No communication standards for V to V communication
Other	Might lead driver to take higher risk because of 'protection' assumed
Other	How is foresight done? V2VC, V2IC -> penetration
Other	SRR frequency allocation
Other	Convincing motorists
Other	How to keep driver alert
Other	No experience from sales people
Technical	Automatic control
Technical	Accuracy + reliability of foresight information
Technical	Reliability of system
Technical	Reliability of function 100 %?
Technical	Deployment ratio
Technical	Reliability

Requirements for a decrease of 'aside' accidents

Do it

Create awareness that the ultimate system remains a dream

Requirements for a decrease of 'frontal' accidents

Create awareness that the ultimate system remains a dream

100 % functionality

Communication with other vehicles (Know what's going on ahead)

Requirements for a decrease of 'head-tail' accidents

100 % functionality

Communication with other vehicles (Know what's going on ahead)

Object classification

Dependent on HMI, workload etc. Goes for all types of accidents

Risk compensation may reduce the effect or even alter the effects

Driver education

Trust the system HMI, driver education

Requirements for a decrease of accidents with vulnerable road users

Detection of small obstacles must be possible

Driver awareness of 'undetected' obstacles

Consider pedestrian presence!

Requirements for a decrease of 'singular' accidents

Clear system limits

Requirements for a positive effect on traffic efficiency

High market penetration

Huge market penetration

Shortest possible headway < 1 second

Car2Car communication standard

100 % functionality

High market penetration

Requirements for a positive effect on comfort

Must be investigated yet

Drive it people have no experience

Driver intention needs to be taken into account (acceleration because of front vehicle)

100 % functionality

High market penetration

Driver will stay in control (& not gets lazy)

Positive marketing with good HMI

Curve speed limit info

Barriers for introduction

Liability/Legal aspects	Clear legal conditions
Liability/Legal aspects	Who garanteers that speed is safe -> liability
Liability/Legal aspects	Liability
Liability/Legal aspects	Liability for correct information
Other	Weather + friction information
Other	Quality of digital data for curve info
Other	Speed map data
Other	Data availability
Other	No standard: where is the info (speed limit) coming from? GPS? Radiotransmitter?
Other	Database must be precise (reliable enough) -> need 'ADAS' database from NT and TA
Other	Information collected, validated and made available
Other	An issue which is never addressed is the way the best/correct manoevre is calculated or if necessary to find it. I believe it is of paramount importance. More research on this has to be carried out.
Other	Security of information -> prevent hackers from producing traffic jams
Other	Speed limit data? From infrastructure? From video camera? Navi (database)?
Other	Standard on data source
Other	Navigation date base with high accuracy
Other	In the case of drivers to believe this function (Driver education)
Technical	System sophistication such as: - accuracy of the speed limit information; - timing of the alert

Requirements for a decrease of 'aside' accidents

-

Requirements for a decrease of 'frontal' accidents

Speed map data

Warning during critical road and weather condition

Depends on HMI, just informing does not has the same impact as supporting. For more positive affects we need supporting systems.

Requirements for a decrease of 'head-tail' accidents

-

Requirements for a decrease of accidents with vulnerable road users

Speed map data

Requirements for a decrease of 'singular' accidents

Recommended speed must be compatible with the ability of the driver, otherwise accident risk increases -> liability of information provider

Effective HMI

Recommended speed must me true for momentary weather condition and all vehicle types or dependent on actual vehicle driven

Working at night and bad weather conditions also

Requirements for a positive effect on traffic efficiency

If recommended speed is chosen much too low, efficiency goes down

Requirements for a positive effect on comfort

Actual limits

Good HMI

Decrease amount of false alarms: Adaptive to driver/situation

Situation adaptive HMI

Accuracy of speed definition + reliability

When available, link with automatic transmission (NAVIMATIC)

Lane keeping assistant

Barriers for introduction

Infrastructure	Good lane markings
Infrastructure	Reliability needs painted lanes -> infrastructure
Infrastructure	Good lane markings necessary
Infrastructure	Construction sites on highway
Infrastructure	How to manage construction site
Infrastructure	Quality of road surface -> sensors
Other	Reliable by all weather and traffic conditions
Other	I believe that in horizontal activity to most functions; what is lacking, is the calculation of the reference (=intervention manoevre). At present is seems to me that a 'simple' manoevre is enough for all the tasks
Other	End-user knowledge + education
Other	Acceptability by drivers
Other	Reliable. Factors:1) weather; 2) traffic; 3) road changes + special cases -> strange marks etc.
Other	Introducing LKA makes driver sleeping
Other	Need to ensure driver does not drive longer -> head-tail accidents
Other	Overtrust -> misuse
Technical	Poor sensor quality; lane markings
Technical	Electric steering
Technical	Limited resolution of images
Technical	Reliability/stability of sensor data. Are road markings visible? Are there road markings at all?

Requirements for a decrease of 'aside' accidents

Cooperative environment

Steer-by-wire

Requirements for a decrease of 'frontal' accidents

Sure system

Requirements for a decrease of 'head-tail' accidents

-

Requirements for a decrease of accidents with vulnerable road users

-

Requirements for a decrease of 'singular' accidents

Combination with active steering

Requirements for a positive effect on traffic efficiency

-

Requirements for a positive effect on comfort

High reliability

Positive if reliability is high -> good lane marks are prerequisite

User acceptance (despite increased driving performance with system)

Lane departure warning

Barriers for introduction

Financial	Costs too high
Financial	System cost/benefit for customer
Financial	Price expectation of OEMS -> Business makes no fun from the very beginning
Infrastructure	Often no road markings on rural roads. Dilemma: LDW especially useful on curvy roads
Infrastructure	Visible lane markings
Infrastructure	Infrastructure: good lane markings necessary
Infrastructure	Lane marking: complexity on the road-construction area; Road curvature (winding road lay out, nobody go along within the single lane!
Infrastructure	Reliability of warning (all roads)
Infrastructure	Quality of road marking – especially rural roads
Infrastructure	Infrastructure lane marking
Infrastructure	False alarm rate; environment: lane markings, poor sensor quality
Liability/Legal aspects	Legal Aspects
Liability/Legal aspects	Driver education + liability
Liability/Legal aspects	Liability
Liability/Legal aspects	Liability, needs lane marking, costs
Other	Less responsibility of the driver
Other	Market penetration
Other	Data reliability (Weather condition), Snow

Requirements for a decrease of 'aside' accidents

Cooperative environment in terms of: Quality of lane markings; Standard of lane markings all over EU

Algo for lane detection

Positive signal for driver (no irritation)

Requirements for a decrease of 'frontal' accidents

A combination with safe distance keeping

Sure warnings

Requirements for a decrease of 'head-tail' accidents

A combination with active systems

Risk compensation may result in negative safety effects

Ensure driver attentiveness

Requirements for a decrease of accidents with vulnerable road users

A combination with pedestrian/cycling detection

Lane detection also in cities functional

Requirements for a decrease of 'singular' accidents

A combination with active steering

Extend domain of operation (crossing, bifurcation)

High penetration necessary -> rumble strips are beneficial for all vehicles

Requirements for a positive effect on traffic efficiency

High market penetration

Requirements for a positive effect on comfort

HMI on haptic channel

Low false-alarm rate; 'sensibility' adjustable.

Reduced false alarm rate + haptic HMI (?)

Lane change assistant

Barriers for introduction

Financial	System cost
Financial	Affordable sensor technology
Financial	Cost effective sensor for long range detection (video, radar, lidar)
Financial	System cost: sensor versus mirror
Human Machine Interface (HMI)	HMI-function
Liability/Legal aspects	Liability
Other	I think that between sensor systems and intervention/warning there is a 'planning' phase worth of better study: e.g. who/what tells which should be the ideal corrective action? This applies to all functions.
Other	Driver education
Technical	Exact position and velocity of the other cars
Technical	As for as motorcycles are considered as vulnerable road users, it has a big impact on safety! -> but need to be good enough to consider motorcycle presence
Technical	Reliability
Technical	Make sure that all types of users (motorcycles) will be well detected at any speed in any visibility condition

Requirements for a decrease of 'aside' accidents

Including blind spot detection functionality

24 GHz frequency allocation YES!

Good reliability

Requirements for a decrease of 'frontal' accidents

Fore sighting necessary over 4 - 6 vehicles

Requirements for a decrease of 'head-tail' accidents

High detection range to rear (> 100 m ?) for highway

Requirements for a decrease of accidents with vulnerable road users

Not to be used in areas with pedestrians present

Needs to detect all roads users

Requirements for a decrease of 'singular' accidents

-

Requirements for a positive effect on traffic efficiency

-

Requirements for a positive effect on comfort

Reliability of the system

Including blind spot detection functionality

HMI may be too complicated