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Human Factors Guidelines Report 1: Literature Review

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Contents

1 Introduction

Driver assistance systems and automated vehicle systems will only be able to realize their full potential in terms of safety effects if they take the end-user into account in their design. In 2019, the Ministry of Infrastructure and Water Management commissioned “Human Factors guidelines for safe in-car traffic information services” [ID5308][1]. These guidelines are intended to provide both policy makers and manufacturers / service providers with guidance in the safety assessment of nomadic devices in vehicles, in particular devices that provide information, such as navigation systems.

In recent years, however, there has also been a strong increase in driver assistance systems, ADAS (Advanced Driver Assistance Systems), which interact with the driver, support tasks, and sometimes even (partly) take over the driving task. The current version of the guidelines contains little or no guidelines specifically related to ADAS. In view of the current developments, it is advisable to expand the guidelines with these types of systems, allowing both system designers and policy makers to take these into account. Here, we follow the definition of ADAS as given by the Dutch Safety Board: *“Advanced Driver Assistance Systems (ADAS) are systems that assist the driver in carrying out the primary driving task. ADAS observe the environment using sensors and are able to take over control of speed or driving direction, subject to the responsibility of the person at the wheel. Systems of this kind are also able to warn the driver in situations that the system considers dangerous.”* [ID14] Where possible, Automated Driving Systems (ADS) will also be included in the development of the HF Guidelines.

If there are guidelines that a design must meet, these guidelines can also be used to check if the design complies with them. In other words, where the "HF Guidelines" specify what should be taken into account in the design of in-vehicle systems, they can also be used for the evaluation of these systems when the guidelines are combined with evaluation tools and criteria. After all, a good system must comply with the guidelines. In the end the objective of the development of the "HF Guidelines" is to arrive at a uniform evaluation framework of the interaction processes between vehicle and driver.

RWS has asked Rijksuniversiteit Groningen (RUG) and TNO to provide these Human Factor Guidelines for ADAS and Automated Driving Systems.
To come to these guidelines a number of separate reports have been prepared:

- Report 1: Literature review and overview
- Report 2: Overview and description of the different driver support systems
- Report 3: Literature study on the use of ADAS and the mental models of drivers
- Report 4: Human Factor Guidelines for ADAS and Automated Driving Systems

[1] The ID numbers between square brackets refer to the ID in the repository as explained in Chapter 2.

- Report 5: Overview of required knowledge to convert HF guidelines into an evaluation tool.

The current report (Report 1) describes the results of a literature study on the topic of Human Factors of driving support systems. The main focus of the search is on the effects of driving support systems on driving behaviour, use, and acceptance of these systems. Both passenger cars and heavy vehicles (i.e., trucks and buses) are considered.

1.1 Selection of ADAS that are studied

For the selection of systems that are included in this report, we first created a longlist of possible intelligent systems in a vehicle and divided these into specific clusters in no particular order (Figure 1). Second, we selected the ADAS that fit in the abovementioned Dutch Safety Board definition [ID14]. In addition, all ADAS that fit the definition but do not require any interaction with the driver or have a relatively low safety impact (e.g., due to their design being intended specifically for parking and/or low speed situations) were discarded from the selection (Figure 1; yellow and orange cells, respectively). This procedure resulted in the inclusion of the following clusters and systems (see Table 1):

- Longitudinal control, speed limitation systems
- Longitudinal control, cruise control resembling systems
- Longitudinal control, crash avoidance systems
- Lateral control, lane keeping
- Lateral control, crash avoidance
- Driver state systems

Cluster	System(s)					
LO-Ctrl: Speed Limitation	Speed Control Function	Intelligent Speed Assistance, incl. Curve Speed Adaptation	Speed Limit Information Function			Active Driving Assistance
LO-Ctrl: Cruise Control	Cruise Control	Adaptive Cruise Control	Cooperative Adaptive CC	Platooning (Trucks)	Traffic Jam Pilot	
LA-Ctrl: Lane Keeping	Lane Departure Warning	Lane Keep Assist	Lane Centering			
LO-Ctrl: Crash Avoidance	Emergency Stop Signal	Forward Collision Warning	Brake Assist	Autonomous Emergency Braking	Autonomous/Assisted Emergency Steering	
LA-Ctrl: Crash Avoidance	Blind Spot Warning	Lane Change Assist	Turn Assist			
Driver State	Driver State Monitoring	Emergency Assist				
(Truck) Stability		Trailer Stability Assist (Trucks)	Active Rollover Protection			
Parking	Curb Warning	Park Distance Warning	Remote Garage / Parking Pilot	(Automatic) Parking Assist	Smart Summon	
Low Speed	Rear View Camera	Omni view / 360° (AR) View	Exit Warning	Cross Traffic Alert	Automatic Reverse Braking	
Visibility Aids	Adaptive Lighting	Traffic Sign Recognition	MirrorCam	Intelligent Headlight	Night Vision Assistant	
Impact Limitation	Pedestrian Protection System	Pre-Sense / Pre-Safe				
Information Support	Active Info Display / HUD	(AR) Navigation System	Tire Pressure Monitoring	Temperature Warning	Wrong Way Alert	
Control Optimisation	Anti-Lock Braking System	Electronic Stability Program	Traction Control	Hill-Hold Control	Hill-Descent Control	
Economy Driving	Gear Shift Indicator	Predictive Efficiency Assist				
Other	Acoustic Vehicle Alert System	Trailer Manoeuvre Assist				

Colour Code	Meaning
Green	Included according to ADAS definition OVV
Light Green	Indirectly included by means of similar system(s) in same cluster
Orange	ADAS, but with low safety impact
Yellow	ADAS, but with no interaction with the driver
Grey	No ADAS according to definition

Figure 1 Overview of ADAS and the inclusion in the study. Rows in the main table indicate different clusters of ADAS. LO-Ctrl = Longitudinal Control, LA-Ctrl = Lateral Control, AR = Augmented Reality, HUD =

Table 1 Systems included in this project

Abbreviation	*System*
ACC	Adaptive Cruise Control
ADA	Active Driving Assistance
AEB	Autonomous Emergency Braking
AES	Autonomous/Assisted Emergency Steering
BSW	Blind Spot Warning
CACC	Cooperative Adaptive Cruise Control
DSM	Driver state monitoring
EA	Emergency Assist
FCW	Forward Collision Warning
ISA	Intelligent Speed Adaptation
LC	Lane Centering
LCA	Lane Change Assist
LDW	Lane Departure Warning System
LKA	Lane Keep Assist
Platoon	Platooning (Trucks)
TA	Turn assist
TJA	Traffic Jam Assist

2 Method

A literature study was conducted to determine the availability and content of scientific and otherwise relevant literature with regard to system functioning and HMI of the selected ADAS (see section 1.1). Information was collected in a digital repository. This chapter first describes the repository, followed by the search and selection strategies of this literature study and its outcome.

2.1 Set-up of repository

The repository is a large (MS-Excel®) spreadsheet in which all found and used project-related literature is archived by means of an entry with a unique ID number. Within each entry, not only basic article information such as (first) author names, year of publication, title, and source information is made available, but the repository is also used to provide short descriptions about the aims of the entries, to score the relevance of articles for the project, and to assign keywords about the content of the articles for further indexing. During the duration of the project the repository is a 'living' document and additional sources of information will be added. While the repository builds, the spreadsheet automatically (cross) counts the number of keywords that have been assigned to the articles. In this way, an overview of the available content of the literature and source information can quickly be obtained based on article IDs.

2.2 Search strategy

First, the researchers included studies from personal and project-based databases[2] in the repository. This resulted in 435 entries.

Second, scientific literature searches were performed in SCOPUS, PsychINFO, and the TRID databases. Keywords were selected to be specific for ADAS and ADS and the interaction of these systems with the driver. Very general keywords, such as *human factors,* were not included in the search strategy because they give very general results that describe the driver HMI on a very high level that is difficult to use for ADAS or ADS.

Third, deliverables from international projects and ISO reports were included based on the relevance of the results for this project.

[2] Specifically:

- Study on the effects of automation on road user behaviour and performance (European Union 2020). Final report and repository by TNO, DLR, ITS-Leeds, VVA and TML. ISBN: 978-92-76-18834-6
- "How to maximize the road safety benefits of ADAS?", draft report by Royal Haskoning DHV, HAN University of Appplied Sciences and TNO for Fédération Internationale de l'Automobile (FIA) (Sept 2020)

SCOPUS

In https://www.scopus.com/, the following search query was run:

> TITLE-ABS-KEY (("ADAS" OR "driver assistance system" OR "automated vehicle" OR "vehicle automation" OR "automated driving") AND ("mental model" OR experience OR interaction OR takeover OR "take over" OR "TOC" OR "transfer of control")) AND (LIMIT-TO (LANGUAGE , "English"))

Total Hits: 4.131
Repository Duplicate Check: 107 (i.e., avoiding adding entries that were already in the repository)
Added to Repository: 4.024

PsychINFO

In PsychINFO, we searched by system name using the following search query:

> <SYSTEMNAME> AND “safety impact” OR interact* OR operat* OR mental model OR cogniti* OR supervis* OR awareness OR learning OR training OR knowledge OR skill OR understanding OR experience OR trust OR acceptance OR old* OR young* OR car* OR truck* OR bus* OR fail* OR “transition of control” OR takeover

Hits per SYSTEMNAME:

Cruise Control AND (77)
Lane Departure Warning AND (34)
Lane Keeping Assist* AND (5)
Lane Keeping System AND (15)
Lane Centering Assist* AND (1)
Steering Assist* AND (9)
Collision Warning AND (102)
Collision Avoidance System AND (55)
Collision Avoidance Assist* AND (5)
Forward Collision Warning OR FCW AND (45)
Autonomous Braking System AND (5)
Brake Assist* (7)
Blind Spot Detection AND (4)
Blind Spot Monitoring AND (4)
Platooning AND (11)
Traffic Jam Pilot AND (1)
Traffic Jam Assist* AND (1)
Traffic Jam System AND (2)
Congestion Assist* AND (3)
Intersection Assist* AND (23)
Crossing Assist* AND (20)
Cross Traffic Alert AND (2)
Intelligent Speed Adaptation AND (29)
Speed Limiter AND (1)
Curve Speed Warning AND (4)
Lane Change Assist* AND (3)
Lane Change AND ADAS (3)
Lane Change Support* (1)

Turn Support* AND ADAS (1)

Total Hits (sum of searches): 473
Unique Hits: 350
Repository Duplicate Check: 31
Added to Repository: 319.

TRID

In the TRID Database (https://trid.trb.org) we ran the following search query:

> ("ADAS" OR "driver assistance system" OR "automated vehicle" OR "vehicle automation" OR "automated driving") AND ("mental model" OR experience OR interaction OR takeover OR "take over" OR "TOC" OR "transfer of control"))

While also filtering on “Language of Publication = English”.

Total Hits: 732.
Repository Duplicate Check: 252.
Added to Repository: 480.

After this, the total amount of first entries in the repository was: 5.258. In the course of the project, some other entries were added to the repository, making the final number: 5379.

2.3 Selection strategy

The first step in manually selecting articles was to filter the SCOPUS, PsychInfo and TRID results on relevance with respect to “HF of ADAS or Vehicle Automation”. Hereafter, entries were excluded if the content of the article’s main topic was one of the following:

- EHMI: (i.e., “external HMI”, looking at how to provide information from a vehicle to other traffic participants outside the ego vehicle)
- Responses of other traffic participants to Automated Vehicles or ADAS
- People Movers
- Motion Sickness

The remaining titles and abstracts were scanned for relevance by the researchers. Articles were rated as relevant if they describe one or more of the selected ADAS either in terms of safety implications, technical functioning, or effects on HMI and driver behaviour. If an entry was judged to be relevant, the researchers manually assigned keywords to further index the articles. Keywords were generated while reading the abstracts and consensus about the keyword set was reached by means of direct, regular communication among the team members. This procedure resulted in the keywords as listed in Table 2 Keywords and frequency counts. .

Table 2 Keywords and frequency counts.

Keyword	Description	Count
TOC	Transition of Control.	191
trust	Trust in automation	162
mental_model	Including mode error, etc.	62
use	When, where, and how are systems used.	150
distraction	Driver distraction	100
learning	Learning; training to use system. Including what users know.	150
age	e.g., older or younger drivers.	74
acceptance	User acceptance of ADAS/Automated driving function	200
quantitative	Source contains something quantitative useful for the GL.	26
modality	e.g., audio vs visual vs haptic.	83
experience	e.g., experienced or novice drivers.	227
system_error	e.g., false alarms; malfunction.	49
FOT	Field Operational Test, including Naturalistic Driving.	76
sim	Driving simulator, Virtual Reality, etc.	231
test_track	Test track experiment.	13
safety	Safety Impact.	261
BA	Behavioural Adaptation.	88
SUG	Special User Group	5
workload	Driver workload	87
SA	Situation Awareness.	53
drowsiness	Driver drowsiness	35
system	Info about functioning of system (turning on/off, TOR, interface).	501
HV	Heavy Vehicle (e.g., truck, bus).	29
Subjective_only	Contains only questionnaires, round tables, focus groups, etc.	33
HAD	Highly Automated Driving	243
Guideline	Guidelines, or standard, or code of practice	45

After the first search, additional searches were conducted for all systems with fewer than 10 hits. These were AES, TJA, and EmergencyAssist. The search queries were broadened to only the system's name and alternative names without including additional keywords. The following queries were performed in Scopus, PsychINFO, and TRID:

AES: TITLE-ABS-KEY ("Evasive Maneuver Assist" OR "Evasive Steering Support" OR "Evasion Assist" OR "City Safety Steering Assist" OR "Automatic Emergency Steering")

Total Hits: 5.
Repository Duplicate Check: 2.
Added to Repository: 3. (All 3 papers concerned (concept) system descriptions).

EA: TITLE-ABS-KEY ("Emergency Assist" OR "Emergency Driver Assistant")

Total Hits: 15. Based on scanning the title or abstract, none were relevant.
Added to Repository: 0.

TJA: TITLE-ABS-KEY ("Traffic Jam Pilot" OR " Traffic Jam Assist" OR " Stop & Go Assist" OR "Congestion Assist")

Total Hits: 25.
Repository Duplicate Check: 9.
Not TJA-Related: 7 (Based on scanning the title and abstract)
Added to Repository: 9.

Furthermore, additional searches were performed on OEM websites or via Google, e.g., for technical information from car manuals. This procedure resulted in an additional 49 entries in the repository.

This yielded a total amount of 5.307 articles in the repository. Total amount of relevant articles in repository based on filtering title & abstract was 1.605.

Because the number of relevant articles based on title/abstract and keywords was still rather large, senior researchers indicated whether these articles were relevant for the project and needed further reading, based on their extensive experience in the field. This was mainly performed for the ACC, FCW, ISA, LDW, and LKA systems because there were more than 20 articles for each of these systems.

3 Results

This section provides a global overview of the available literature. The number of repository entries and assigned keywords (incl. counts) are displayed for each system first, grouped similarly to the clusters mentioned in section 1.1. These counts are based on the primary selection, i.e., on reading the title and abstract.

Hereafter, the full texts of the articles were scanned and the Repository IDs that were selected for further reading are provided in the sections “Selected Repository IDs”. In Chapter 5, an overview of these articles is provided including source information, assigned keywords, and a short description of (the aim of) the study (e.g., as is described in the abstract of the article).

3.1 ISA

Table 3: ISA search results and assigned keywords.

Keyword	ISA (46)
TOC	0
Trust	1
Mental Model	0
Use	8
Distraction	0
Learning	6
Age	2
Acceptance	16
Quantitative	0
Modality	4
Experience	0
System Error	1
FOT	9
Sim	7
Test Track	0
Safety	14
BA	10
SUG	1
Workload	2
SA	0
Drowsiness	0
System	16
HV	1
Subjective Only	2
HAD	0
Guideline	0

A useful number of papers were found which contain information about ISA. The focus of most of these is on acceptance, safety effects, behavioural adaptation, and system functioning.

Selected Repository IDs based on scanning Full Text (Includes Heavy Vehicles):*
ISA: [ID19], [ID28], [ID29], [ID162]*, [ID164], [ID181], [ID199], [ID211], [ID220], [ID561], [ID589], [ID5259], [ID5260], [ID5284], [ID5285], [ID5287], [ID5288], [ID5289], [ID5290], [ID5304].

3.2 ACC, CACC, Platooning, and TJA.

Table 4. ACC, CACC, Platooning, and TJA search results and assigned keywords.

Keyword	ACC (142)	CACC (15)	Platooning (20)	TJA (16)
TOC	18	1	4	4
Trust	20	0	0	1
Mental Model	20	0	2	0
Use	32	0	0	1
Distraction	5	0	1	1
Learning	18	0	0	0
Age	6	0	0	0
Acceptance	30	0	5	3
Quantitative	3	0	1	1
Modality	2	0	0	0
Experience	2	0	0	0
System Error	11	0	0	0
FOT	21	1	3	2
Sim	25	0	2	4
Test Track	2	0	0	0
Safety	23	3	2	4
BA	25	0	3	0
SUG	0	0	0	0
Workload	13	0	3	0
SA	7	0	2	0
Drowsiness	1	0	0	0
System	46	6	2	6
HV	4	0	6	1
Subjective Only	6	0	0	0
HAD	5	1	7	1
Guideline	2	2	1	0

ACC yields most system-specific articles. Most keywords are represented and there is also an ACC-dedicated literature review available [ID134]. An additional factor for the large number of ACC-related articles is that ACC is regularly studied as one of multiple, simultaneously used systems (e.g., together with LDW or LKA).

With regard to CACC, a fraction of the number of papers is available compared to ACC. This is most probably because CACC is not (yet) implemented and available

for use. CACC-related papers mainly concern system descriptions, (theoretical) safety impact assessments, and (expected) HMI requirements and implications.

For platooning a relatively small number of studies were found, which are mainly about TOC and Acceptance. It should be noted that, despite platooning being developed as an assistance system for trucks, the system is also studied by means of conventional cars (e.g., in car driving simulators).

The first search strategy on TJA did not reveal many studies (7) and therefore additional searches were performed, where the systems name was used as a keyword without any additional search terms to be able to find anything about the system (see 2.3). This was done for any system with fewer than ten results (e.g., also driver drowsiness detections systems). Some relevant papers were added, which resulted in articles mainly related to system functioning, safety, TOC, Acceptance, and trust.

Selected Repository IDs based on scanning Full Text (Includes Heavy Vehicles):*
ACC: [ID1], [ID5], [ID11], [ID15], [ID28], [ID29], [ID30], [ID74], [ID87], [ID97], [ID111], [ID122], [ID134], [ID136], [ID143], [ID153], [ID164], [ID170], [ID178], [ID229], [ID230, [ID424], [ID425], [ID493], [ID506], [ID663]*, [ID1589], [ID4916], [ID5252], [ID5265], [ID5273], [ID5284], [ID5285], [ID5287], [ID5288], [ID5289], [ID5290].

CACC: [ID28], [ID169], [ID403], [ID491], [ID493], [ID5265], [ID5276], [ID5286].

Platoon: [ID69], [ID77]*, [ID86]*, [ID130], [ID151], [ID458]*, [ID464], [ID560], [ID783]*, [ID926]*, [ID5261]*, [ID5305].

TJA: [ID1], [ID444], [ID482], [ID640], [ID683], [ID5261]*, [ID5295], [ID5297].

3.3 LDW, LKA, LC, ADA, and HAD

Table 5: LDW, LKA, LC, ADA, and HAD search results and assigned keywords.

Keyword	LDW (73)	LKA (46)	LC (15)	ADA (386)	HAD (243)
TOC	1	8	0	3	110
Trust	5	7	1	0	38
Mental Model	3	5	2	3	16
Use	14	11	3	11	15
Distraction	2	5	1	1	42
Learning	2	3	1	4	14
Age	7	0	0	1	9
Acceptance	16	8	3	0	46
Quantitative	0	1	0	1	0
Modality	2	1	1	0	28
Experience	3	1	0	45	6
System Error	5	2	0	0	8
FOT	10	6	0	2	8
Sim	9	11	0	1	71
Test Track	2	1	0	2	6
Safety	17	6	0	2	9
BA	9	7	0	1	19
SUG	1	0	0	0	0
Workload	3	5	0	0	19
SA	0	0	0	0	26
Drowsiness	0	1	0	0	8
System	28	18	8	25	38
HV	4	1	1	0	3
Subjective Only	3	2	0	0	10
Guideline	1	1	0	0	5
HAD	0	2	0	4	243

LDW and LKA systems are well-represented and nearly all keywords are covered. It should be noted that relatively many LDW and LKA studies are also shared with ACC and, therefore, their effects are not always studied in isolation. LC studies are less numerously available, although some behavioural effect studies were found. All LC studies on behaviour are shared with other systems (e.g. LDW, LKA, ACC).

Given the high number of articles with HAD content, this topic should also be well-represented in the repository.

Selected Repository IDs based on scanning Full Text (Includes Heavy Vehicles):*
LDW: [ID1], [ID5], [ID19], [ID28], [ID29], [ID45], [ID164], [ID170], [ID178], [ID422], [ID442], [ID462], [ID479], [ID495*], [ID497], [ID498], [ID506], [ID513], [ID528]*, [ID529], [ID597]*, [ID5260], [ID5262], [ID5269], [ID5284], [ID5285], [ID5287], [ID5288], [ID5289], [ID5290].

LKA: [ID1], [ID8]*, [ID11], [ID15], [ID19], [ID29], [ID30], [ID45], [ID97], [ID104], [ID136], [ID230], [ID429], [ID496], [ID4916], [ID5246], [ID5260], [ID5262], [ID5269], [ID5275].

LC: [ID424], [ID425], [ID506], [ID4916], [ID5269], [ID5284], [ID5285], [ID5287], [ID5288], [ID5289], [ID5290].

ADA: [ID885], [ID957], [ID1406], [ID1457], [ID5284], [ID5285], [ID5287], [ID5288], [ID5289], [ID5290].

HAD: [ID42], [ID69], [ID74], [ID79]*, [ID89], [ID130], [ID134], [ID151], [ID169], [ID458]*, [ID560], [ID777], [ID885], [ID920], [ID1080]*, [ID5246].

3.4 FCW and AEB

Table 6: FCW and AEB search results and assigned keywords.

Keyword	FCW (114)	AEB (31)
TOC	2	0
Trust	14	3
Mental Model	2	2
Use	11	4
Distraction	14	1
Learning	8	2
Age	9	0
Acceptance	18	0
Quantitative	10	1
Modality	20	0
Experience	4	0
System Error	13	3
FOT	15	2
Sim	33	1
Test Track	1	0
Safety	16	9
BA	6	1
SUG	0	0
Workload	4	0
SA	2	0
Drowsiness	0	0
System	40	15
HV	4	1
Subjective Only	2	2
Guideline	2	0
HAD	1	0

FCW systems are well-represented in the literature search, with nearly all keywords covered. AEB articles, however, mainly concern technical papers and impact assessments on safety. This could be due to the fact that the system will intervene in the driving task if its detection threshold is exceeded, regardless of what the driver does at that moment. The interaction-phase between the driver and the AEB system is a pre-collision warning, which, in principle, is FCW.

Selected Repository IDs based on scanning Full Text (Includes Heavy Vehicles):*
FCW: [ID29], [ID164], [ID170], [ID178], [ID206], [ID462], [ID477], [ID481], [ID493], [ID494], [ID513], [ID535], [ID584]*, [ID597]*, [ID804], [ID5252], [ID5260], [ID5262], [ID5274], [ID5278].

AEB: [ID5], [ID19], [ID29], [ID187], [ID481], [ID493], [ID505], [ID506], [ID527], [ID567]*, [ID804], [ID5252], [ID5259], [ID5260], [ID5284], [ID5285], [ID5287], [ID5288], [ID5289], [ID5290].

3.5 BSW, LCA, TA, and AES

Table 7: BSW, LCA, TA, and AES search results and assigned keywords.

Keyword	BSW (25)	LCA (17)	TA (15)	AES (12)
TOC	0	2	0	0
Trust	2	1	1	0
Mental Model	2	0	0	0
Use	5	0	1	0
Distraction	0	0	1	0
Learning	1	0	0	0
Age	1	0	7	0
Acceptance	3	2	3	0
Quantitative	0	0	2	0
Modality	1	0	3	1
Experience	0	1	1	0
System Error	0	0	1	0
FOT	2	0	0	1
Sim	1	3	7	1
Test Track	0	0	1	0
Safety	5	1	3	1
BA	1	1	2	0
SUG	0	0	0	0
Workload	0	2	0	0
SA	0	1	0	0
Drowsiness	0	0	0	0
System	15	10	5	10
HV	1	0	0	0
Subjective Only	3	0	0	0
Guideline	0	1	0	0
HAD	0	2	0	0

A limited number of studies were found for BSW and LCA. Furthermore, BSW and LCA are different terms that some authors use for the same system. Studies about BSW or LCA-specific behavioural effects are very limited. Additional search is recommended.

Turn Assist: A relatively low number of studies although most keywords are covered. More than half of the found studies concern different age groups (e.g.,

older drivers). This is not surprising, as in particular older drivers may have difficulties while driving at intersections.

AES: Small number of studies, mainly system descriptions. One behavioural study was found in which three different AES configurations were tested.

Selected Repository IDs based on scanning Full Text (Includes Heavy Vehicles):*
BSW: [ID462], [ID505], [ID506], [ID513], [ID597]*, [ID660], [ID5284], [ID5285], [ID5287], [ID5288], [ID5289], [ID5290].

LCA: [ID42], [ID89], [ID435], [ID553], [ID5256], [ID5262], [ID5270], [ID5277], [ID5285], [ID5288], [ID5290].

TA: [ID459], [ID472], [ID480], [ID522], [ID524], [ID555], [ID566], [ID570], [ID585], [ID587], [ID647], [ID5260].

AES: [ID1633], [ID5260], [ID5271], [ID5285], [ID5288], [ID5290].

3.6 DSM and EA

Table 8: DSM and EA search results and assigned keywords.

Keyword	DSM (23)	EA (6)
TOC	0	0
Trust	2	0
Mental Model	1	0
Use	3	0
Distraction	1	0
Learning	1	0
Age	0	0
Acceptance	3	0
Quantitative	0	0
Modality	1	0
Experience	0	0
System Error	0	0
FOT	3	0
Sim	6	0
Test Track	0	0
Safety	3	0
BA	2	0
SUG	0	0
Workload	0	0
SA	0	0
Drowsiness	8	0
System	13	5
HV	1	0
Subjective Only	1	0
Guideline	0	0
HAD	2	0

DSM: Entries about DSM largely concern system functioning for determining drowsiness. One entry includes DSM warning systems in terms of modalities, timing, reliability, design, acceptance, and trust [ID5272].

EA: No relevant scientific literature has been found so far. Only technical functioning-related information was found in car manuals.

Selected Repository IDs based on scanning Full Text (Includes Heavy Vehicles):*

DSM: [ID146], [ID179], [ID777], [ID816], [ID920], [ID1071], [ID5260], [ID5272], [ID5285], [ID5288], [ID5290], [ID5306].

EA: [ID5284], [ID5285], [ID5287], [ID5288], [ID5289], [ID5290].

4 Conclusions

There are many studies available on the topic of driving support systems and their effects on driving behaviour, use, and acceptance, which resulted in a total of 5.307 repository hits at the start of the project, of which 1.605 were rated as relevant based on the title and abstract.

The amount of available system-specific papers, however, depends on the time that these systems are available in concept or on the market. For example, most of these papers concern ACC. Furthermore, FCW, ISA, LDW, and LKA systems consist a large proportion of system-specific papers as well, all being systems which are somewhat more “mainstream” compared to other systems. This also means that the number of studies which concern ‘newer’ systems are less available, and some may be restricted to system functioning information from manuals only.

Most keywords that were assigned to the repository entries (> 100 keywords) concern system functioning, safety impact, user experience, acceptance, TOC, trust, learning, and use. However, because the “Heavy Vehicle” keyword is assigned to only 29 entries, the main focus is clearly on cars. Furthermore, the keyword ‘mental model’ is assigned to 62 articles, but these seem to mainly concern ACC and HAD. Additional searches about mental models in combination with systems other than ACC and HAD are required.

During the project additional literature was searched and added to the repository which eventually led to 5.379 entries, of which 1.662 were rated as relevant based on title and abstract. Furthermore, the searches were limited to the sources that were available for the authors and it could be that some relevant articles are missing. However, based on the amount of currently identified papers in the repository, this should give a sufficient impression of which information is available on the topic of driving support systems’ effects on driving behaviour, use, and acceptance.

5 Selected sources and short descriptions

[ID1] AAA (2020). Evaluation of Active Driving Assistance Systems (report). Washington, D.C.: American Automobile Association, Inc.

Keywords: ADAS; ACC; LKA; system; TJA; LDW; trust

Performance of 5 COST ADAS in practice was characterised. Evaluated on public highways and interstates.

Close-course testing as well as naturalisitic highway driving. Included an analysis of "events related to system operation", e.g. Lane departures; Erratic lane positioning; Inadequate braking; Unexpected speed fluctuations; Inappropriate following distance; unexpected system disengagement, failure to engage/re-engage.

[ID5] Harms, I. M., Bingen, L. & Steffens, J. (2020). Addressing the awareness gap: A combined survey and vehicle registration analysis to assess car owners' usage of ADAS in fleets. Transportation Research Part A: Policy and Practice 134, 65-77.

Keywords: ADAS; ACC; LDW; AEB; use; learning

Authors investigated awareness of ADAS as well as self-stated usage of the systems

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[ID8] Roozendaal, J., Johansson, E., de Winter, J., Abbink, D. & Petermeijer, S. (2020). Haptic Lane-Keeping Assistance for Truck Driving: A Test Track Study. Human Factors 0 (0), 0018720820928622.

Keywords: LKA; HV; modality; distraction; acceptance

Compared "continuous feedback," provides torques on the steering wheel that continuously guide the vehicle back to the lane center with "bandwidth feedback," that provides torques only when a certain lateral position threshold is exceeded.

[ID11] AAA (2019). Advanced Driver Assistance Technology Names; AAA's recommendation for common naming of advanced safety systems (report). Washington, D.C.: American Automobile Association, Inc.

Keywords: ADAS; ACC; LKA; system

Automakers have devised their own branded technology names (many!). This report concludes that there is a need for standardized terms and definitions for ADAS features, and proposes such a list for consideration shown within the tables below.

[ID15] Dunn, N., Dingus, T. & Soccolich, S. (2019). Understanding the Impact of Technology: Do Advanced Driver Assistance and Semi-Automated Vehicle Systems Lead to Improper Driving Behavior? (report). Washington, DC: AAA Foundation for Traffic Safety.

Keywords: ADAS; BA; FOT; ACC; LKA; drowsiness

A naturalistic driving study to 1) Investigate driver behavior and the associated risks of ADAS use; 2) Fill a critical knowledge gap by providing information regarding the potential for changes in driver error, drowsiness, secondary task engagement (STE), and eye-glance behavior (e.g., surrogates for distracted driving behaviors) relative to ADAS use; and 3) Investigate changes in safety-critical event (SCE; i.e., crash or near-crash) risk related to the use of ADAS.

[ID19] Kidd, D. & Reagan, I. (2019). Attributes of Crash Prevention Systems that Encourage Drivers to Leave Them Turned on. Advances in Intelligent Systems and Computing 786, 523-533.

Keywords: AEB; ISA; LDW; LKA; system

Survey study about the use of FCW, LDW, BSW and reasons to keep these systems on while driving.

[ID28] SWOV (2019). Intelligent transport and advanced driver assistance systems (ITS and ADAS). The Hague: SWOV.

Keywords: ADAS; ACC; CACC; ISA; LDW; system; safety

Dutch factsheet summarising definitions, safety effects, regulations, design principles, shortcomings, and reported use of multiple ADAS.

[ID29] Vlakveld, W. P. (2019). Veiligheidseffecten van rijtaakondersteunende systemenBijlage bij het convenant van de ‘ADAS alliantie’ (R-2019-14). Den Haag: SWOV.

Keywords: ADAS; FCW; AEB; ACC; ISA; LDW; LKA; safety; system

Overview of the safety impact of ADAS, as found in the literature of FOTs.

[ID30] AAA (2018). AAA Level 2 Autonomous Vehicle Testing; AAA propriety research into the performance of SAE Level 2 autonomous systems (report). Washington, D.C.: American Automobile Association, Inc.

Keywords: ACC; LKA; test_track; FOT; system

This work provides insight into the current state of transportation infrastructure as it relates to autonomous vehicle implementation. Findings from this work are intended to illustrate limitations that must be addressed to facilitate the eventual transition to fully autonomous vehicles.

[ID42] Madigan, R., Louw, T. & Merat, N. (2018). The effect of varying levels of vehicle automation on drivers’ lane changing behaviour. PLoS ONE 13 (2).

Keywords: LCA; HAD; acceptance; sim

Driving simulator study on the effect of varying levels of vehicle automation on drivers' lane changing behaviour

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[ID45] Miller, E. E. & Boyle, L. N. (2018). Behavioral Adaptations to Lane Keeping Systems: Effects of Exposure and Withdrawal. Human Factors 0 (0), 0018720818800538.

Keywords: workload; LDW; LK; BA

A driving simulator study to evaluate the longitudinal effects of an intervention and withdrawal of a lane keeping system on driving performance and cognitive workload.

[ID69] Heikoop, D., de Winter, J., van Arem, B. & Stanton, N. (2017). Effects of platooning on signal-detection performance, workload, and stress: A driving simulator study. Applied Ergonomics 60, 116-127.

Keywords: platoon; workload; HAD

By means of a driving simulator experiment, the effects on recorded and self-reported measures of workload and stress for three task-instruction conditions were investigated: (1) No Task, in which participants had to monitor the road, (2) Voluntary Task, in which participants could do whatever they wanted, and (3) Detection Task, in which participants had to detect red cars.

[ID74] Louw, T., Madigan, R., Carsten, O. & Merat, N. (2017). Were they in the loop during automated driving? Links between visual attention and crash potential. Injury Prevention 23 (4), 281-286.

Keywords: ACC; sim; HAD; TOC; SA

Driving simulator study about drivers' (n = 75) gaze fixations during SAE2 driving while approaching critical and non-critical events in 5 'out-of-the-loop' conditions. Main conclusion: automated driving systems should direct drivers' attention to hazards in less than 6 seconds before a critical outcome.

[ID77] Mioch, T., Kroon, L. & Neerincx, M. A. (2017). Driver Readiness Model for Regulating the Transfer from Automation to Human Control. In Proceedings of the 22Nd International Conference on Intelligent User Interfaces (pp. 205-213). New York, NY, USA: . ACM.

Keywords: TOC; mental_model; platoon; HV; SA; acceptance; BA; workload

This paper presents a Driver Readiness (DR) ontological model that specifies the core factors, with their relationships, of a chauffeur's current and near-future readiness for taking back the control of driving.

[ID79] Nilsson, P., Laine, L. & Jacobson, B. (2017). A Simulator Study Comparing Characteristics of Manual and Automated Driving During Lane Changes of Long Combination Vehicles. IEEE Transactions on Intelligent Transportation Systems.

Keywords: HV; acceptance; HAD; sim

This paper presents a back-to-back performance comparison of lane-change maneuvers using two automated driving approaches and manual driving. The lane changes were conducted in a moving-base truck driving simulator using an A-double long combination vehicle.

[ID86] Willemsen, D., Hueting, T., Joosten, B., Uittenbogaard, J. & Martens, M. (2017). Adaptive Virtual Tow Bar, research results 2016 (TNO 2017 R10330). Soesterberg: TNO Earth, Life Social Sciences.

Keywords: platoon; HV; toc; sim

The main question that is currently being asked in A-VTB is: 'How long does it take for a driver to regain control after having used a platooning automation function (A-VTB)?'. An estimator named Driver Readiness Estimator (DRE) will be developed to answer this question.

[ID87] de Winter, J., Gorter, C., Schakel, W. & van Arem, B. (2017). Pleasure in using adaptive cruise control: A questionnaire study in The Netherlands. Traffic Injury Prevention 18 (2), 216-224.

Keywords: ACC; subjective_only; acceptance; use; system; system_error

Dutch questionnaire study about the use of ACC by drivers (n = 182). ACC-users rate their system highly with an 8 out of 10, and are most pleased with ACC on high-speed roads and low-density traffic. Pleasure is greater for ACC with full-stop capabilities. Respondents who are displeased with ACC report 'occasional clumsiness' and 'dangerous situations', while pleased ACC-users value the complementarity of human and machine and emphasize the roles of responsibility and experience in using ACC.

[ID89] Banks, V. & Stanton, N. (2016). Keep the driver in control: Automating automobiles of the future. Applied Ergonomics 53, 389-395.

Keywords: HAD; workload; trust; TOC; sim; LCA

This research aimed to test the idea of driver initiated automation, in which the automation offers decision support that can be either accepted or ignored. The test case examined a combination of lateral and longitudinal control in addition to an auto-overtake system.

[ID97] Eichelberger, A. & McCartt, A. (2016). Toyota drivers' experiences with Dynamic Radar Cruise Control, Pre-Collision System, and Lane-Keeping Assist. Journal of Safety Research 56, 67-73.

Keywords: ACC; ADAS; LKA; acceptance; learning; system; system_error

Telephone interviews regarding acceptance and use were conducted with 183 owners of 2010–2013 Toyota Sienna and Prius models, which were equipped with adaptive cruise control, forward collision avoidance, and lane departure warning and prevention (Prius models only).

[ID104] Navarro, J., François, M. & Mars, F. (2016). Obstacle avoidance under automated steering: Impact on driving and gaze behaviours. Transportation Research Part F: Traffic Psychology and Behaviour 43, 315-324.

Keywords: LKA; sim

This experiment aimed to analyse unexpected obstacle avoidance manoeuvres when lateral control was delegated to an automated steering device (AS).

[ID111] Beggiato, M., Pereira, M., Petzoldt, T. & Krems, J. (2015). Learning and development of trust, acceptance and the mental model of ACC. A longitudinal on-road study. Transportation Research Part F: Traffic Psychology and Behaviour 35, 75-84.

Keywords: ADAS; ACC; learning; trust; mental_model; acceptance

FOT (n = 15 drivers; no ACC experience) about the learning process and the formation of trust, acceptance, and mental models for interacting with ACC. Reading the ACC manual before driving with an ACC is related to a quick learning process and formation of acceptance. However, ACC system limitations tend to diminish from the driver's mental model if these are not experienced while driving. Periodic reminders of ACC-system limitations are therefore recommended.

[ID122] Pereira, M., Beggiato, M. & Petzoldt, T. (2015). Use of adaptive cruise control functions on motorways and urban roads: Changes over time in an on-road study. Applied Ergonomics 50, 105-112.

Keywords: trust; mental_model; learning; ACC

FOT in which 15 drivers drove a BMW with ACC (incl. Stop&Go) and short-term learning and use was assessed. The results indicate that drivers used ACC on the motorway and in urban sections, and learning the different circumstances required different amounts of learning time. Drivers set ACC speed relatively high (on average higher than speed limit in urban sections, and high on the motorway being without speed limit). Default headway was preferred in the first urban sessions, followed by shorter headways later. Default settings are important as drivers may rely on these with first use.

[ID130] Willemsen, D., Stuiver, A. & Hogema, J. (2015). Automated driving functions giving control back to the driver: a simulator study on driver state dependent strategies. In 24th International Technical Conference on Enhanced Safety of Vehicles (ESV2015). Gothenburg, Sweden: June 8-11, 2015.

Keywords: TOC; HAD; platoon

This paper presents research into this transition. By taking into account the attentiveness of the driver, different strategies were evaluated in a simulator study to create an optimal transition given the situation at hand. The study concentrates on an automated platoon system 'Virtual Tow Bar'.

[ID134] De Winter, J. C. F., Happee, R., Martens, M. H. & Stanton, N. A. (2014). Effects of adaptive cruise control and highly automated driving on workload and situation awareness: A review of the empirical evidence. Transportation Research Part F: Traffic Psychology and Behaviour 27 (PB), 196-217.

Keywords: ACC; HAD; SA; use; system;

Literature review about the effects of ACC and HAD on workload and situation awareness. ACC-use only slightly reduces subjective workload and may free up mental capacity without affecting eye movements.

Furthermore, ACC-use may increase SA if the driver is motivated to search the environment. However, ACC-use deteriorates SA if the driver engages in non-driving related tasks.

[ID136] Kircher, K., Larsson, A. & Hultgren, J. A. (2014). Tactical driving behavior with different levels of automation. IEEE Transactions on Intelligent Transportation Systems 15 (1), 158-167.

Keywords: ACC; trust; sim; LKA; mental_model

This paper investigated how different types of automation affect tactical driving behavior, depending on trust in the system. Behavioral and gaze data from 30 participants driving an advanced simulator were recorded in four driving conditions, namely, manual driving, intentional car following, adaptive cruise control (ACC), and ACC with adaptive steering. Measures of trust in the systems were recorded with a questionnaire.

[ID143] Piccinini, G., Rodrigues, C., Leitão, M. & Simões, A. (2014). Reaction to a critical situation during driving with Adaptive Cruise Control for users and non-users of the system. Safety Science 72, 116-126.

Keywords: ACC; BA; learning;

Driving simulator study with inexperienced and experienced ACC users (n = 26). Drivers drove with and without ACC. The results indicate that ACC-use may lead to negative behavioural adaptation: the risk of colliding with a stationary vehicle stopped in the cruising lane of highway increased both in experienced and inexperienced ACC-users.

[ID146] Saini, V. & Saini, R. (2014). Driver Drowsiness Detection System and Techniques: A Review. (IJCSIT) International Journal of Computer Science and Information Technologies 5 (3), 4245-4249.

Keywords: DD; drowsiness

Short overview paper of different driver drowsiness detection techniques.

[ID151] Willemsen, D., Stuiver, A., Hogema, J., Kroon, L. & Sukumar, P. (2014). Towards guidelines for transition of control. In FISITA 2014 World Automotive Congress. Maastricht, The Netherlands: 2-6 June 2014.

Keywords: platoon; acceptance; HAD; BA

This paper concentrates on finding different parameters and settings that may influence the transition of control for a ‘virtual tow bar’ system that is being developed at TNO.

[ID153] Beggiato, M. & Krems, J. F. (2013). The evolution of mental model, trust and acceptance of adaptive cruise control in relation to initial information. Transportation Research Part F: Traffic Psychology and Behaviour 18, 47-57.

Keywords: mental_model, trust, acceptance, ACC

Longitudinal driving simulator study (n = 51) in which drivers received different forms of ACC descriptions. Conclusion: participants' mental model about ACC converges to the 'correct group' after using the system. Non-experienced problems tend to disappear from the mental model if these were not activated by experience. Automation failures do not negatively impact trust if these are known beforehand: Trial-and-error is therefore not sufficient for developing appropriate trust, acceptance, and mental models.

[ID162] TML (2013). Ex-post evaluation on the installation and use of speed limitation devices (Final report). Transport & Mobility Leuven.

Keywords: ISA; system; HV; safety

The overall objective of this study is to assist the European Commission with the ex-post evaluation of the "Speed Limitation Directive" and to explore and assess options for revising the Directive (ex-ante evaluation). These options include changing the maximum speed applied for HCVs, extending the scope of the Directive to Light Commercial Vehicles (LCVs, including Light Goods Vehicles and small buses, respectively N1 and M1 vehicles) and/or introducing requirements for the installation of various types of ISA. The analysis builds on a literature review, a survey among stakeholders and Member States, interviews, a stakeholder workshop and extensive data analysis and modelling.

[ID164] Benmimoun, M., Pütz, A., Ljung Aust, M., Faber, F., Sánchez, D., Metz, B., Saint Pierre, G., Geißler, T., Guidotti, L. & Malta, L. (2012). EuroFOT Final evaluation results (Deliverable D6.1).

Keywords: ACC; FCW; ISA; LDW; FOT; ADAS; ISA; use; system; BA

The euroFOT project was the first large-scale Field Operational Test (FOT) of multiple Advanced Driver Assistance Systems (ADAS) in Europe. It evaluated the impact of eight different ADAS on safety, traffic efficiency, environment, driver behaviour and user-acceptance in real life situations by collecting data from instrumented vehicles.

[ID169] Saffarian, M., De Winter, J. & Happee, R. (2012). Automated Driving: Human-factors issues and design solutions. In Proceedings of the Human Factors and Ergonomics Society 56th annual meeting - 2012. Boston, MA: .

Keywords: CACC; HAD; TOC

Conference paper overviewing the main challenges of interaction between human and automation in general. Also provides very concrete design requirements and solutions for CACC.

[ID170] Sanchez, D., Garcia, E., Saez, M., Benmimoun, M., Pütz, A., Aust, M. L., Gustafsson, D., Metz, B., Pierre, G. S., Tattegrain, H., Guidotti, L., Schindhelm, R., Heinig, I., Malta, L. & Obojski, M.-A. (2012). Final results: User acceptance and user-related aspects (Deliverable D6.3). EuroFOT.

Keywords: safety; FOT; ACC; FCW; LDW; acceptance

The euroFOT project is a large-scale Field Operational Test (FOT) undertaken in Europe in order to evaluate different Advanced Driver Assistance Systems (ADAS) with regard to user related aspects, traffic safety, efficiency and environment. Test vehicles instrumented with data acquisition systems and equipped with different ADAS have been provided by different manufacturers to drivers for everyday driving.

[ID178] Strand, N., Nilsson, J., Karlsson, M. & Nilsson, L. (2011). Interaction with and use of driver assistance systems: a study of end-user experiences. In Proceedings of the 18th World Congress on Intelligent Transport Systems. Orlando, Florida, USA: October.

Keywords: ADAS; ACC; FCW; LDW; use; trust

The paper explores drivers', i.e. end-users', self-reported interaction with and experiences of using five different advanced driver assistance systems (ADAS): adaptive cruise control, blind spot monitor, forward collision warning, lane departure warning, and driver state warning. Main themes investigated in three focus group interviews were (i) usage of system, (ii) functional limitations and trust, and (iii) driving behaviour and traffic safety.

[ID179] Wilschut, E., Caljouw, C. & Valk, P. (2011). Evaluation of in-car systems that prevent sleepiness (Report VTI notat12A-2011, pp 16-18). Link?ping: VTI.

Keywords: drowsiness; DD

This report provides an overview of methods to prevent drowsy driving of drivers

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[ID181] Lai, F., Hjämdahl, M., Chorlton, K. & Wiklund, M. (2010). The long-term effect of intelligent speed adaptation on driver behaviour. Applied Ergonomics 41 (2), 179-186.

Keywords: ISA, learning; BA

This paper investigates the impact of prolonged experience with an Intelligent Speed Adaptation (ISA) system on driver behaviour. Drivers' interaction with the ISA system was explored by means of data collected from long-term field trials carried out in the UK and Sweden.

[ID187] Wada, T., Hiraoka, S., Tsutsumi, S. & Doi, S. (2010). Effect of activation timing of automatic braking system on driver behaviors. In Proceedings of the SICE Annual Conference (pp. 1366-1369).

Keywords: AEB; system; trust

In this paper, effect of the braking timing of the system on the driver's behavioral changes that may reflect over-trust on the system will be investigated.

[ID199] Warner, H. & Aberg, L. (2008). The long-term effects of an ISA speed-warning device on drivers' speeding behaviour. Transportation Research Part F: Traffic Psychology and Behaviour 11 (2), 96-107.

Keywords: ISA; BA; learning

Between 2000 and 2003 a total of 61 test drivers had an ISA speed-warning device installed in their vehicles. Data from these trials show that, initially, the device greatly reduced the amount of time the majority of test drivers spent above the speed limit, and to some extent also reduced their mean speeds, but this effect decreased with time.

[ID206] Abe, G. & Richardson, J. (2006). Alarm timing, trust and driver expectation for forward collision warning systems. Applied Ergonomics 37 (5), 577-586.

Keywords: Trust; FCW; ADAS;sim; system_error

This driving simulator study focused on alarm timing and its impact on driver response to alarm. The experimental investigation considered driver perception of alarm timings and its influence on trust at three driving speeds (40, 60 and 70 mile/h) and two time headways (1.7 and 2.2 s). The results showed that alarm effectiveness varied in response to driving conditions.

[ID211] Rook, A. M. & Hogema, J. H. (2005). Effects of Intelligent Speed Adaptation HMI Design on Driving Behavior and Acceptance. Transportation Research Record (1937), 79-86.

Keywords: ISA, BA; acceptance; sim

The effects of human-machine interface (HMI) design for intelligent speed adaptation (ISA) on driving behavior and acceptance were measured in a moving-base research driving simulator study (n = 64)).

[ID220] Carsten, O. (2002). European Research on ISA: Where Are We Now and What Remains To Be Done. In ICTCT Workshop on Intelligent Speed Adaptation.

Keywords: ISA; system; modality; acceptance; BA

Overview article of what has been studied about ISA and what is yet to be known.

[ID223] Marchau, V., Wiethoff, M., Penttinen, M. & Molin, E. (2001). Stated Preferences of European Drivers regarding Advanced Driver Assistance Systems (ADAS). European Journal of Transport and Infrastructure Research 1 (3).

Keywords: subjective_only; ADAS; HV

In this paper the acceptance of potential users is explored regarding the first ADAS currently deployed. These systems involve proper distance keeping, speed limit adaptation and navigational support.

[ID229] Hoedemaeker, M. & Brookhuis, K. A. (1998). Behavioural adaptation to driving with an adaptive cruise control (ACC). Transportation Research Part F: Traffic Psychology and Behaviour 1 (2), 95-106.

Keywords: ACC; sim; BA; acceptance

Driving simulator study (n = 38) about the effects of driving style on driver behaviour with a new ACC system. Conclusions: drivers show behavioural adaptation in terms of higher speed, smaller minimum time headway, and larger brake force. Limited effects of driving style. Acceptance is also discussed.

[ID230] Stanton, N. & Young, M. (1998). Vehicle automation and driving performance. Ergonomics 41 (7), 1014-1028.

Keywords: ACC; LKA; workload; TOC

This paper presents a review of studies addressing adaptive cruise control and active steering systems. These studies suggest that there may be some cause for concern. They show a reduction in mental workload, within a secondary task paradigm, associated with some forms of automation and some problems with reclaiming control of the vehicle in failure scenarios.

[ID403] Dey, Kakan C. and Yan, Li and Wang, Xujie and Wang, Yue and Shen, Haiying and Chowdhury, Mashrur and Yu, Lei and Qiu, Chenxi and Soundararaj, Vivekgautham, 2016

Keywords: CACC; system

A literature review of CACC technical communication systems, driver behaviour, (expected) acceptance, design requirements, design effects, and implications.

[ID422] Gaspar, John G. and Brown, Timothy L., 2020

Keywords: LDW; trust; distraction

The current study investigated whether LDWs were more effective for drivers when they were distracted compared to when they were undistracted, using a high-fidelity driving simulator. During distracted lane departures, drivers with LDW responded faster and had less severe lane departures than drivers without LDW. During undistracted lane departures, there was no evidence of a benefit of LDW over no warning.

[ID424] Mueller, Alexandra S. and Cicchino, Jessica B. and Singer, Jeremiah and Jenness, James W., 2020

Keywords: ACC; LC; learning;

Paper describing the effect of learning what the different symbols mean in terms of automation. Paper describes the working principles of ACC and LC shortly. Results indicate that this kind of training helps to recognize when LC was active or inactive

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[ID425] Reagan, Ian J. and Cicchino, Jessica B. and Kidd, David G., 2020

Keywords: ACC; LC; trust; use

In this study, volunteer drivers operated five vehicles equipped with automated longitudinal and lateral control and completed surveys about their experience. A subset of drivers also documented uncomfortable experiences as they used the automation while driving.

[ID429] Benloucif, M. A. and Sentouh, C. and Floris, J. and Simon, P. and Popieul, J. C., 2019

Keywords: LKA; distraction

In this framework a study is conducted in order to investigate the effects of online adjusting the authority level of a lane keeping assist system to match the driver's distraction state while engaging in a demanding secondary task. The study took place in the SHERPA-lamih driving simulator.

[ID435] Guo, Chunshi and Sentouh, Chouki and Popieul, Jean-Christophe and Hau©, Jean-Baptiste, 2019

Keywords: LCA; TOC; system

In this paper, a shared control framework for driver's override of automatic steering control is proposed. At a higher level in the framework, the system detects driver's lane-change intention so that the low-level controller can actively assist the driver in a lane-change maneuver. The whole framework was evaluated in a user test based on a driving simulator.

[ID442] Navarro, Jordan and Deniel, Jonathan and Yousfi, Elsa and Jallais, Christophe and Bueno, Mercedes and Fort, Alexandra, 2019

Keywords: LDW; system_error

Driving simulator study investigating the influence of LDWS incorrect warnings along with the warning onset on driving performances.

[ID444] Pampel, Sanna M. and Large, David R. and Burnett, Gary and Matthias, Rebecca and Thompson, Simon and Skrypchuk, Lee, 2019

Keywords: TJA; TOC; quantitative

To investigate the impact of short (unplanned, 5 seconds) and long (planned, 50 seconds) traffic jam assist TOC requests, while playing/not playing an engaging tablet game, a simulator experiment was conducted with 16 participants.

[ID458] Zhang, Bo and Wilschut, Ellen S. and Willemsen, Dehlia M. C. and Martens, Marieke H., 2019

Keywords: HAD; Platoon; TOC; distraction; HV

In this study, truck drivers' take-over response times after a system initiated request to take back control in noncritical truck platooning scenarios were investigated.

[ID459] Becic, Ensar and Edwards, Christopher J. and Manser, Michael P. and Donath, Max, 2018

Keywords: TurnAssist; Age

This study examines the efficacy of an in-vehicle intersection crossing assist system in a real-world rural setting across age groups. Thirty-two, older and younger drivers completed several crossings of a busy rural intersection.

[ID462] Halabi, Osama and Bahameish, Mariam A. and Al-Naimi, Latefa T. and Al-Kaabi, Amna K., 2018

Keywords: BSW; LDW; FCW; modality; sim

This study investigated the effect of auditory and vibrotactile on directional attention in driver assistance systems. Moreover, two types of immersive displays were used in the driving simulation, namely the Head Mounted Display (HMD) and CAVE display, to study the effect of the type of display on the human performance.

[ID464] Heikoop, Dani´l D. and de Winter, Joost C. F. and van Arem, Bart and Stanton, Neville A., 2018

Keywords: Platoon; workload; SA; mental_model

In a driving simulator experiment, 33 participants completed three 40-min runs in an automated platoon, each run with a different level of mental task demands.

[ID465] Kidd, David G. and Reagan, Ian J., 2018

Keywords: ACC; LKA; FOT; acceptance; TOC; use; system

Fifty-one Insurance Institute for Highway Safety employees used an Audi A4 or Qty 7, Honda Civic, Infiniti QX60, or Toyota Prius for up to several weeks and completed surveys about their experiences. Each vehicle had adaptive cruise control (ACC), and the Audis and Honda had active lane keeping (ALK).

[ID472] Schoemig, Nadja and Heckmann, Martin and Wersing, Heiko and Maag, Christian and Neukum, Alexandra, 2018

Keywords: TurnAssist; age; acceptance; sim; modality

In a driving simulator study a speech-based driver assistance system for urban intersections (called Assistance on Demand AoD system) which supports the driver in monitoring and decision making was evaluated. The system provides recommendations for suitable time gaps to enter the intersection based on the observation of crossing traffic. Following an ‘‘on-demand”-concept, the driver activates the assistance only if support is desired.

[ID477] Winkler, Susann and Kazazi, Juela and Vollrath, Mark, 2018

Keywords: FCW; acceptance; sim;

This psychological driving simulator experiment investigated how to warn drivers visually in order to prevent accidents in various safety-critical situations. Collision frequencies, driving behavior and subjective evaluations of situation criticality, warning understandability and helpfulness of sixty drivers were measured in two trials of eight scenarios each (within-subjects factors).

[ID479] Aksan, Nazan and Sager, Lauren and Hacker, Sarah and Lester, Benjamin and Dawson, Jeffrey and Rizzo, Matthew and Ebe, Kazutoshi and Foley, James, 2017

Keywords: LDW; age; sim; SUG

The effectiveness of an idealized lane departure warning (LDW) was evaluated in an interactive fixed basedriving simulator.

[ID480] Bella, Francesco and Silvestri, Manuel, 2017

Keywords: TurnAssist; modality; sim;

The main objective of the present study was to assess, in response to a potential conflict event at the intersections, the effects of directional auditory and visual warnings on driving performance.

[ID481] Cicchino, Jessica B., 2017

Keywords: FCW; AEB; safety

The objective of this study was to evaluate the effectiveness of forward collision warning (FCW) alone, a low-speed autonomous emergency braking (AEB) system operational at speeds up to 19 mph that does not warn the driver prior to braking, and FCW with AEB that operates at higher speeds in reducing front-to-rear crashes and injuries.

[ID482] Dogan, Ebru and Rahal, Mohamed-Cherif and Deborne, Renaud and Delhomme, Patricia and Kemeny, Andras and Perrin, J©r¥me, 2017

Keywords: TJA; sim; TOC; distraction

A driving simulator study was carried out to investigate the effect of anticipatory information and non-driving-related task involvement on drivers' monitoring behavior and transition of control while driving with a Traffic Jam Assist.

[ID491] Li, Ye and Wang, Hao and Wang, Wei and Xing, Lu and Liu, Shanwen and Wei, Xueyan, 2017

Keywords: CACC; system; safety

Theoretical and simulation model study about the expected safety effects of CACC on rear-end collisions on freeways. Based on the Intelligent Driver Model (IDM), CACC may decrease the risk for such crashes dramatically, if properly setup.

[ID493] Li, Ye and Xing, Lu and Wang, Wei and Wang, Hao and Dong, Changyin and Liu, Shanwen, 2017

Keywords: FCW; AEB; ACC; CACC; safety

Theoretical and simulation model study about the expected safety effects of ACC, FCW, AEB, and CACC on reducing the risk for multi-vehicle rear-end crashes in bad weather. According to the Intelligent

Driver Model (IDM); ACC and FCW perform poorly in reducing rear-end crashes in bad weather. AEB performs better, although CACC performs best: probably due to the V2V communication not being obstructed by reduced visibility circumstances.

[ID494] Lubbe, Nils, 2017

Keywords: FCW; distraction; modality; sim;

This study contributes by quantifying brake reaction time and brake behavior (deceleration levels and jerk) to compare the effectiveness of an audio-visual warning only, an added haptic brake pulse warning, and an added Head-Up Display in reducing the frequency of collisions with pedestrians. Further, this study provides a detailed data set suited for the design of assessment methods for car-to-pedestrian FCW systems.

[ID495] Medina-Flintsch, Alejandra and Hickman, Jeffrey S. and Guo, Feng and Camden, Matthew C. and Hanowski, Richard J. and Kwan, Quon, 2017

Keywords: LDW; HV; safety

This paper presents the cost benefits of two different onboard safety systems (OSS) installed on trucks as they operated during normal revenue deliveries. Using a formal economic analysis approach, the study quantified the costs and benefits associated with lane departure warning (LDW) systems and roll stability control (RSC) systems.

[ID496] Melman, T. and de Winter, J. C. F. and Abbink, D. A., 2017

Keywords: LKA; sim; BA

The aim of the present driving simulator study was to examine whether haptic steering guidance causes BA in the form of speeding, and to evaluate two types of haptic steering guidance designed not to suffer from BA.

[ID497] Navarro, Jordan, 2017

Keywords: LDW; acceptance

The article presents several human factor theories relative to human–machine interactions and how they can explain driver behaviour using lane departure warning systems (LDWS).

[ID498] Navarro, Jordan, 2017

Keywords: LDW; acceptance

Corrigendum for article ID 497.

[ID505] Silla, Anne and Leden, Lars and Rämä, Pirkko and Scholliers, Johan and Van Noort, Martijn and Bell, Daniel, 2017

Keywords: BSW; AEB; safety

This paper presents the results of a quantitative safety impact assessment of five systems that were estimated to have high potential to improve the safety of cyclists, namely: Blind Spot Warning (BSW), Bicycle to Vehicle communication (B2V), Intersection safety (INS), Pedestrian and Cyclist DetectionSystem + Emergency Braking (PCDS + EBR) and VRU Beacon System (VBS).

[ID506] Souders, Dustin J. and Best, Ryan and Charness, Neil, 2017

Keywords: BSW; AEB; ACC; LDW; LC; age; acceptance;

This study investigated older (aged 65 and greater; N = 49) and younger (ages 18–23; N = 40) adults' valuation of a blind spot monitor and asked if self-reported visual difficulties while driving predicted the amount participants were willing to pay for a particular system (BMW's Active Blind Spot Detection System) that was demonstrated using a short video.

[ID513] Harper, Corey D. and Hendrickson, Chris T. and Samaras, Constantine, 2016

Keywords: BSW; LDW; FCW; safety

This paper evaluates the benefits and costs of fleet-wide deployment of blind spot monitoring, lane departure warning, and forward collision warning crash avoidance systems within the US light-duty vehicle fleet.

[ID522] Zhang, Yuting and Yan, Xuedong and Li, Xiaomeng and Xue, Qingwan, 2016

Keywords: TurnAssist; sim; quantitative; trust

This study focuses on exploring the patterns in drivers' eye movements as a function of ICAWS's warning conditions in red light running scenarios based on a driving simulation experiment. Two types of speech warning conditions including warning timings (varied form 2.5 s to 5.5 s) and directional information (with or without) are examined, and the no-warning condition is the baseline.

[ID524] Dotzauer, Mandy and de Waard, Dick and Caljouw, Simone R. and Pöhler, Gloria and Brouwer, Wiebo H., 2015

Keywords: TurnAssist; BA; age; sim; safety

Effects of an intersection crossing system were studied in a longer-term study involving 18 healthy older drivers between the ages of 65 and 82 years and 18 healthy young drivers between the ages of 20 and 25 years. Participants repeatedly drove 25 km city routes in eight sessions on separate days over a period of two months in a driving simulator.

[ID527] Hamdane, Hédi and Serre, Thierry and Masson, Catherine and Anderson, Robert, 2015

Keywords: AEB; system; quantitative

The purpose of this study was to analyze real crashes involving pedestrians in order to evaluate the potential effectiveness of autonomous emergency braking systems (AEB) in pedestrian protection.

[ID528] Hickman, Jeffrey S. and Guo, Feng and Camden, Matthew C. and Hanowski, Richard J. and Medina, Alejandra and Mabry, J. Erin, 2015

Keywords: LDW; HV; safety

The purpose of this study was to evaluate the two OSSs, lane departure warning (LDW) and roll stability control (RSC), using data collected from motor carriers.

[ID529] Huang, Zhi and Wu, Yiwan and Liu, Jian, 2015

Keywords: LDW; acceptance; sim;

In this paper, the pulse steering torque warnings technique is studied, and the effects of pattern, amplitude and frequency of pulse steering torque warnings on the effectiveness and customers' acceptance are studied through in-door experiments based on a fixed-based driving simulator.

[ID535] Meng, Fanxing and Ho, Cristy and Gray, Rob and Spence, Charles, 2015

Keywords: FCW; sim; modality

Three experiments were conducted to assess the effectiveness of dynamic vibro-tactile warning signals with different spatial patterns and to compare dynamic towards-torso and towards-head vibro-tactile warnings in a simulated driving task.

[ID553] Itoh, Makoto and Inagaki, Toshiyuki, 2014

Keywords: LCA; safety; acceptance

This paper discusses the design of a driver assistance system for avoiding collisions with vehicles in blind spots. The following three types of support systems are compared: (1) a warning system that provides the driver with an auditory alert, (2) a 'soft' protection system that makes the steering wheel stiffer to tell the driver that a lane-change manoeuvre is not recommended and (3) a 'hard' protection system that cancels the driver's input and controls the tyre angle autonomously to prevent lane departure.

[ID555] Lubbe, Nils and Rosén, Erik, 2014

Keywords: TurnAssist; quantitative; test_track

This study aims at quantifying driver comfort boundaries for pedestrian crossing situations to offer guidance for the appropriate timing of interventions.

[ID560] Skottke, Eva-Maria and Debus, Günter and Wang, Lei and Huestegge, Lynn, 2014

Keywords: HAD; Platoon; sim

In the present study, we tested to what extent highly automated convoy driving involving small spacing (“platooning”) may affect time headway (THW) and standard deviation of lateral position (SDLP) during subsequent manual driving.

[ID561] Spyropoulou, Ioanna K. and Karlaftis, Matthew G. and Reed, Nick, 2014

Keywords: ISA; sim; acceptance

In this paper driver behaviour changes when driving vehicles equipped with Intelligent Speed Adaptation (ISA) systems was studied. The primary tool used is a driving simulator. Three different ISA human machine interface functionalities are investigated: informative, warning, and intervening.

[ID566] Becic, Ensar and Manser, Michael and Drucker, Christopher and Donath, Max, 2013

Keywords: TurnAssist; age; distraction

The current study examined the impact of a drivers’ use of an in-vehicle intersection crossing assist system under demanding cognitive load conditions. 48 drivers crossed a busy rural intersection in a simulated environment while completing four blocks of trials, in half of which they used the assist system and engaged in a working memory task.

[ID567] Cafiso, Salvatore and Di Graziano, Alessandro and Pappalardo, Giuseppina, 2013

Keywords: ADAS; HV; safety; AEB; subjective_only

Operations managers for Italian bus agencies were asked to give their opinions, using a questionnaire, on safety issues related to drivers, vehicles and roads in order to evaluate their knowledge and perceptions regarding safety issues and the potential effectiveness of various new technologies.

[ID570] Dotzauer, Mandy and Caljouw, Simone R. and de Waard, Dick and Brouwer, Wiebo H., 2013

Keywords: TurnAssist; age; sim; BA; safety

In a longer-term driving simulator study, the effects of an intersection assistant on driving were evaluated. 18 older drivers (M = 71.44 years) returned repeatedly completing a ride either with or without a support system in a driving simulator.

[ID584] Wege, Claudia and Will, Sebastian and Victor, Trent, 2013

Keywords: FCW; HV; distraction;

The purpose of this field operational test study is to assess visual attention allocation and brake reactions in response to a brake-capacity forward collision warning (B-FCW), which is designed similarly to all forward collision warnings on the market for trucks. Truck drivers’ reactions immediately after the warning (threat-period) as well as a few seconds after the warning (post-threat-recovery-period) are

analyzed, both with and without taking into consideration the predictability of an event and driver distraction.

[ID585] Werneke, Julia and Vollrath, Mark, 2013

Keywords: TurnAssist; sim; acceptance

In a driving simulator study, two warning strategies varying in their timing: (1) top-down

warning while approaching a critical intersection and (2) bottom-up warning directly before the critical incident were investigated in a T-intersection situation. For the bottom-up warning, two warning signal designs were compared.

[ID587] Becic, Ensar and Manser, Michael P. and Creaser, Janet I. and Donath, Max, 2012

Keywords: TurnAssist; system; age; sim

The current study examines the transition from an infrastructure-based rural intersection crossing assist system to one located inside a vehicle. Moreover, we investigate the efficacy of the in-vehicle system. Three different designs of the assist system were examined regarding their impact on driving performance and applicability to varying age groups and visibility conditions. These designs differed in terms of their complexity based on the amount of information that drivers received about the intersection traffic.

[ID589] Carsten, Oliver, 2012

Keywords: ISA; safety

Editorial about ISA by Oliver Carsten

[ID597] Jermakian, Jessica S., 2012

Keywords: BSW; FCW; LDW; HV; safety

The objective of this paper was to estimate the maximum potential large truck crash reductions in the United States associated with each of four crash avoidance technologies: side view assist, forward collision warning/mitigation, lane departure warning/prevention, and vehicle stability control. Crash records were extracted from the 2004–08 files of the National Automotive Sampling System General Estimates System (NASS GES) and the Fatality Analysis Reporting System (FARS).

[ID640] Brookhuis, Karel A. and van Driel, Cornelie J. G. and Hof, Tineke and van Arem, Bart and Hoedemaeker, Marika, 2009

Keywords: TJA, acceptance, sim

To gain understanding of the effects of driving with a Congestion Assistant on drivers, mental workload of drivers was registered under different conditions as well as acceptance of the system.

[ID647] Mohebbi, Rayka and Gray, Rob and Tan, Hong Z., 2009

Keywords: TurnAssist, SUG

This study examined the effectiveness of rear-end collision warnings presented in different sensory modalities while drivers were engaged in cell phone conversations in a driving simulator.

[ID660] Kiefer, Raymond J. and Hankey, Jonathan M., 2008

Keywords: BSW; FOT

This in-traffic study explored the effect of a side blind zone alert (SBZA) system on driver lane change behavior. Such a system may help drivers avoid lane change crashes by warning them with a side mirror display when a vehicle is detected in their blind zone.

[ID663] Lin, Tsang-Wei and Hwang, Sheue-Ling and Su, Jau-Ming and Chen, Wan-Hui, 2008

Keywords: ACC; TOC; HV; sim; distraction; quantitative

This research aimed to find out the effects of in-vehicle distractions and time-gap settings with a fix-based bus driving simulator in a following scenario. Professional bus drivers were recruited to perform in-vehicle tasks while driving with adaptive cruise control (ACC) of changeable time-gap settings in freeway traffic.

[ID683] Van Driel, C. J. G. and Hoedemaeker, M. and Van Arem, B., 2007

Keywords: TJA; acceptance; sim

This paper describes the impacts of the Congestion Assistant on the driver in terms of driving behaviour and acceptance. Thirty-seven participants took part in a driving simulator study. The observed driving behaviour showed promising improvements in traffic safety when approaching the traffic jam.

[ID777] Zhou, F., Alsaid, A., Blommer, M., Curry, R., Swaminathan, R., Kochhar, D., Talamonti, W., Tijerina, L., Lei, B. (2020). Driver fatigue transition prediction in highly automated driving using physiological features. Expert Systems with Applications, 147,

Keywords: HAD; drowsiness; DD; system

In this research, the aim is to predict the driver’s transition from non-fatigue to fatigue in highly automated driving using physiological features. First, we capitalized on PERCLOS (i.e., PERcent of time the eyelids CLOSure) as the ground truth of driver fatigue. Next, we selected the most important physiological features to predict driver fatigue proactively. Finally, using these critical physiological features, we built prediction models that were able to predict the fatigue transition at least 13.8 s ahead of time using a technique called nonlinear autoregressive exogenous network.

[ID783] Castritius, S.-M., Hecht, H., Möller, J., Dietz, C.J., Schubert, P., Bernhard, C., Morvilius, S., Haas, C.T., Hammer, S. (2020). Acceptance of truck platooning by professional drivers on German highways. A mixed methods approach. Applied Ergonomics, 85, 340

Keywords: Platoon; acceptance; FOT; safety; HV

Level-2 truck platoon driving had not been tested with professional drivers in real traffic before. It was hypothesized that user acceptance would improve after the experience of platoon driving. Quantitative questionnaires and qualitative interviews were conducted with 10 drivers before and after an extensive Autobahn experience.

[ID804] Azevedo-Sa, H., Jayaraman, S.K., Esterwood, C.T., Yang, X.J., Robert, L.P., Tilbury, D.M. (2020). Comparing the effects of false alarms and misses on humans' trust in (Semi)autonomous vehicles. ACM/IEEE International Conference on Human-Robot Interaction, , 719-728.

Keywords: Trust; FOT; AEB; FCW; system_error;

This study presents a mixed design user experiment where participants conducted a non-driving task while traveling in a simulated semiautonomous vehicle with forward collision alarm and emergency braking functions. Results reveal that misses are more harmful to trust development than false alarms, and that these effects are strengthened by operation on risky roads.

[ID816] Cabrall, C.D.D., Stapel, J.C.J., Happee, R., de Winter, J.C.F. (2020). Redesigning Today’s Driving Automation Toward Adaptive Backup Control With Context-Based and Invisible Interfaces. Human Factors, 62 (2), 5491-31.

Keywords: DD; sim; distraction

In a driving simulator, 91 participants either supervised driving automation (auto- hand- on- wheel vs. auto- hands- off- wheel), drove with different forms of DMS- induced backup control (eyes- only- backup vs. eyes- plus- context- backup; visible- backup vs. invisible- backup), or drove without any automation. All participants performed a visual N- back task throughout.

[ID864] Lotz, A., Russwinkel, N., Wohlfarth, E. (2020). Take-over expectation and criticality in Level 3 automated driving: a test track study on take-over behavior in semi-trucks. Cognition, Technology and Work, , 113-115.

Keywords: test_track; HV; learning

A test track study was conducted, simulating highway driving with 27 professional non-affiliated truck drivers. The participants drove an automated Level 3 semi-truck while a non-driving-related task was available. Multiple time critical take-over situations were initiated during the drives to investigate four main objectives regarding driver behavior. (1) With these results, comparison of reaction times and behavior can be drawn to previous simulator studies. The effect of situation criticality (2) and training (3) of take-over situations is investigated. (4) The influence of warning expectation on driver behavior is explored.

[ID885] Yang, S., Kuo, J., Lenné, M.G. (2020). Effects of Distraction in On-Road Level 2 Automated Driving: Impacts on Glance Behavior and Takeover Performance. Human Factors, , 105352

Keywords: HAD; distraction, TOC; ADA; FOT; test_track

Thirty-six participants were recruited to drive a Tesla Model S in manual and ADA modes on a test track while engaging in secondary tasks, including temperature-control, email-sorting, and music-selection, to impose low and high distractions. During the test drive, participants needed to quickly change the lane as if avoiding an immediate road hazard if they heard an unexpected takeover request (an auditory warning). Driver state and behavior over the test drive were recorded in real time by a driver monitoring system and several other sensors installed in the Tesla vehicle.

[ID914] Laßmann, P., Reichelt, F., Stimm, D., Maier, T. (2020). User-centered design within the context of automated driving in trucks – guideline and methods for future conceptualization of automated systems. Advances in Intelligent Systems and Computing, 1131 AISC, 165-171.

Keywords: ADAS; SA; HV; distraction

Guideline of design process of an attention and activity assistance system for trucks

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[ID920] Sato, T., Takeda, Y., Akamatsu, M., Kitazaki, S. (2020). Evaluation of driver drowsiness while using automated driving systems on driving simulator, test course and public roads. Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics), 12213 LNCS, 717-720.

Keywords: HAD; Drowsiness; DD; FOT; sim

This paper describes an investigation of evaluation indices for assessing driver conditions when using an automated driving system. We focused on a driver drowsiness in the automated mode. A driving simulator experiment was conducted to identify evaluation indices which were sensitive to the subjective evaluation of the driver’s drowsiness.

[ID926] Castritius, S.-M., Dietz, C.J., Schubert, P., Moeller, J., Morvilius, S., Hammer, S., Tran, C.A., Haas, C.T. (2020). Truck Platooning Under Real Traffic Conditions: First Insights on Behavioral Adaptations and Gap Preference of Professional Drivers. Human Factors, , 133-144.

Keywords: HV; platoon; FOT

The aim of the study was to investigate (1) how different gap sizes are perceived by professional truck drivers under real traffic conditions and (2) whether semi-automated platoon driving leads to changes in driving behavior of subsequent manual driving.

[ID957] Loeb, H., Belwadi, A., Maheshwari, J., Shaikh, S. (2019). Age and gender differences in emergency takeover from automated to manual driving on simulator. Traffic Injury Prevention, 20 (sup2), 15-30.

Keywords: age; sim; ADA; toc; safety

The objective of this study was to explore how age and sex impact the ability to respond to an emergency when in a self-driving vehicle. 60 drivers were invited to ride in a driving simulator that mimicked a vehicle in ADA mode (longitudinal and lateral control).

[ID1071] Yi, D., Su, J., Liu, C., Quddus, M., Chen, W.-H. (2019). A machine learning based personalized system for driving state recognition. Transportation Research Part C: Emerging Technologies, 105,

Keywords: DD; drowsiness; system; FOT

This paper is mainly focused on developing a personalized driving state recognition system by learning from non-intrusive, easily accessible vehicle related measurements and its validation using real-world driving data. Compared to conventional approaches, this paper first highlights the necessities of adopting a personalized system by analysing feature distribution of individual driver's data and all drivers' data via advanced data visualization and statistical analysis.

[ID1080] Lotz, A., Russwinkel, N., Wohlfarth, E. (2019). Response times and gaze behavior of truck drivers in time critical conditional automated driving take-overs. Transportation Research Part F: Traffic Psychology and Behaviour, 64, 39-51.

Keywords: TOC; HAD; HV

For the first time take-over behavior of heavy duty truck drivers in time critical take-overs is considered in CAD research. This study analyzes the effect of non-driving related tasks, CAD duration, take-over situations and number of take-overs on reaction times of truck drivers.

[ID1406] Lv, C., Cao, D., Zhao, Y., Auger, D.J., Sullman, M., Wang, H., Dutka, L.M., Skrypchuk, L., Mouzakitis, A. (2018). Analysis of autopilot disengagements occurring during autonomous vehicle testing. IEEE/CAA Journal of Automatica Sinica, 5 (1), 52-59 and 74.

Keywords: -

This work analyses the first disengagements reports from Bosch, Delphi, Google, Nissan, Mercedes-Benz, Volkswagen, and Tesla Motors. Data from these disengagement reports with the aim of gaining a better understanding of the situations in which a driver is required to takeover, as this is potentially useful in improving the Society of Automotive Engineers (SAE) Level 2 and Level 3 automation technologies.

[ID1457] Dikmen, M., Burns, C. (2017). Trust in autonomous vehicles: The case of tesla autopilot and summon. 2017 IEEE International Conference on Systems, Man, and Cybernetics, SMC 2017, 2017-January, 679-685.

Keywords: -

In this paper, the results of a survey conducted with Tesla drivers about their experiences with two advanced driver assistance systems, Autopilot and Summon, are reported. It is found that drivers have high levels of trust in Autopilot and Summon. Trust decreased with age for Autopilot but not for Summon.

[ID1589] De Gelder, E., Cara, I., Uittenbogaard, J., Kroon, L., Van Iersel, S., Hogema, J. (2016). Towards personalised automated driving: Prediction of

preferred ACC behaviour based on manual driving. IEEE Intelligent Vehicles Symposium, Proceedings, 2016-August, 353-364.

Keywords: -

Paper about increasing driver acceptance of ACC with machine-learning algorithms which store ACC parameters based on observations of the driver.

[ID1633] Sieber, M., Siedersberger, K.-H., Siegel, A., Farber, B. (2015). Automatic Emergency Steering with Distracted Drivers: Effects of Intervention Design. IEEE Conference on Intelligent Transportation Systems, Proceedings, ITSC, 2015-October, 68

Keywords: EMA; sim; modality

Three different ADAS configurations for an automatic emergency steering intervention with small lateral offset were tested against an unassisted baseline condition in a driving experiment with distracted drivers.

[ID4916] Sullivan, John M. and Flannagan, Michael J. and University of Iowa, Iowa City, 2019

Keywords: LKA; LC; ACC; acceptance; trust

In this study, two types of lane keeping assist (LKA) were investigated: a lane centering system that continuously repositioned the vehicle in the center of the lane, and a lane departure prevention system that intervened when the vehicle wandered near the lane edge. Driver knowledge of each LKA (and accompanied ACC) were tested over a series of five drives.

[ID5252] Bärgman; J., Victor, T., 2019

Keywords: FCW; AEB; ACC; ADAS; safety; system_error

This study develops a method for holistic risk assessment focusing on the combination of glance behaviour and ADAS safety effects. It uses what-if computer simulations to (first paper aim) demonstrate the need for the combined risk assessment of (i) the effect of off-road glances, and (ii) the effect of ADAS (FCW, AEB, ACC, DA) being present and active when the glance data was collected.

[ID5253] Diederichs, F., Knauss, A., Wilbrink, M., Lilis, Y., Chrysochoou, E., Anund, A., Bekiaris, E. ... Bischoff, S., 2020

Keywords: ADAS; system; TOC; HV

This study has presented an HMI framework to be used as a method to define the adaptation of HMI elements to account for driver states, personalisation, and environmental conditions. Furthermore, a system architecture has been presented which gives an overview of how the different parts of the framework are connected and can be implemented.

[ID5256] Nagahama, A., Suehiro, Y., Wada, T., 2020

Keywords: LCA; sim; workload

The present study aims to propose assistance methods for merging, which decreases driver's workload and difficulty in decision making. The proposed methods recognize drivers' decision ambiguity using a decision-making model for respective drivers and instruct them on acceleration to decrease the ambiguity.

[ID5259] European Road Safety Observatory, 2016

Keywords: ADAS; ISA; AEB

Report containing definitions and (known and unknown) safety effects of multiple ADAS.

[ID5260] Euro NCAP (2020). Assessment protocol – Safety Assist (Version 9.0.3). European New Car Assessment Programme (Euro NCAP).

Keywords: ADAS; DD; ISA; AEB; FCW; EMA; TurnAssist; LDW; LKA

European New Car Assessment Programme

[ID5261] ERTRAC Working Group "Connectivity and Automated Driving", 2017

Keywords: ADAS; safety; TJA; Platoon; HV

The main objective of the ERTRAC Roadmap is to provide a joint stakeholders view on the development of Automated Driving in Europe. The Roadmap starts from common definitions and a listing of available technologies, and then identifies the challenges for the implementation of higher levels of automated driving functions. Development paths are provided for the different categories of vehicles.

[ID5262] ERTRAC Working Group "Connectivity and Automated Driving", 2019

Keywords: ADAS; FCW; LDW; LKA; LCA

The main objective of the ERTRAC Roadmap is to provide a joint stakeholders view on the development of Connected Automated Driving in Europe. The Roadmap starts with common definitions of automation levels and systems, and then identifies the challenges for the implementation of higher levels of automated driving functions. Development paths are provided for three different categories of vehicles (v2019).

[ID5265] Bu, F., Chan, C-Y. (2012), Adaptive and Cooperative Cruise Control. In: Eskandarian, A., Handbook of Intelligent Vehicles, pp. 191-208. London: Springer.

Keywords: ACC; CACC

Book chapter providing a comprehensive overview of ACC and CACC systems, designs, and human factors implications. Most information in this chapter is about ACC, CACC is shortly mentioned.

[ID5269] Gayko, J.E. (2012). Lane Departure and Lane Keeping. In: Eskandarian, A., Handbook of Intelligent Vehicles, pp. 689-708. London: Springer.

Keywords: LDW; LKA; LC; system

Handbook describing all kind of ADAS. Their functioning and how they should be designed is the main focus.

[ID5270] Bartels, A., Meinecke, M.-M., Steinmeyer, S. (2012). Lane Change Assistance. In: Eskandarian, A., Handbook of Intelligent Vehicles, pp. 729-758. London: Springer.

Keywords: LCA; system

Book Chapter 28 "Lane Change Assistance" about LCA requirements, system functions, test procedures, implementations, performance, and developments.

[ID5271] Dang, T., Desens, J., Franke, U., Gavrila, D., Schaefers, L., Ziegler, W. (2012). Steering and Evasion Assist. In: Eskandarian, A., Handbook of Intelligent Vehicles, pp. 759-784. London: Springer.

Keywords: EMA; system

Book Chapter "Steering and Evasion Assist" concerning the system's safety potential, technical design, HMI, and case studies.

[ID5272] Sayed, R.A., Eskandarian, A., Mortazavi, A. (2012). Drowsy and Fatigued Driver Warning, Counter Measures, and Assistance. In: Eskandarian, A., Handbook of Intelligent Vehicles, pp. 975-996. London: Springer.

Keywords: DD; modality; acceptance; trust

Book Chapter 37 (p. 975) concerning DD warning systems modality, timing, reliability, design, acceptance, and trust.

[ID5273] ISO 15622:2018. Intelligent transport systems — Adaptive cruise control systems — Performance requirements and test procedures

Keywords: ACC; system

ISO standard for ACC

[ID5274] ISO 15623:2013. Intelligent transport systems — Forward vehicle collision warning systems — Performance requirements and test procedures

Keywords: FCW; system

ISO standard for FCW

[ID5275] ISO 11270:2014. Intelligent transport systems — Lane keeping assistance systems (LKAS) — Performance requirements and test procedures

Keywords: LKA; system

ISO standard for LKA

[ID5276] ISO 20035:2019. Intelligent transport systems — Cooperative adaptive cruise control systems (CACC) — Performance requirements and test procedures

Keywords: CACC; system

ISO standard for CACC

[ID5277] ISO 17387:2008. Intelligent transport systems - Lane change decision aid systems (LCDAS) - Performance requirements and test procedures

Keywords: LCA; system

ISO standard for LCA

[ID5278] ISO 22839:2013. Intelligent transport systems - Forward vehicle collision mitigation systems - Operation, performance, and verification requirements

Keywords: FCW; system

ISO standard for AEB

[ID5284] Ford Focus 2018 User Manual

Keywords: ACC; LDW; LC; ISA; AEB; BSW; ADAS; EmergencyAssist; ADA

Ford Focus 2018 User Manual

[ID5285] Mercedes-Benz 2020 S class operator's manual

Keywords: ACC; LDW; LC; LCA; ISA; AEB; DD; BSW; ADAS; EMA; EmergencyAssist; ADA; system

Mercedes-Benz 2020 S class operator's manual

[ID5286] Wang, Z., Wu, G., Bartyh, M.J. (2018). A review on Cooperative Adaptive Cruise Control (CACC) systems: Architectures, controls, and applications. 21st International Conference on Intelligent Transportation Systems (ITSC), 2884-2891.

Keywords: CACC; system

In this paper, the progress achieved by researchers worldwide regarding different aspects of CACC systems is reviewed. Literature of CACC system architectures are reviewed, which explain how this system works from a higher level.

[ID5287] Owner's manual BMW 3 serie

Keywords: ACC; LDW; LC; ISA; AEB; BSW; ADAS; EmergencyAssist; ADA; system

Owner's manual BMW 3 serie

[ID5288] Owner's manual BMW 5 serie

Keywords: ACC; LDW; LC; LCA; ISA; AEB; DD; BSW; ADAS; EMA; EmergencyAssist; ADA; system

Owner's manual BMW 5 serie

[ID5289] Owner's manual Mercedes C-Class

Keywords: ACC; LDW; LC; ISA; AEB; BSW; ADAS; EmergencyAssist; ADA; system

Owner's manual Mercedes C-Class

[ID5290] Owner's manual Audi A5

Keywords: ACC; LDW; LC; LCA; ISA; AEB; DD; BSW; ADAS; EMA; EmergencyAssist; ADA; system

Owner's manual Audi A5

[ID5295] Rao, Sughosh J. and Forkenbrock, Garrick J. and Administration, National Highway Traffic Safety and Administration, National Highway Traffic Safety, 2019

Keywords: TJA; FOT; safety

The primary objective of the work described in this report was to evaluate test methods and metrics appropriate for the evaluation of traffic jam assist (TJA) system performance.

[ID5297] Urhahne, J. A. and Piastowski, P. and van der Voort, M. C., 2015

Keywords: TJA; sim; TOC

This paper presents the outcome of a driving simulator study regarding the evaluation of a control transition strategy. The strategy was found to provide adequate support to drivers. However, driver acceptance can be increased. A refined model is proposed.

[ID5306] Lemkaddem, A., Delgado-Gonzalo, R., Turetken, E., Dasen, S., Moser, V., Gressum, C., Sola, J., Ferrario, D., Verjus, C., 2018

Keywords: DD; sim; system

In this paper, we present an unobtrusive system that combines a dashboard-mount camera alongside with a watch-like wearable system recording optical (PPG) signals.
