Europe Chapter
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Understanding Human Behaviour in Complex Systems

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BOOK OF ABSTRACTS

Europe Chapter
Human Factors and Ergonomics Society

Organization Committee 2019

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WEDNESDAY OCTOBER 2nd

SESSION 1: AUTOMATION

Contradictions in cooperation with artificial intelligence: a sociotechnical systems perspective

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Utopian artificial intelligence (AI) views promise a brighter future that is approaching fast with expected impacts on the world of work. Reducing workload and letting people focus on more creative tasks, is heralded as a way to boost motivation and increase satisfaction with the job, by promoting a shift in role and skills (changing the job while keeping its overarching goal, as the concept of ambidexterity). However, there are cautionary warnings on potential AI downsides, with a focus on the data used for machine learning (such as AI is only as good as the data on which it is based). AI explainability and accountability to collaborators could help to reduce biases and increase fairness, requiring a specific set of skills from humans to understand the AI algorithms. The promise is that the joint cognitive system of people in organizations and AI will lead to high efficiency and high thoroughness, dismissing the need for efficiency-thoroughness trade-offs. However, the unintended effects of the change ought to be considered beforehand to the extent that they can be foreseen. The paper explores the notion of contradictions in cooperation with AI with several theoretical backgrounds as reference, including joint cognitive systems and organizational learning theory.

An adaptive assistance system for subjective critical driving situations: Understanding the relationship between subjective and objective complexity

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Germany

In recent years, assistance in vehicles has grown dramatically, with current advanced systems permitting partial automation and future systems promising conditional automation. The amount of time addressing the driving task has decreased and unexpected driving situations may arise that not necessarily require take-over but the driver feels the necessity to take-over. This can lead to difficult and potentially dangerous situations for the driver, as the driver needs to regain situational awareness, plan an appropriate route and act accordingly, based on the perceived situation complexity. In this paper, we introduce an assistance system that compares situations in which the driver previously felt the need to take-over, to suggest the redirection of attention towards the driving task in similar situations. Functionality of the system will be presented based on cut-in (sideswipe) manoeuvres. It will be shown that the proposed system learns freely, take-over suggestions may vary and adapt depending on driver's preferences and the driving scenarios that are encountered. The system also promotes the debate of the relationship of subjective and objective

perception of object constellations and complexities. This work delivers a system that can facilitate the research of the connection between subjective and objective complexity to improve advanced assistance systems.

The role of social stress in human-machine interaction

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The concept of social stress has attracted considerable interest in several domains of psychology (e.g. social psychology, clinical psychology), though it has not yet featured very prominently in the field of ergonomics. This review paper is concerned with the present and future role of social stressors in the field of human-machine interaction. In addition to humans, machine agents may also be the source of social stress in so-called hybrid teams given the increasing capabilities of automated systems. The paper provides a first draft of a classification system in which different social stressors are evaluated (e.g., social exclusion, negative performance feedback, illegitimate tasks). The review of the empirical research notably showed a lack of studies examining the link between social stress and performance. In particular, experimental (lab-based) work is lacking, which makes it difficult to examine cause-effect relationships. The possibilities of simulating social stress in the laboratory are examined, with ethical aspects being taken into consideration. We conclude that the field of ergonomics would benefit from a closer link between the separate research areas of social stress and automation.

I don‘t care what it does! Trust in automation in context of HRC with a heavy-load robot

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Reasons for implementing human robot collaboration (HRC) are diverse. While novel opportunities arise to design ergonomic work places, HRC also enables flexibility of increasingly complex production sites. The economic aim of process efficacy is thereby threatened by workers fear and mistrust in collaborative robots. Especially fenceless heavy-load robots go along with serious risks. Under- or overtrust in automation can result in serious injuries. An experiment with 26 participants and a heavy-load industrial robot was conducted in a real-world test field. Within-subjects effects of various robot trajectories and interaction levels between human and robot on emotional experience and trust in automation were examined systematically. Additionally, temporal position of first-failure was varied between participants. Robot trajectory, interaction level and position of first-failure did not reveal effects on trust. While participants showed short-term emotional responses to first-failure events, following scenarios were not influenced by first-failure regarding trust. In accordance with other research the results indicate a strong overtrust effect in automation. Implications for practical implementation of HRC are given.

SESSION 2: SURFACE TRANSPORTATION - 1

Measuring pedestrian behaviour in real traffic: Evaluating video and self-report data

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Germany

Pedestrian behaviour can be assessed with a variety of methods ranging from self-report to observation and simulation. In this study, we present a new approach for measuring pedestrian behaviour in real traffic that is time efficient and feasible by making use of instructed pedestrians and combining objective and subjective data. In a field study instructed pedestrians deliberately interacted with a research vehicle in urban traffic. Interaction scenarios focussed on instructed pedestrians either crossing or not crossing the street when the research vehicle passed by. Instructed pedestrians filled in 2687 self-report questionnaires about experienced scenarios from their point of view. Additionally, 75 hours of video-recorded interaction scenarios were gathered with a camera placed on the inside of the research vehicle. Self-report and video data were matched and evaluated regarding instructed pedestrians' communication behaviour, instructed pedestrians' crossing actions and the research vehicle's actions. Furthermore, instructed pedestrians' communication and crossing behaviour was compared to data from non-instructed pedestrians. Instructed pedestrians' subjective and objective data in large parts resembled one another, as did instructed and non-instructed pedestrians' data. Selected results from these analyses are presented, and advantages and disadvantages, as well as implications of this methodological approach, are discussed.

Training Wavedrivers online

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Spain

Traffic flows are managed worldwide assuming a car-following axiom: drivers must keep a safety distance when following other drivers. Current knowledge concerning car-following dynamics is increasingly connecting that axiom with an international plague: traffic congestions (Blanch et al., 2018; Lucas-Alba et al., 2019). We have already proposed that the so-called 'rational driver' should not just keep safety distance, but manage distance and speed in order to promote uninterrupted traffic flows. However, transforming traffic flows and eliminating traffic jams requires that each individual driver (human or non-human) understands their role in traffic flows, the genesis of traffic jams, and how to behave to avoid them. We have termed this adaptive, anti-jam behaviour Wavedriving. After some pilot studies (Melchor et al., 2018), this paper presents the consolidated design and structure of an online Wavedriving course (WDC) conceived to teach to avoid traffic jams and to evaluate its effects. The WDC follows the customary driving-school theory-then-practice way (i.e., watching tutorial then practice on simulator). Two mental analogies (the traffic light, the spring)

structure the modification of poor car-following schemes along three stages. Before-after empirical results concerning speed, distance, fuel consumption and platoon spacing are presented.

Studying the link between hazard perception ability and hard braking events by using a range of thresholds for hard braking

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Israel

Hard braking events are related to driver risk of collision. Therefore, researchers are studying the determinants of hard braking events. In this study, we tested the relationship between hazard perception (HP) ability and hard braking events with an original approach. Usually, researchers define hard braking according to a single deceleration threshold (e.g., g<-0.5). In this study, we chose different thresholds for hard braking (-0.25 to -0.6g) and for each threshold, we examined the linkage between HP test (HPT) scores and the proportion of hard braking events. We expected that this linkage would be stronger if the threshold for hard braking is higher, because stronger braking is more likely to result from later detection of hazards. We asked 33 drivers to complete an HPT and to drive three weeks with an application that registered their braking intensities. We ran multiple binomial regression models on the proportion of hard braking events- One for each threshold for hard braking. We found that the coefficient of HPT score was higher if the threshold for hard braking was higher. Our findings point to a relationship between HP ability and braking events and support the usage of ranges of thresholds to study such events.

Hybrid Electric Vehicle Drivers' Interaction with Eco-Automation: The Perspective of User-energy Interaction

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Germany

Although the implications of increasingly automated road transport for driver behavior are often studied from the perspective of safety and comfort, automation is also expected to increase energy efficiency and thus contribute to environmental sustainability. However, drivers' interaction with automated systems that optimize the vehicle's energy efficiency by controlling the energy flows has not yet been understood. Based on the perspective of user-energy interaction, the present research aims to contribute to closing this research gap. In a questionnaire study with 121 HEV drivers of the Toyota Prius (2, 3, c), we studied drivers' interaction with the vehicle's eco-automation. Results indicated high user diversity in the interaction with the eco-automation, ranging from complete reliance to active disengagement of eco-automation. These interaction patterns were significantly related to differences in fuel efficiency, as well as the drivers perceived trust and knowledge of the eco-automation. The study provides first evidence for the relevance of understanding drivers'

interaction with eco-automation to increase energy efficiency and contribute to sustainability of road transport.

SESSION 3: HUMAN-MACHINE INTERACTION / HUMAN-ROBOT INTERACTION

The making of Museum' works as smart things

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Most important purpose of understanding Human Behavior in Complex Systems is the making of personalized Human-Artificial dialogs for task-oriented co-operation. Among complex systems are teams of Museum' works that cooperate to build the museum visitors experience (VX), as user experience (UX), to enhance the learner experience (LX). Until now, museums' artworks were passive things people cannot interact with. The "CULTE" project is to offer visitors the possibility to dialogue with connected artworks displayed in the Museum through I.O.T. Thus, as connected objects, Museums' artworks become Smart Things by enriching the visitor experience through trans-media dialogs. We report the rationale for our approach: a problem-solving based approach that is used for designing a smart personalized dialoguing system integrating (i) the context of Museum's complex system, (ii) an ontology of the "what's about" and (iii) the three necessary dialogs components that are the Pragmatic, meta-cognitive and, - as the core of the dialog -, the cognitive components. For the purpose of modelling, from less to more situated, the COGNITION component is embedded in the METACOGNITION component that is in turn embedded in the PRAGMATIC/SEMANTIC component.

Information needs regarding the purposeful activation of automated driving functions

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Research mostly focuses on the period of automated driving and the transition back to manual driving, while overlooking the period before the activation of a conditionally automated driving (CAD) function. Attempting to close this gap, factors influencing the intention to use CAD, such as the potential to engage in non-driving related tasks (NDRTs), were analysed by means of a literature research. Furthermore, a focus group involving automated driving experts was performed to anticipate the drivers' information needs regarding an activation of CAD. These information needs as well as the drivers' expectations regarding the availability duration of CAD were investigated in an exploratory driving simulator study. For this purpose, participants (N = 15) experienced four scenarios with variable durations of availability regarding the CAD function in combination with NDRTs of different lengths. The information needs anticipated by the focus group were evaluated. Results show that before activating the automation, participants mainly desired to receive a display

of the availability duration, or otherwise, a display of the duration until CAD will be available. When CAD was not available, participants wanted to know the detailed reasons. The determined information needs are assumed to assist drivers in purposefully using CAD considering their planned NDRTs.

Investigating hyperlink selection with gaze-driven user agents

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Many websites are built with the basic assumption that conventional devices, such as mice and keyboards, are to be used as the primary input modalities. Such peripherals require a certain level of dexterity to operate and as a result, people with severe motor limitations are inherently excluded. Although advances in accessible gaze-based user-agent design have been made in recent years, certain web-based interaction scenarios are still problematic, presenting usability challenges for users. This work considers two specific problem areas, namely: (a) high link density areas (HLDA) and (b) navigation menus. HLDAs present a challenge due to the level of accuracy required to select links from a cluster of closely placed links, while navigation menus generally assume the use of click, tap or hover commands, none of which is natively afforded by an eye-tracker. This work proposes two novel interaction patterns, Quadtree-based Link Selection with Secondary Confirmation (QLSSC) for link selection in HLDAs and Hierarchical Re-Rendering of Navigation Menus (HRNM) for navigation menu interaction. These patterns were empirically evaluated against a gold standard approach through a lab-based single-blind study. Results for the emerging patterns are encouraging. This study also introduces 'Cactus', a purpose-built cross-platform web browser.

Social stress and performance in hybrid teams

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With the continuous development of technology and automation, people are increasingly likely to be confronted in their professional life with machines inducing social stress, (e.g. by giving negative performance feedback). We investigated the effects of negative performance feedback on subsequent performance, comparing a human or computer source. 90 participants were assigned to three groups: negative feedback on earlier performance from a supervisor (human source), from a computer program (computer source), or no feedback (control group). Subsequent performance was measured on different tasks (e.g. attention, creativity). Preliminary results indicate no effect of negative feedback on performance. Rather, negative feedback seems to be affecting subjective measures such as interpersonal fairness. These findings carry important implications for implementation of automated performance monitoring at work. Knowing how machine-induced

social stress affects an employee will be crucial in helping organisations adapt to increasing automation at work.

SESSION 4: HUMAN FACTORS IN HEALTHCARE

Why is circular suturing so difficult?

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Circular suturing is a challenging task used in both laparoscopic and robot-assisted minimally invasive surgery. In a radical prostatectomy procedure, circular suturing is performed to reconnect the bladder and urethra after the prostate has been removed. Task analysis of four different intracorporeal suturing techniques (linear vs. circular; laparoscopic vs. robotic) was conducted through interviews as well as video review with expert surgeons and observation of live surgeries. Results revealed that circular suturing involves more motoric and perceptual constraints than in linear suturing, requiring depth perception and proper alignment of two differently sized circular structures. Robotic techniques can reduce some of these constraints by providing a stereoscopic view of the circular structures and increasing the manipulability of the needle and tissue. Understanding the task requirements and limiting constraints will allow us to design more effective tools to improve the performance of circular suturing.

Reviewing Usability Standards for Medical Devices: Some Gaps and Possible Risks

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Computer-based medical devices become ever more widespread and sophisticated, for more diverse users and environments: their usability is essential, especially to ensure safety. Usability standards and guidelines play an important role; we reviewed several, especially EN 62366 and EN 60601-1-6. Standards condense for developers important knowledge from human factors research; but we argue they have potentially dangerous limitations, including: - neglect of the often complicated trade-offs involving usability and other system attributes such as safety and security, - a narrow depiction of the causes of use errors, singling out user interface design (e.g. the need to make alarms audible) to the detriment of other human factors (e.g. how to ensure that users not only hear alarms but act upon them). Yet research (regarding e.g. "automation bias") has shown major effects of these latter factors on use errors, - terminological inconsistencies and intentionally limited scope of the standards that may create "blind spots" for designers. We motivate our critique by examples from current research and incident reports, and take into account human factors culture in other advanced domains, specifically aviation. This work is relevant to designers applying the standards, standards committees, and researchers in human factors.

An extended version of the Dynamic Safety Model to analysis medical emergency team

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The Dynamic Safety Model (DSM, Rasmussen, 1997) constituted an original approach of safety issues. According to this model, adverse events are mainly caused by pressures coming from work constraints that lead operators' activity to migrate towards unacceptable limit of performance. In particular, Ramussen highlighted the economic and workload pressures exerted on activity, insidiously pushing operators to tolerate risky behaviours as long as no critical event occurs. Recently, Morineau & Flach (2019) proposed to extend DSM in order to fully integrate this model in the Cognitive Work Analysis framework by considering that: the model can be applied on different levels of granularity in organizations; workspace constraints can be specified differently according the analysis viewpoint; risk margins exist for each constraining boundary involving their own pressures and migrations; workspace constraints can be considered both as attractors and repellors; operators' activity corresponds with a dynamic trajectory in the workspace that seeks to coordinate the pressures exerted by the workspace constraints. Based on this extended version of DSM, complex work systems as loosely coupled with the work domain and involving conflicting goals can be analysed. In this scope, we proposed to analysis medical team activity confronted with a medical adverse event in an emergency room.

THURSDAY OCTOBER 3rd

SESSION 5: HIGHLY AUTOMATED VEHICLES -1

Driving with a L3- motorway chauffeur: How do drivers use their driving time?

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In a driving simulator study, N=30 drivers use a L3-motorway chauffeur during six driving sessions which take place at six different days. On four of the six session, the drive on the motorway lasts about 30 minutes, on the two other session about 90 minutes. Before every session, the drivers know the length of the oncoming trip and they are informed that they are free to prepare for the drive as they like to. This means for instance that they can bring something to read, something to eat or prepare other potential side tasks to fill the time of the automated drive. Furthermore, they are allowed activate, deactivate and override the L3-function as they like. Handling of the system, driver's state and drivers' engagement with self-chosen side tasks is continuously annotated by the experimenter for all drives. After every drive, evaluation and acceptance of the system is assessed with a questionnaire. Results will be presented on the usage of the system by the drivers. This includes for instance the frequency of system activation / deactivation and the types and frequency of engagement with self-chosen side tasks. The research leading to these results has received funding from the European Commission Horizon 2020 program under the project L3Pilot, grant agreement number 723051.

The Renaissance of Wizard-of-Oz

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The strong increase in momentum behind the development of automated systems leads to a change in paradigm with regard to the distribution of control in human-machine interaction. Therefore, in the context of automated driving, it is necessary to explore fundamental questions such as the interaction between driver and vehicle. However, the underlying piloted driving functions are still under development and thus can only be used for experimental studies to a limited extend. From a technical point of view, the introduction of autonomous systems results in an increased proportion of probabilistic components. Due to the resulting non-determined behaviour of the automation, it is difficult to perform studies in a systematic manner. A suitable method to study the effects of such "intelligent" probabilistic systems are Wizard-of-Oz (WoOz) set-ups, where a human simulates the behaviour of a technical system. The results obtained through WoOz driving studies are promising, but considering the system behaviour reproduced by the driving wizard researchers apply the method in different ways. Furthermore, there seems to be a lack of systematics regarding the experimental procedure, ethics and the guarantee of scientific quality. This article evaluates and

systematizes published experimental approaches and proposes a specification language for the driving wizard's behaviour.

Does driving experience matter? Influence of trajectory behaviour on student and experienced driver's trust, acceptance and perceived safety in automated driving

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Human factors studies in automated driving show preferences for anticipatory, safe and naturally-looking driving styles. Trajectory behaviour as one part of the driving style is mostly implemented as a lane-centric position of the vehicle in the lane. From a technical point of view this is a logical conclusion, but drivers show quite different preferences, especially in case of oncoming traffic. In manual driving, subjects react to oncoming traffic by moving to the right edge of the lane. This natural trajectory behaviour was transferred into an automated driving behaviour to compare a reactive trajectory with a static trajectory behaviour in a driving simulator using a within-subject experiment with 22 subjects aged 16 to 18. There were twelve oncoming traffic scenarios that varied in type (trucks and cars), quantity (one or two in a row) and position (cars in the middle of the oncoming lane and cars with lateral offset to the road centre) in balanced order. The paper focuses on the perception and rating of the different trajectory behaviours and the comparison with results of a previous study with 30 experienced drivers that showed higher level of perceived safety, acceptance, trust and subjectively experienced driving performance for the reactive trajectory behaviour.

Keeping drivers 'somewhat' in the perceptual-motor loop during conditionally automated driving

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How can we increase the safety of taking back manual control from conditionally automated vehicles (SAE Level 3; SAE, 2014)? A viable approach may be to keep drivers perceptually attuned and motorically calibrated to the environment (Mole et al., 2019). We tested this approach by recruiting 88 participants for an experiment in a dynamic driving simulator. We manipulated perceptual attunement via placement of a non-driving related task in a head-up display in the windshield (head-up), or a tablet near the gear shift (head-down). Motor calibration was manipulated by providing participants with uninterrupted automation throughout the ride, or four (noncritical) take-overs, forcing them to drive for 30 seconds before automation was reactivated. The effect of these manipulations was measured through a critical take-over after 13 minutes. Results showed that drivers in the "most in the loop condition" (head-up display & intermittent take-overs) needed significantly less steering wheel motor exploration and time to deactivate the system than the

participants in the “least in the loop condition” (head-down display & continuous automation). Keeping the driver somewhat in the perceptual-motor loop can thus have important effects on safe take-overs in conditionally automated driving.

Evaluation of Different Driving Styles During Conditionally Automated Highway Driving

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Discomfort and well-being of the driver and/or the passengers during automated driving as well as their acceptance and trust in the automation system are important criteria considering the usage of automated driving vehicles. Thereby, the driving behaviour of the automated vehicle plays an important role. For this contribution, we implemented three driving styles which differ only regarding the tactical driving behaviour on the manoeuvre level. Trajectory planning and control was identical. One driving style contained only lane following on the right lane without lane changes. The other two driving styles varied according to their lane change decision behaviour. To evaluate the aforementioned criteria of the driving styles, a driving study (N = 31) was conducted in real traffic on a highway with a test vehicle in which vehicle guidance was performed by an automation system. The results reveal that the well-being of the drivers is not influenced by the driving style. On the contrary, trust and acceptance are influenced by the driving style. Overall, 97% of the participants would prefer a driving style including lane change manoeuvres. However, 61% had the highest feeling of safety while driving without lane changes.

SESSION 6: INDUSTRIAL HUMAN FACTORS

Identification of behaviour indicators for fault diagnosis strategies

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In manufacturing the increasing automation leads to a rising demand for professionals fulfilling non-routine tasks like fault diagnosis of complex systems. Pre-knowledge is an important predictor for diagnosis quality and influences the strategies chosen by the operator. Simultaneously low occurrence rates of faults and working conditions like shift work hinder learning. Additional information can be offered during the diagnosis process but a challenge exists in deciding on timing and quantity. One way to estimate the useful amount of information is to recognize if the operator uses an associative, knowledge-intensive or a rule-based strategy. In an attempt to identify reliable criteria to distinguish these strategies, we asked 40 participants to operate the microworld AWASim (Urbas & Heinath, 2008) and confronted them with six fault scenarios. All participants received intensive training on the start-up and operation of AWASim and practiced the fault diagnosis and documentation beforehand. Fault scenarios were randomized; the sequence contained additional non-fault scenarios. We collected data on, inter alia, interaction with the microworld, eye movements, mental effort and perceived diagnosis certainty. The results show overlaps with known strategy classifications and various indicators emerged. We will discuss these indicators and their informative value regarding the strategy chosen by the operator.

Investigating the effect of passive exoskeletons on arms-elevated tasks

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France

Exoskeletons present interesting qualities for high demanding physical tasks, but their integration in companies is still a challenge. The aim of this study is to evaluate the effects of exoskeletons on the completion of arm-elevated tasks. Three categories of dependent variables are studied in a lab experiment: physical measurements (cardiac cost, EMG), performance indexes (quality and duration) and perceived benefits (reported by subjects on quantitative scales). The independent variables of the experiment are the presence (or not) of the exoskeleton, and the media used for the familiarization process of the subject before the use of the exoskeleton. Two levels of familiarization are proposed to the subjects: brochure of the exoskeleton manufacturer, and live tutorial demonstration by a skilled experimenter. A laboratory study (n=36 participants) involving two arms elevated tasks was specifically designed to simulate industrial work situations. Results show that the use of the exoskeleton reduces cardiac cost, global and local perceived effort, number of errors, and increases tasks performance. Concerning the familiarization process, the live tutorial demo provides

higher task performances and users acceptance, lower global and local perceived effort and number of errors. These results confirm that user acceptance and integration of exoskeletons in companies require training supports.

A Model for the Development of Railway Trainers in Integrating Non-Technical Skills into Training and Assessment: An International Case Study of Train Driver Trainer Skills Development

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Non-Technical Skills (NTS) are thinking skills underpinning technical tasks. Although established in other industries, such as aviation (typically as Crew Resource Management), NTS is new to the railway industry, which has a much more 'traditional' culture. A three-phased approach was used to develop operational trainers in integrating NTS into training content. The aim of the project was to get the trainer group to a level where they could independently develop NTS training materials. In between sessions, trainers experimented with ideas and developed NTS simulator scenarios for train drivers and operational managers. The project has achieved the objective of creating a small group within Nederlandse Spoorwegen (NS) who are able to develop and deliver NTS training materials. The approach is now being 'rolled-out' in the UK to a range of railway operators and engineering maintenance organisation.

Interpersonal trust to enhance cyber crises management

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In the field of cyber-security, software performance optimization is a major focus of research to better prevent cyber threats. However, once threats are detected, they have to be managed by a human operator or more often by human operators' joint actions. The purpose of this study is to show that in these collaborative situations, the interpersonal trust level between these actors shapes their handling of the threat. Forty-five participants performed with twenty-eight different fictive teammates, a collaborative counting task with aleatory phases of jamming. Each fictive teammate was described through two adjectives selected to induce a predefined interpersonal trust level (low or high). The subject and his collaborator were working on different systems with different objects to count and different jamming phases. Nevertheless, each participant had the possibility to supervise his teammate's work by checking out his task and modifying his answers (number of targets and jamming reported) if required. The subject was responsible for the validation of the final team's result. The experimental data show that, in this type of collaborative task, the interpersonal trust level has indeed an influence on the supervision strategy used and the team performance.

SESSION 7: NEUROERGONOMICS

Contributions of physiological markers to enhance Human-System Interaction in the aeronautical domain

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For decades, human-system interaction has been studied using subjective measures (i.e. questionnaires), behavioural markers (e.g. response time and accuracy), and more recently by measuring the Autonomous Nervous System (e.g. measures of cardiac and electrodermal activities). New technological developments have enabled the rise of portable and low cost cerebral acquisition devices: electroencephalography and functional near-infrared spectroscopy. This plethora of measurement techniques has opened the way for engineers and researchers to better assess operators' mental state in risky settings such as in aeronautics. The next challenge is to perform this assessment online and to use it to enhance the human-system interaction. Using illustrations from studies on fatigue and workload assessment performed at ISAE-SUPAERO, this presentation will address two key issues: i) how to perform mental state monitoring on single operators and dyads who interact with a system in an aeronautical setting; ii) how to close the loop by injecting this assessment into a control loop with a decisional system unit in order to enhance the human-system interaction.

Fault detection and correction in the engine room of a ship: An fNIRS study

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80% of errors that occur in the maritime sector are due to human error. These errors could be the result of seafarer inexperience coupled with a high mental workload. A simulator study was conducted to investigate the influence of training and distraction on the process of fault detection and correction in a maritime engine room. 20 participants were recruited, half received hands-on training on the engine room software interface, half read paper-based instructions. The participants interacted with a Transas 1:1 engine room simulator during a 30min scenario where they had to detect and correct a fault with the ballasting system. During this interaction, half of the participants received an additional task as a distractor where they were required to report various readings from the engine room interface. Functional near-infrared spectroscopy (fNIRS) was utilised to measure neurophysiological activation from the dorsolateral prefrontal cortex (DLPFC). The results indicated increased activation of lateral regions of the DLPFC during fault correction, this trend was enhanced due to training, i.e. participants who received paper-based training showed greater activation and distraction, i.e. greater activation for distracted participants. The results are discussed with respect to the neural efficiency of the operator during high mental workload.

Ecological EEG evaluation of auditory alarm perception during flight simulation

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ISAE SUPAERO, Université de Toulouse
France

Accidents analyses disclosed that critical auditory alarms could fail to reach awareness, with devastating consequences. It is possible to perform single trial classification to detect this inattention phenomenon using a 32-wet-electrodes EEG. Such systems are bulky and difficult to use in ecological environments. Our aim is to assess the feasibility of measuring auditory inattention through less invasive systems, to transpose them to real flight. In this study, we used both a dry-electrodes Enobio (Neuroelectrics) and around-the-ear wet-electrodes cEEGrid (TMSI) systems, recording respectively 8 and 16 channels. So far, 10 participants have been recorded with the two EEG systems in a flight simulator in motion. They performed an approach and landing on Toulouse airport, with two levels of difficulty/flight visibility, performing at the same time a standard oddball task. During this presentation we will show and compare the data recorded with the two systems. Behavioral data reveal more than 30% (34.87±7.22% and 42.32±9.14%) of misses in both conditions. EEG data are currently under analysis for inattentional deafness components, but using a small amount of electrodes in order to detect, analyze and classify ERPs and time-frequency components of inattentional deafness draws a promising avenue towards online monitoring of this phenomenon in a comfortable and real-life context.

SESSION 8: SURFACE TRANSPORTATION - 2

On-board HMI design for highly automated driving: Examining user's information needs about an automated car's driving intentions in two user studies

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With the development of progressively high and fully automated vehicles (AV), the role of a nowadays car driver will transform from an active operator into the future role of a mere user of the automated system. In effect, this will allow users to predominantly treat nowadays secondary tasks as the future primary ones. Consequently, this raises the question of the appropriate amount of information that should be conveyed by the on-board Human-Machine Interface (HMI) about AV's driving intentions, to the to-be user's needs for user acceptance. In order to address this gap in knowledge, we conducted two user studies. The first study (12 participants), an interview study, focused on assessing the information requirements of an AV for two conditions (distracted with a secondary task vs. non-distracted), using preliminary HMI designs. Results indicate that users demand minimal information, especially least in the distracted conditions and related to gender. Based on its results, the second study (33 participants) run in a VR driving simulator assessed the usability of HMI design suggestions which used a LED-band with rather minimal information compared to nowadays Head-down-display (HDD). Considering the findings with regard to AV's HMI design, proposed perception-based interaction design conveyed using LED-band is recommended.

Early Stages of Cooperative-Intelligent Transportation System acceptance : The SCOOP French FOT

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Car manufacturers and road managers launched a French research project in 2016 to evaluate the potential of a new Cooperative-Intelligent Transportation System (C-ITS): SCOOP@F. A large number of vehicles was equipped with the SCOOP system and Road Sign units were installed over 5 different regions in France including Bordeaux ring road. Our study is aimed at studying a priori acceptability (expectation), first experience, bounded experience and reconsidered experience. Using Bordeaux ring road was a unique opportunity to study acceptability in real conditions. A Renault Megane and a Citroen C4 were lent to a panel of 30 drivers with no link to automotive industry. Each driver could use the car for one week, in a naturalistic way with the only instruction of commenting the experience. Before and at the end of the driving session, the driver was interviewed a by a psycho ergonomist and during driving, driver could express feelings and experience using a voice recorder.

The use of the voice recorder clearly appeared as a powerful tool to recover first experience with the system that usually vanishes with subsequent memories. The study provided interesting results on users' needs in terms of C-ITS enhancements and in particular concerning the SCOOP system acceptability.

Driver's Experience and Mode Awareness in between and during transitions of different levels of car automation

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Germany

Highly automated driving will have a significant impact on our future mobility. When a driver uses a system that comprises different SAE level (L0, L2 and L3) the Human Machine Interface (HMI) needs to support the mode awareness of the driver at all times. While during L2 the driver has to monitor constantly, in L3 he can spend time on non-driving-related-tasks. The publicly funded project TANGO (Technology for automated driving, optimized to the benefit of the user) enables the design of an "attention and activity assistant" for automated truck driving in L2 and L3. The HMI of the project provides information about the automation level through different perception channels: visually via the instrument cluster and a LED strip, auditory via sounds and voice message and a haptically matrix within the seat. By conducting a driving simulation study, we investigated the usability of this HMI. Firstly, we wanted to find out how many and which automation levels the driver can cognitively differentiate from each other. Secondly, the goal was to determine if the HMI is able to support the mode awareness of the driver. Thirdly, we wanted to find out which parts of the HMI have the greatest impact on the mode awareness.

Objective kinetosis detection in a real driving scenario

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Germany

Passengers pursuing – not-driving-related – activities in the car, bear a higher risk of getting motion sick. Especially in autonomous cars this risk rises as all occupants are out of the loop regarding the driving task. This deficiency is mostly overcome by countermeasures. However, more work is needed to obtain objective sickness levels. There have been successful approaches towards detection using physiology in a laboratory environment. It would be challenging to reproduce the results in a real car. The aim is to develop an objective rating method allowing for the evaluation of measures without any subjective influences using multiple parameters. An approach in a real driving scenario will be presented along with first results. A study with a reproducible stop-and-go-scenario was conducted. About 40 participants – selected according to their kinetosis susceptibility – were exposed to the scenario for 17 minutes or until an abort criterion was reached. Physiological data such as

temperature, EDA, respiration and ECG were recorded using both, classic electrodes and touchless integrated sensors. The physiological data are referenced to a subjective rating on a scale from 0-6 (no symptoms – unbearable), logged on a minutely basis. Finally, the parameter's effectivity level is assessed regarding the objective rating method for motion sickness.

KEYNOTE

Towards human-robot symbiosis – control and co-operation with tools and vehicles

Prof. dr. ir. David A. Abbink
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Near-future robot capabilities offer great potential for the next evolution in our society – provided we can effectively control, cooperate and co-exist with this technology. My talk will focus on the research of my group at the Delft Haptics Lab, where we aim to better understand how humans physically perform dynamic control tasks with robotic tools or vehicles, and design multi-modal interfaces that facilitate control and co-operation. Our research consists of many iterative cycles of human modelling, interface design and human-in-the-loop evaluation, and my talk will also cover these three elements. First, I will present theory and computational models of the human as an adaptive and learning hierarchical controller that can easily move across strategical, tactical and operational levels of tasks. I will illustrate the power of leveraging understanding of low-level perception-action couplings, developed through techniques from neuroscience and system identification. Second, I will propose design guidelines for effective control and co-operation, with a particular focus on haptic shared control as a means to mitigate traditional human-automation issues. Third, I will highlight some 'lessons learned' in human factors experiments, and our search for methods and metrics that capture relevant human control behaviour. These three elements will be illustrated through practical applications of our work – from telerobotic arms operating in complex remote environments, to highly-automated driving. I will end with my personal perspectives for the future of our field, including topics like symbiotic driving (mutually adaptive driver-vehicle interaction, which essentially closes the loop on an iterative design and evaluation cycle), and the responsible integration of robotic technologies in our society.

FRIDAY OCTOBER 4th

SESSION 9: AVIATION

Visual anticipation in the real world: Does eye tracking data explain the aviation expert's skills?

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The present study aims to investigate whether the Visual Anticipation (VA) can be used to assess the trainee's air skills. The VA contributes to the development of situational awareness (Endsley, 1996), making it a key factor in aviation performance and safety. Blättler et al (2011) have shown that VA is larger among pilots than novices, but do pilots extract more appropriate visual information to anticipate than novices or do they improve their memory traces with the information contained in LMT? This study was conducted to separate these hypotheses during an experiment with 10 aircraft flight experts, 29 advanced beginners and 23 novice pilots from the French Air Force. Participants were shown dynamic real-world landing scenes in ego-motion (Thornton & Hayes, 2004) during a VA task. Eye gaze data were also recorded. The results show significant differences between novices and advanced beginners. These distinctions are correlated with different visual strategies. The experts' results are not consistent with current VA models and require further investigation. This study provides evidence that VA methodology can discriminate novices from advanced beginners with only a few hours of training which seems promising for evaluating the trainee's progress after real or simulated flight training.

Disentangling the Enigmatic Slowing Effect of Microgravity on Sensorimotor Performance

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Germany

The success of many space missions depends on astronauts' performance. Yet, prior research documented that sensorimotor performance is impaired in microgravity, e.g. aimed arm motions are slowed down and are less accurate. Several explanatory approaches for this phenomenon have been discussed like distorted proprioception or stress-related attentional deficits. In the current work, sensorimotor performance was investigated during aimed joystick-controlled motions in a simulation. The task included rapid as well as fine matching motions. Results of two different studies were compared: 1) a study utilizing a dual-task paradigm to investigate the impact of attentional distraction (N = 19) and 2) a study investigating the impact of microgravity during spaceflight (N = 3). In both studies, we found an overall slowing effect. Yet, results diverged when comparing feedforward vs. feedback controlled parts of aiming. Reduced attentional resources mainly affected feedforward control, which was reflected in significantly longer response times and longer rapid motion times. Microgravity, however, did not affect response times at all, but rapid aiming times as

well as fine matching times substantially increased. These findings provide first evidence that impaired attention is not the main trigger behind the slowing effect, but distorted proprioception which impairs feedback controlled, precise motions.

Teamwork in the Cockpit: The Impact of a Reduced Crew on Pilot Behaviour

Anja K. Faulhaber
Institute of Flight Guidance, TU Braunschweig
Germany

The cockpit of commercial aircraft is a complex sociotechnical system that is built upon the principle of redundancy to ensure safety – all systems and instruments are available twice to provide backup in case of failure. This applies also to the human component, even though the second pilot is not only a backup but both pilots share the work as a team. They usually assume the roles of a pilot flying (PF) and a pilot monitoring (PM). Research currently investigates the feasibility of Reduced-Crew or Single-Pilot Operations (RCO/SPO) which would entail drastic changes to the whole sociotechnical system. For an adequate redesign, we need to understand how the absence of the PM affects the PF's behaviour. A flight simulator study was conducted and fourteen pilots participated. Their task was to manually fly short approach and landing scenarios either with a PM or alone. A combination of quantitative and qualitative data was collected in the form of simulator parameters, workload ratings, eye tracking data, video recordings, and debriefing interviews. The results showed the importance of teamwork on various levels and pitfalls in human-autonomy teaming. Challenges and open issues that need to be considered in the development of potential RCO/SPO concepts were revealed.

The influence of audiovisual cues on remote pilot manual flying performance

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Remotely Piloted Aircraft Systems (RPAS) have facilitated new growth in civil aviation. However, compared to manned aircraft, accident rates are higher. A lack of audiovisual cues available to operators may account for the higher accident rate. RPAS can be operated in direct visual line of sight to the remote pilot (VLOS) or beyond VLOS with first-person-view imagery transmitted via onboard cameras (BVLOS). Auditory feedback from the propellers is only present in the VLOS condition, providing the remote pilot is close to the RPAS. Hence, the aim of this research was to examine the effect of audiovisual feedback on remote pilot manual flying performance. After training to operate an RPAS, eighteen fixed-wing aircraft pilots (three female) each flew six navigation and twelve spotting tasks. In counterbalanced permutations of three visual (control VLOS, BVLOS-Monitor, BVLOS-Goggles), two auditory (with and without auditory feedback) and two environmental (with and without wind) conditions, pilot performance was measured for timeliness, horizontal and vertical deviation. Timeliness and horizontal deviation improved under the BVLOS-Monitor condition

compared to control, whilst auditory feedback produced nuanced examples of improved and degraded pilot performance. Hence, task specificity combined with different levels of audiovisual feedback appears to influence remote pilot performance.

SESSION 10: HIGHLY AUTOMATED VEHICLES - 2

Monitoring visual strategies to detect the out-of-the-loop phenomenon in automated driving

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During highly automated driving, drivers do not physically control the vehicle anymore, but they still have to monitor the driving scene. This is particularly true for SAE levels 3 and 4, as they need to be able to react quickly and safely to a take-over request. Without such a (even partial) monitoring, drivers are considered out-of-the-loop (OOTL) and safety may be compromised. This OOTL phenomenon may be particularly important for long automated driving periods. The current study aimed at scrutinizing driver's visual behaviour for a prolonged period of highly automated driving (18 minutes). Intersections between gaze and 13 areas of interest (AOI) were analysed, considering both static (percentage of time gaze spent in one single AOI) and dynamic (transitions from one AOI to another) patterns. Then, a prediction of both self-reported OOTL level (subjective assessment) and driver's response to a critical scenario (success/failure to take over vehicle control on time) was performed using Partial Least Squares (PLS) regression models. The outputs of the PLS regressions paved the way for an online estimation of the OOTL phenomenon based on driver's visual behaviour.

How will autonomous cars interact with cyclists: an analysis of cyclist behaviour

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Despite much progress on vehicle automation in the last years, there are still barriers to overcome before autonomous vehicles would be able to drive on every road. In particular interaction with cyclist seems difficult for autonomous vehicles. Cyclists have many options when choosing how to behave, they can use the road, cycle path or pavement. They are small, so moving to the left, middle or right of a lane makes a difference. Although slower than cars, their speed can vary considerably (5 to 45 km/h) and quickly. Cyclists usually interact with cars in a complex urban area. Cyclists do not always follow traffic rules, making their behaviour even more difficult to predict. This work analyses cyclist behaviour and contextualizes it in their future interaction with autonomous vehicles. An overview of behaviour and situations is given and these are analysed showing how human drivers behave and how autonomous vehicles may do in those cases. The analysis is based on a literature survey, video analysis, and real-world observations. The results from this report will be used to inform a traffic simulation model to test different solutions and approaches to safety of Autonomous Vehicles.

Task load of professional drivers during level 2 and 3 automated driving

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As level 2 automated driving systems (SAE partial automation) become more elaborate, the similarity to a level 3 system (SAE conditional automation), from a driver's perspective, is gradually increasing. We examined differences in driver behaviour concerning level 2 and 3 automation in a driving simulator experiment with 31 professional truck drivers. All drivers received specific instructions concerning differences in the driver's role in both automation levels. Despite this, drivers had difficulties in adapting their behaviour to the differential demands of level 2 vs. level 3 driving. An analysis of driver reactions shows potentially critical lapses in attention during level 2 drives, when drivers were performing an engaging secondary task while driving. A comparison of drivers' gaze distributions suggests that these lapses are likely due to a deprioritization of on-road glances during task performance. These results highlight the difficulties that may accompany improvements of level 2 automation performance and underline the need for measures to assist drivers in adapting their behaviour accordingly.

Initial level of Trust and driver's behaviour during Automated Driving

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Trust in Automation is known to influence human-automation interaction and user behaviour. In the Automated Driving (AD) context, studies showed the impact of drivers' trust in the automated driving system on AD use, and also linked this trust with, e.g., difference in gaze behaviour or takeover performance. Here we investigated the influence of driver's initial level of Trust in Automated Vehicle (TiAV) on driving behaviour and further trust evolution during Highly Automated Driving (HAD). Forty drivers participated in a driving simulator study. Based on a trust questionnaire, participants were divided in two groups according to their initial level of TiAV: high (Trustful) vs. low (Distrustful). Declared level of trust, gaze behaviour and Non-Driving-Related Activities (NDRA) engagement were compared between the two groups over time. Results showed that trustful drivers engaged more in NDRA and spent less time monitoring the road compared to Distrustful drivers. However, an increase in TiAV after HAD was observed in both groups. These results suggest that initial level of TiAV impact drivers' behaviour and further trust evolution.

POSTERS

External HMI of communication and autonomous vehicles: a pedestrian's study

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France

Researches on autonomous vehicles increase for several years. One of the research scopes is the presence of an external HMI of communication (eHMI) on autonomous vehicles to indicate their intentions to other road users. To reduce both financial and time costs while testing user's understandability and acceptance, we used virtual reality technologies for this study. We tested three eHMIs to observe pedestrian's crossing behaviour and to collect their feelings about different types of vehicles (i.e., conventional vehicle with driver, autonomous vehicles without eHMI and autonomous vehicles with eHMI). Our study confirms the importance of setting up eHMIs. Indeed, they influence the decision of the pedestrians to cross the road. The proportion of pedestrians who cross in front of autonomous vehicles is greater for the vehicle equipped with eHMI than the vehicle without eHMI. In 10% of cases, pedestrians used circumvention strategies when they are faced to vehicle without eHMI. Furthermore, this behaviour appeared in particular when there is no protected infrastructure (e.g., pedestrian crossing). Moreover, if our objective data failed to determine whether one eHMI is preferable to another, the subjective data on the participants' preferences provide some interesting thoughts for further researches.

Objective Workload Evaluation with Lane Keeping Assistance System using Physiological Signal and Driving Performance Metrics

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The present study investigates the mental workload associated with driving in automated vehicle. Specifically, an experiment was carried out with N = 21 participant driving with Lane Keeping Assistance System (LKAS) in four real-world scenarios. The mental workload were measured with objective metrics such as heart rate (HR) and electrodermal activity (EDA), whereas the driving behaviour was evaluated with performance metrics like steering reversal rate (SRR), lateral position (MSDLP) and steering effort. The result suggested that LKAS has reduced physical workload in the steering task. However, the steering behaviour of LKAS was not ideal such that the steering reversal rate was significantly higher than driving manually. This additional effort was reflected in the physiological metrics. On one hand, an acclimatization effect of HR was found with a certain order introducing LKAS in the experiment. On the other hand, the count of skin conductance response (SCR) was significantly higher when driving with LKAS than manual driving. In summary, it is concluded that the additional attention was necessary to driver with the LKAS, particularly in the curvy scenario. The physical workload required as well as stressful events occurred has implied that LKAS has still some room for improvement.

Impact of Task Demands on Operators' Performance during Pilot-UAVs Interaction

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France

To move further with the future of Manned-Unmanned Teaming, the solution to enhance human-system interaction is to dynamically define agents' tasks according to their abilities. This work is intended to evaluate the impact of task demands on operator's performance in human-machine interaction setting. A realistic scenario was designed to mimic a search and rescue operation, in which human-agent (pilot) interacts with multiple UAVs from plane's cockpit. While piloting in the Aerofly simulator, one has to follow Air Traffic Commands (ATC) and answer UAV requests concerning identification tasks on a separate geolocation UAV monitoring interface named U-track. This displays real-time positions of the plane and the UAVs working alongside. Task demand is controlled by varying the difficulty of ATC commands, and the number of non-flyable zones pilot needs to avoid. The experiment has 2 high and 2 low workload states. Behavioral performance is measured by evaluating the response time and the accuracy of the identification task, as well as the flying parameters. Subjective measures of workload are obtained using the Instantaneous Self-Assessment workload survey, performed at the beginning and at the end of each experiment block. Preliminary behavioral and subjective impact of workload on human performance will be presented and discussed.

Steady, flashing, sweeping - An exploratory evaluation of light signals as an eHMI in automated driving

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Communication between automated vehicles (AVs), where the driver is potentially absent, and vulnerable road users (VRUs) requires a transformation to ensure road safety and comfort. External human-machine interfaces (eHMIs, e.g. light signals) offer one opportunity to communicate with VRUs in ambiguous traffic situations. Currently, the comprehension of eHMIs in AVs is rarely investigated. A total of N = 38 participants (two age groups: 65 years) evaluated (1) three different signal colours (white, purple and cyan) and (2) three different light signals (automation mode: steady light; starting mode: flashing light; and crossing mode: sweeping light), presented by a light bar placed on the test vehicle's roof. Comprehensibility, acceptance, trust, perceived usefulness and visibility of the signals were assessed by questionnaires and interviews in a field setting applying a within-subjects-design. Results indicate that the displayed light signals are rather unintuitive without prior information. Nevertheless, informed participants accepted and trusted the signals. Generally, light signals as eHMIs were evaluated as useful to communicate AVs' states and manoeuvres to VRUs. A descending order regarding signals visibility could be found for purple > cyan > white. Acknowledgement. The study was conducted within the project "InMotion – Light-based communication between automated vehicles and other road users" which is funded by the German Federal Ministry of Transport and Digital Infrastructure (BMVI).

A gender-sensitive data acquisition framework for quantification of trust and acceptance of advanced driver assistance systems

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The state-of-the-art on interaction between drivers and advanced driver assistance systems (ADAS) lacks studies in the field instead of a simulated environment. Beyond that, studies explicitly respecting diversity of drivers – e.g., age, gender, experience with ADAS – are underrepresented in research. Most studies infer their results from participant groups consisting of relatively young, technology-affine, male persons. Project GENDrive makes use of the recent possibility to conduct field studies with recently introduced commercial ADAS (Level 2). In order to maximize the generalization of insights, GENDrive tests within a field study 100 drivers with different characteristics. For this purpose, a set of heterogeneous variables coming from various data sources are recorded. Such interaction patterns are measured by various sensors aiming at gathering data from subjects as well as objectified vehicle data. These sensors range from qualitative data (e.g., interviews) to psycho-physiological measurements (e.g., skin conductance) to eye-tracking to data acquired from the vehicle itself (e.g., speed). Using methods of data science, these measurements are combined and synchronized in order to obtain a comprehensive view on drivers. In this way, results from GENDrive allow to draw conclusions on trust and acceptance related to ADAS covering a broader range of drivers.

Seat Belt Based Vibrotactile Warnings for Takeover Situations in Automated Driving

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Germany

The transition from automated to manual driving is the most critical situation for the safety and thus the success of automated driving. Acerbated by the fact that the driver can be engaged in non-driving related tasks, warnings have to precede the takeover and prepare the driver. While visual warnings might go unnoticed because of the attention being turned away, acoustic warnings can be annoying for the person in charge as well as for additional passengers. A solution to these shortcomings is seen in vibrotactile warnings directed directly to the driver. The effectiveness of seat belt based vibrotactile warnings for takeover situations was tested in a simulator study (motorway, length 50 km, N=40) both for a critical (relevant for Level 3) and a non-critical (relevant for Level 4) situation. In a randomized repeated measures design, each situation was tested with and without vibrotactile warning. For the critical situation safety was in the focus, for the non-critical situation it was comfort. The results showed a positive effect of the vibrotactile warning (faster reaction times, higher TTC) and no negative effects regarding comfort in the non-critical situation. These effects indicate the benefits of vibrotactile warnings for takeover situations in automated driving.

Headmovement measures in a real driving situation for understanding motion sickness development

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Activities in a car other than driving can raise the issue of motion sickness. It is known, that visual information can affect the symptoms (1), but the passenger's behaviour in the driving environment still has a lack of understanding. Especially braking to standstill with a high jerk leads to strong reactions of the passengers. Therefore understanding head- and eye-motion in terms of their active and passive nature can support the development of countermeasures. In a driving study, two conditions with the focus on A) a proceeding car and on B) a tablet-pc were conducted. A situation with longitudinal acceleration was generated to provoke the reactions. The conditions were tested in a within subject design with N=62 subjects divided into a high and a low susceptible group. The visual conditions produce the known effect that more visual information of the driving environment A) leads to less symptoms. Susceptibility has a significant effect on the symptom ratings. Further on a change in head movement occurs between the conditions. In detail, passengers in A) show an inverse movement about 230 ms earlier compared to the inertial nodding reaction seen in A) and B). This knowledge can be used to evaluate the effect of visual countermeasures in the car environment.

The usefulness of physiological data as indicator for situation awareness in semi-autonomous driving

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Switzerland

Car manufacturers are developing semi-autonomous cars in order to increase road safety and driver strain. In the near future, drivers in automated cars will be able to perform a secondary task while the car is driving autonomously, without requiring them to monitor the vehicle environment. In critical situations however, the driver may have to take over control of the vehicle. In order to propose an optimal support to the driver when a takeover is required, knowledge about their level of situation awareness might be useful. This piece of research addresses the question whether it is possible to use physiological indicators of drivers in order to evaluate their level of situation awareness in different takeover situations. Ninety participants took part in a semi-autonomous driving session in a fixed-base driving simulator. Half of them performed backward counting in order to manipulate cognitive workload. In addition to driving behaviour, subjective data and physiological measures such as electrodermal activity and electrocardiogram have been recorded. Data analysis indicates that physiological data might be an interesting indicator for situation awareness in automated driving.

Integration of Human Information Processing Models for Human Centred AI

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The Nederlands

Human Information Processing models have a long history in explaining human behaviour, the acquisition of skills, and performance in multiple tasks (dual-tasking). In this talk we present not only an overview of current models in Human Information Processing but also an integration of these models and how this integration can be used to explain interaction behaviour of humans with (complex) systems, especially in autonomous driving. For example, in Jansen, van Egmond & de Ridder (2016) we proposed an integration of the Threaded Cognition Theory and Hockey's Compensatory Control Model to explain human preferences and task prioritization in a dual-task situation. Human Information Processing models will become more important because in autonomous driving systems the role of AI will become increasingly more prominent. Especially, if the level of autonomy increases from level 1 through 5: from a mere driving assistance system (e.g., adaptive cruise control) towards a complex decision system in which the AI system completely takes over the role of the driver. Our premise is that a properly functioning AI can only exist if we can explain this behaviour in corresponding Human Information Processing models in order to predict human-interaction-behaviour in all driving situations.

This is not a gun: The influence of cue plausibility on performance in visual inspection of cabin baggage

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This study investigated the effects of cue plausibility (i.e. how similar to a target is a cued non-target) in a baggage screening task. 120 novice screeners (i.e. student participants) were instructed to determine whether a prohibited item was present (or absent) in a series of grey-scaled X-ray images of cabin baggage. They were assisted by an imperfect support system which surrounded the exact location of a potential target object if it detected one. A 3-factorial experimental design was used with cue plausibility (high or low), system reliability (high or low) and justification for system failures (provided or not) as between-subject factors. Results showed better detection performance for low-plausibility cues than for high-plausibility cues. As expected, performance improved with increasing system reliability. Finally, providing a justification for system failures (JSF) resulted in an increase in response time. This suggest that JSF may have made participants more cautious which lead them to delay their responses without affecting accuracy. Furthermore, the results showed that high-plausibility cues have a negative impact on novices' performance, which may be reduced by effective (computer-based) training.

Virtual planning concept for the Human Robot Cooperation using software tools and virtual reality

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The Human-Robot-Cooperation (HRC) is a new concept of automation, which focuses on the direct interaction between human and robot at any time without a separating safety guards. Economic and ergonomic benefits have been proven with the already implemented HRC applications particularly in the production industry. To gain the maximal benefits from HRC, various scenarios should be tested before the implementation to find out the best solution. In addition, the acceptance and training of the human element for the planned HRC application must be considered. To the present, the scope of such planning revolves around hardware-based tests, which is normally costly and time-consuming. To reduce the efforts of such testing, a software-based solution should be adopted. Although there exists several specialized software that provide functions to plan automation and human works, they are not especially suited for HRC planning. In this paper, a virtual planning concept for HRC application (including rough and detailed planning, risk assessment, acceptance test, virtual commissioning and training) will be described and realized using an example of an assembly station. In this concept, simulation software and virtual reality are used in a combination. The potential future directions and the transferability of this concept onto other industries will also be discussed.

Evaluating a physiological sensor for cognitive workload assessment in two different military settings

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In complex man machine systems unbalanced cognitive workload of operators (over- and underload) can cause human error and may even lead to catastrophic breakdowns. Hence, a fine grained evaluation of cognitive workload is an important requirement of modern Human Factors Engineering. In two experimental studies the cardio sensor Bioharness was used to evaluate the diagnostic power of psychophysiological measures (e.g. heart rate (HR), heart rate variability (HRV), and breathing rate (BR)) for cognitive workload assessment in two different military settings. The setting of the first experiment (n=10) was a simulated radar-surveillance-task in a laboratory. HRV ($F(9,1)=8.552$, $p<.05$) and BR ($F(9,1)=6.834$, $p<.05$) significantly differed between low and high task load conditions. HRV ($r=-0.50$, $p<.01$) and BR ($r=0.39$, $p<.05$) also significantly correlated with the subjective workload scale NASA-TLX in the expected direction. The setting of the second field experiment (n=24) was a three hour driving task with armoured vehicles by night, to compare two different night vision devices. Conforming to expectations, HR and HRV differed between high and low task load segments ($p<.05$); BR was not statistically significant. Results indicate the usefulness of the Bioharness sensor for evaluating cognitive workload with psychophysiological measures. Lessons learned will be discussed in the full article.

Usability and Interfaces of Lower Limb Exoskeletons: a Framework for Assessment and Benchmark

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Different types of Lower-Limb Exoskeletons (LLEs) are already used in different fields of application (i.e. industry, military and health). One major issue when designing LLEs is the lack of requirements, guidelines and performance analysis tools, specifically, there is the need to address the usability and the practical value of exoskeleton systems. Furthermore, a recent review on human factors principles (Stirling et al., 2018) highlights the importance to explore the human-exosystem interaction to improve safety and human performance. The present study is part of the STEPbySTEP, a sub-project of EUROBENCH, funded by the Horizon 2020 programme. The EUROBENCH project aims at creating the first benchmarking framework for robotic systems in Europe. The framework will allow companies and researchers to test the performance of robots at any stage of development. The sub-project STEPbySTEP aims to develop staircase testbeds supplied with measurements and relative metrics to quantify LLEs characteristics in terms of cognitive ergonomics. We investigated usability of Lower-Limb Exoskeletons. Furthermore, an analysis of existing command and communication interfaces has been carried out.

Design of Experiments for the evaluation of the interaction human - exoskeleton in the context of small data collections

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The introduction of active human physical assistance in ThyssenKrupp's factories, specialized in the assembly of steering columns, especially on workstation where handling and packaging of steering column are necessary, is being studied to improve the working posture and to reduce the amount of torques of upper limb joints requires to perform operations. To identify the effects of such assistance systems on the biomechanical and psychological risk factors of the operators, we reproduced the workstation and the production parameters in our laboratory (production rate, the level of noise, temperature, etc.). Participants of the experiments are six real operators (N=6), females and males, that represents the three somatotypes. The range of work tasks (packing of steering columns) requires the mobilization of a large number of body segments with speed, stability and precision to perform complex movement in a closed loop sensorimotor control. Due to a small set of data, a statistical study was excluded in favour of ergonomic mapping based on observations and has required a multimodal measurement protocol that includes kinematic, force-plate, numerous physiological variables like EMG and subjective survey. These human factors allowed to qualify the range of efficiency of exoskeleton and make recommendations to the production manager and the consortium in health work.

Context-aware HMIs in the field: Effects on usability and user experience

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New display technologies, including head-up displays, larger screens and new positions within the vehicle cockpit enable further possibilities to display information to the driver. Though, enhanced displaying space does not necessarily imply further support of the driver. Conversely, drivers have to re-adapt their resource allocation and the risk of distraction might increase. A potential solution to overcome this issue poses the adaptation of displayed content based on the driving scenario. A previous simulator study (N = 41) investigated the effects of different context-aware HMI concepts on usability and user experience. The results indicated no significant differences between static and context-aware HMIs but a preference towards the personally-configured HMI. Further, half of the participants configured their HMI to be context-aware. It is of interest whether these findings will be supported in a field setting, with HMI concepts that were modified based on the simulator study results. In this field study, the HMI will adapt regarding the information content and quantity based on the complexity of the driving scenario. Two static, two context-aware and a user-controlled HMI system will be tested with N = 15 through a five hours test drive. The effects on usability and user experience will be reported.

Do I look at what I'm saying?

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The use of VR and AR technologies demands new forms of human-technology interaction, since classical input devices such as keyboard or mouse do not meet the requirements of a usable application in a virtual context. Natural forms of interaction such as speech and gaze have the potential to close this gap. However, the technologies are often flawed when viewed individually. For example, speech recognition systems have problems with dialects, ambiguities and deixis. The combination of speech and gaze as multimodal input can reduce errors because the focus of attention (gaze) is related to speech. The authors ask themselves the question to what extent the gaze behavior changes with a repeated language selection of the same object, if the speech recognition does not understand the first input correctly. For this purpose, 10 participants were presented several objects on a screen to select one of the objects linguistically. The Wizard of Oz method was used to simulate speech recognition that randomly prompted the user to retype the speech. Gaze data could be collected by eye tracking. The results show differences between first and second input. In the further course, the study design will be applied in VR and AR contexts.

Affordance-based scenario modeling and lived experience evaluation in Virtual Reality

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In this paper, we propose an affordance-based conceptual framework for both the design and the study of users' experiences in Virtual Reality (VR). Affordances are the multiple possibilities for action offered to humans by their environment. However, for a particular individual in a specific situation, only a subset of the landscape of affordances stands out as relevant, this subset can be referred to as sollicitations. We argue that sollicitations, as relevant affordances, are important constituents of the unique experience of individuals. We designed a conceptual affordance-based framework aiming at understanding this user experience in VR. From the framework we were able to define two methodologies for: VR design and user experience evaluation. The first VR design methodology specifically based on the characterisation of the objective properties of affordances offered in the VR environment, suggests that designers take advantage of the affordance concept to model several VR scenarios from a situation. We then explore how scenarios conduct to the configuration of a the VR environment. The second evaluation methodology specifically based on the identification of the subjective and objective characteristics of sollicitations in the lived experience, proposes that evaluators benefit from the affordance concept to identify measures in order to evaluate the objective and subjective lived experience of the individual. To conclude we present a possible contribution of our work for mental health diagnosis.

Changing the interface design of smartphones : effects on usage and well-being

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Previous studies have shown that many people believe they spend too much time on their smartphone and desire to modify their behavior. We wished to see if changes in the interface design could help reduce the problematic use of smartphones. We conducted a field experiment involving two design interventions to reduce smartphone use over a seven-day period. Ninety-eight participants were assigned to one of the three experimental conditions that were implemented after a baseline week: grayscale (color was removed from the interface), movement of applications (three most used applications were moved two phone pages further) and a control group. Subjective data concerning problematic usage, well-being and time spent on phone were collected via a survey before and after the intervention. Objective smartphone usage data of the intervention week and a baseline week were also measured. Smartphone usage significantly decreased for all participants. However, there was no significant difference between the conditions in terms of smartphone usage time. These results may suggest an awareness effect rather than an effect of design on participants' usage behavior. Further quantitative and qualitative results will be discussed.

Rear Seat Belt Comfort: a DFSS experimental approach

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Rear seat belts can generate comfort issues, even if customers complaints are not so frequent within European market, due to the low rear seat and seat-belts frequency-of-use. Nevertheless, guaranteeing the rear seat belt comfort requires a significant effort for car makers, in terms of design and validation activities. DFSS method provides an innovative approach to this vehicle performance, consisting in: - Identify opportunities to carry-out a DFSS projects on this topic, - Define technical requirements, - Developing concepts, - Optimizing the best performing system design, - Verifying & Launching the technical solution. An IDD project has been carried out in order to collect data from customers and to focus on the main engineering measurements. In this way, the best concept has been selected through iterative and comparative assessments based on design parameters. A hybrid concept has been developed, including new components for which a patent request is still pending. A further IOV project has been subsequently developed, collecting more than 600 measurements, in order to maximize the signal-to-noise ratio of the system and to achieve both the best exerted belt compression force and the best layout configuration. A vehicle installation and full validation of the technical solution is currently under investigation.

Human Factors in Unmanned Aerial Systems in the German Bundeswehr

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In military contexts, unmanned aerial systems (UAS) efficiently fulfil reconnaissance duties and increase the safety of military personnel. However, compared to conventionally piloted aircraft, there is an increased rate of accidents involving UAS, some of which were a result of technological factors. Crucially, human factor failures have also been shown to contribute to UAS mishaps. As yet, little is known about the specific demands on operating UAS personnel. The aim of the present study, conducted in cooperation with the German Air Force's Center of Aerospace Medicine, is to empirically assess the demands of the UAS operating positions within the German Bundeswehr. A total of 218 experienced UAS operators completed an extended version of the Fleishman Job Analysis Survey consisting of 75 scales for assessment of required abilities and skills from cognitive, psychomotor, physical, sensory and interactive/social domains. Results show both general and system- or position-specific demands on UAS operators. The outcomes of this study contribute to the development of specific requirement profiles for UAS operating personnel and will serve as a basis for future expert evaluation workshops, in which the impact of HMI concepts and designs and different levels of automation on operator demands will be determined.

The Exploration of Augmented Reality Principles and Futur Cockpits in Basic Flight Training

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In aeronautics, glass cockpits are widely used, but studies (Funk et al., 1999) showed that it can create critical pitfalls (NTSB, 2010) such as too much "Head Down" effect. In extenso, we could

expect pitfalls from new technologies as Augmented Reality (AR). The purpose of this study is to find new basic flight training (BFT), as recommended by regulation authority, which could reduce “Head Down” effect (Froger et al, 2018) and to evaluate pros and cons of AR. We conducted a 2 days experiment on 23 novices with no aircraft piloting experience in a controlled simulation environment with an eye tracker. The first day (1) was an BFT where instruments were available for a short time on participants’ request. The second day (2) was a landing pattern training where virtual squares in the air, plotting the air trajectory, were available for a short time on participants’ request. The results showed (1) a decrease of “Head Down” without any reduction of performances, and (2) that AR increases participant workload and reduce their performances. While results (1) show a promising way to address “Head Down” pitfalls in real flights, results (2) shows the need to further explore the right ways to introduce AR into BFT and its security risks.

Helicopter pilots' tasks and external visual cueing during shipboard landing

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Helicopter shipboard landing is a cognitively complex task that is challenging both for the pilots and the crew. Effective communication, accurate reading of the flight instruments, as well as monitoring of the external environment are crucial for landing to be successful. Particularly the final phases of landing are crucial as they imply high workload situations in an unstable environment with restricted space. In the present qualitative study, we interviewed ten helicopter pilots using an adapted Applied Cognitive Task Analysis interview protocol. We aimed to obtain a detailed description of the landing procedure, and to identify relevant factors that affect the pilots' workload, performance and safety. Based on the content analysis of the interviews, we have identified six distinct phases of approaching and landing on a ship deck, and four categories of factors that may significantly affect pilots' performance and the landing procedure. Consistent with previous studies, our findings confirm that external visual cueing is vital for a successful landing. Therefore, based on the pilots' statements, we provide suggestions for possible improvements of external visual cues that have the potential to reduce pilots' workload and improve the overall safety of landing operations.

Experimentation of “empowerment” in an aeronautic industry: identification of the levers and obstacles to managerial innovations based on employees’ interviews

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Context: Since five years, an aeronautic industry is experimenting innovative managerial practices through the empowerment of the workforce within a production plant of 3200 employee’s. The teams of the pilot production unit (300 employees) are self-organized, the operators have elected their leader and they manage their own budget. *Purpose*: In an action-research perspective, three exploratory quantitative surveys have been launched to measure the influence of leadership empowerment behaviours on wellbeing and performance. The main purpose of the present study – in a qualitative approach – was to identify more specifically the employees’ expectations towards theses new ways of working regarding the experimentations already implemented. *Methodology*: A total of 38 interviews (individual and collective) have been conducted with 128 workers – meeting some representativeness criteria (sex, seniority, sector, functions, etc.). *Results*: The results put forward organizational and individual obstacles and levers associated to “empowering organizations” by pointing out specific recommendations among sectors which are considered “empowered” versus those considered “non-empowered”. *Discussion & Practical implications*: Our findings are of special interest because they contribute to focus more attention on employee’s well-being by taking into account their individual perceptions and expectations towards these managerial innovations – which are initially intended to increase companies’ performance.

Detection thresholds for mid air interaction. How sensitive are we during stressful tasks?

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Novel contactless interfaces like sound or gesture input create an instinctive interaction and are seen as natural interfaces. However, the loss of haptic feedback and references limits the usability of corresponding products. In order to re-integrate them, vortex-generators and ultrasound arrays for mid-air feedback can be used. Theory postulates that tactile feedback is useful, when it is integrated under conditions with a high cognitive workload. It is necessary to determine detection thresholds and derive the feedback intensity to guarantee a reliable feedback detection. Current prototypes of vortex-generators do not provide reliable feedback parameters and measuring the exact pressure of ultrasonic arrays is challenging. Hence, a study investigates effects of feedback intensity, repetitions and frequency on detection thresholds was conducted, using a contact-based simulator, stimulating the same receptors as the vortex-generator does (Meissner's corpuscles). In order to create different workload levels, participants were ought to conduct a dual-task setting in a driving simulator. Results indicate that a higher workload and number of repetitions cause higher perception thresholds. Whereas, the frequency had no impact. Based on the findings, the determined values will be used in

an experiment including an advanced vortex-generator for mid-air interaction in order to proof the transferability.

Impact of Anthropomorphic Robot Design on Human Trust and Visual Attention in Cooperative Human-Robot Interaction

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A current trend in human-robot interaction is to create humanlike robots to increase trust in this emerging technology. Anthropomorphic design elements are frequently chosen as they build on existing knowledge from human-human interactions. Anthropomorphism thereby increases familiarity and helps users to comprehend and predict the robot's behaviour. The current study investigates the impact of an anthropomorphic robot design on trust and visual attention allocation in interaction with an industrial robot. In a laboratory experiment, participants (N = 40) work on a typical assembly line task, building parts of a circuit board. Participants work cooperatively with the robot, which hands over boxes with the electronic parts. As independent variables, the robot appearance is manipulated as a between-subject factor (humanoid face/neutral display). Additionally, the robot's proper functioning (failure / no failure) is varied as a within-subject factor. Trust is measured on a subjective level (via questionnaires) and on an objective level by the amount of time participants operate in a "handover" area, i.e. have their hands in close proximity to the robot. Visual attention is assessed through mobile eye-tracking, detecting the number and duration of fixations in predefined areas of interest. We hypothesize that an anthropomorphic robot design is beneficial in increasing trust, but leads to a shift of visual attention away from important task areas towards the robotic face.

Cardiac activity variations ellicited by alarms during Human-Robot Interaction

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Mixed-initiative human-robot interaction (MI-HRI) proposes an architecture design where each agent (human or artificial) could seize the initiative from the other. Authorising or encouraging one of the agents to seize the initiative from the other may depends on its performance, in particular when the long-term system's (human and artificial agents in their environment) performance is the objective. It may include, for instance, to launch alarms in order to increase situation awareness, or even getting over the human operator when her/his performance is not as expected. In this context, we designed a firefighter robotic mission, in which a human operator may fight fires in cooperation with a robot in a limited time. The human operator is in charge of controlling and supervising robot parameters while managing the supply water tank level. During the mission, the robot operation mode can change: it can be manually controlled or it can navigate autonomously. Due to this fact, human

operator may face multi-tasking, which can have a negative impact on her/his performance. In this study, we focus on the cardiac activity variation evoked by alarms that were launched during the mission. Electrocardiogram (ECG) data (inter-beats or R-R intervals) were collected for 18 participants performing 4 missions each. Alarms concerned the robot battery, temperature and embedded water level, robot operation mode, remaining mission time, and refill tank level. Results show a significant increase of the evoked Heart-Rate (eHR), in response to alarms' occurrence. Additionally, the observed trends for the evoked Heart-Rate Variability (eHRV) and the results for evoked cardiac responses depending on the alarm type are also presented and discussed.

Sharing Rides in Autonomous Mobility-on-Demand-Systems – Acceptability, Information Needs and Incentive Systems

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The penetration of autonomous vehicles of level 5 will be a turning point for mobility. Depending on the scenario traffic will either dramatically rise or significantly decrease. Raising the occupancy rate of autonomous mobility-on-demand-systems by ridesharing is an essential prerequisite for future sustainable mobility. Yet, sharing rides with strangers in driverless vehicles might cause acceptance problems concerning privacy and safety issues, especially due to flexible routing. In how far do travel time changes and a detour due to fellow travellers affect the willingness to use shared autonomous mobility-on-demand-systems? Could a pricing system be used to incentivize sharing rides? Which information about fellow travellers is suitable to increase the acceptability of sharing rides? The contribution summarizes the findings of two stated choice experiments (N = 150 and N = 154). The results highlight the importance of a pricing system that is adjustable to travel time and detour. The willingness to share rides increases when more information about fellow passengers is presented and a rating system proved especially beneficial. The contribution adds to the limited empirical findings by a first explorative step to understand human choice behaviour in these complex and dynamic systems and provides concrete recommendations for the user-centred design.

Minimalism in User Interface Design; Prospects and Challenges for startup developers

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User Interface Design (UID) process is a significantly time and cost intensive task in most software development and maintenance projects. The task is more demanding when it relates to Graphical User Interface (UI) design of interactive systems. Notwithstanding, there is high expectancy of increment in UI task relative to the reliance on digital products and call for user-centred designs. UI designers have the task of understanding system functions and interpreting that in looks with

element layouts on the screen. With increasing interest in software development and the proliferation of startup software companies, this important aspect of software development faces a threat of being overlooked. Minimalism in UI design is a concept which advocates stripping away of all unnecessary elements in a design and focusing of purpose for every elements and their layout. This concept in various forms is noted for enhancing User Experience and usability, however, generating minimalistic UI is problematic especially for startups, most of whom can hardly procure the services of professional UI designers. Over the course of the next three(3) years, the project develops a UI design conceptual guide to support startup in developing minimalistic and excellent UIs.

Relationship between self-reported attentional errors and the ability to predict upcoming hazards on the road, with driving experience having a moderating role

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The current study collected self-reported attentional errors from drivers by using the Spanish version of the Attention Related Driving Errors Scale (ARDES) in order to examine whether novice drivers suffered from inattention more than experienced drivers. Novice drivers scored more highly on ARDES than experienced drivers. ARDES scores were then related to performance in a Hazard Prediction (HPr) test, where participants had to report what hazard was about to happen in a series of video clips that occlude just as the hazard begins to develop. Our results demonstrate a relationship between self-reported attentional errors and the ability to predict upcoming hazards on the road, with driving experience having a moderating role. In the case of novice drivers, as their scores in the Manoeuvring Errors ARDES factor increase, their ability in HPr diminishes, while for experienced drivers the increase is not significant. These data could be used to plan new evaluation strategies and promote training that would improve the visual search of novice or unsafe drivers, and to improve the adaptability of automated driving systems to the hazardous nature of driving environments, providing knowledge that might guide the road “scan” they perform so as to resemble that of experienced drivers.

Risk perception at the driver seat in an autonomous vehicle

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In autonomous cars, the automation is in charge of the operational control of the vehicle. It is essential that the passengers always feel comfortable with the decisions of the vehicle. In this project, we are specifically interested in the risk appraisal by the passenger/drivenger of an

autonomous car while navigating among many pedestrians in a shared space i.e., an urban design with no demarcation between vehicle traffic and pedestrians. Since risk perception in a dynamic environment is a complex phenomenon, we firstly have to understand and quantify the factors that influence the assessment of the vehicle/environment interaction. To this end, an experiment aimed to link the "driving style" of the autonomous vehicle, more particularly its pedestrian avoidance behaviour, with the feeling of the participant at the driver seat in term of subjective risk. The "driving style" was manipulated by varying metrics like the time-to-collision or the distance to pedestrian. Risk perception was measured by means of continuous rating through an analogical device. Physiological data (cardiac, respiratory and skin conductance measures) are also under analysis. The results will be discussed in relation to the current literature on risk perception.

Psychological factors associated with aviation accidents

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This research examined psychological factors associated with aviation accidents comparing differences between male/female pilots, environmental conditions, and aircraft activity. The NTSB accident database, 2008-2018, included 1667 entries for psychological factors. Male pilots averaged 51.83 years (SD=15.65), females, 42.93 (SD 16.54). Five psychological factors overlapped for male and female pilot accidents: lack of attention, lack of task vigilance, inadequate monitoring of the general environment, inadequate monitoring of other crew, and lack of situational awareness. A test for significance of a difference in independent proportions did not indicate gender differences on overlapping factors. For general aviation the most frequent psychological code was inadequate monitoring of the general environment; for commercial aviation accidents, perceptual distortions or illusions. For ideal weather, the most frequent psychological code was failure to adequately monitor the general environment. For adverse weather/sky conditions, spatial disorientation was the most frequent code. Levels of aircraft damage and individual injury were also examined. For damage, none-to-substantial, failure to adequately monitor the general environment was the most frequent code. For destruction of the aircraft, spatial disorientation was most frequent. For injury (none to fatal), failure to adequately monitor the general environment was the most frequent code.

How the availability of privacy information influences users´ smartphone app selection behaviour

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This study was conducted to create an awareness of handing out private data that has been found to be lacking in a previous study. In an attempt to enhance this awareness privacy information was illustrated as a colour-coded scale in an Appstore in a further step. The impact of this scale on

choosing and downloading an application for a certain task was measured. The privacy scale is based on real data gathered from several mobile devices with more than 80 applications in 8 categories. A pre-study was conducted to identify the most intuitive and adequate illustration of a privacy scale which was implemented into an Appstore-like environment. The participants of the subsequent study were divided into three samples which were presented the privacy scale with varying (optional) additional description. An additional control group was presented an Appstore without a privacy scale. The participants were deceived by being told that the study investigated the usability of the Appstore. Further, they were asked to empathize with 8 different scenarios in which a task had to be solved by using a certain type of application. For a deeper understanding of the selection behaviour participants´ gazes were recorded by an eye-tracker. The recording was used for a subsequent video-confrontation to examine the testee´s reflection and thereby understand the reasons of the selection behaviour. Results will be discussed after evaluation.

Interaction Strategies for Handing over Objects to Blind People

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Handing over an object is seen as basic ability in robotic systems. Since there is a growing range of application, it is necessary to cover characteristics of several user groups to design safe and intuitive interactions. One application is handing over objects to users who can't see it, e.g. blind people. Up to now little is known about strategies of how blind people hand over objects and in which situations this is important to them. Therefore we designed a focus group with blind and sighted people to explore strategies and difficulties of blind people in such situations. Analysis revealed that simply handing over of objects is seldom in blind people's interaction with each other or seeing individuals. If possible it is preferred to hand over an object by put it down so that the blind person can grasp for it on his or her own. Because there is no information from the eyes, acoustic information becomes far more important. This is verbal communication about what is handed over and its location as well as sound to know where the robot and especially the target object exactly is. Dangerous objects are grasped in the same way but more cautious.

Studying driving styles on a driving simulator: The case of overtaking on highways

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The increasing prevalence of autonomous driving technologies raises the need for comprehending how trajectory control algorithms affect the perception of safety and efficiency experienced by car occupants. A first step towards that goal is to understand what characterizes different driving styles. We conducted a study to verify if and how driving styles can be quantitatively distinguished in a fixed-base driving simulator. We analyzed overtaking maneuvers in two-lane, one-direction highways. Eight participants drove 6 sessions of 3 blocks each, in which they had to overtake vehicles driving on the same lane with different speeds (0, 45 and 90 km/h) in controlled curvature road sections. Across blocks, participants were expected to drive with a different driving style, according to an instruction to drive a) in their unrushed driving mode (everyday), b) as if they were transporting a child (defensive), and c) as if they were late to an important meeting (aggressive). Despite the small sample size, significant differences were found between driving styles regarding longitudinal (speed and acceleration) and lateral (acceleration and jerk) control variables, steering wheel (angular acceleration and jerk) and distances to overtaken vehicle. Results indicate that driving style is a quantifiable dimension that can be studied on fixed-base simulators.

NeSitA - Neuroergonomical Assessment of Situation Awareness in a Continuous Multidimensional Approach

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Technological advancement often cumulates in complex dynamic systems. Controlling these systems requires Situation Awareness (SA) of the human operator, consisting of perception, comprehension, and prediction of system state changes. SA has long been part of human factors research and several options to measure SA have been proposed. However, these measures largely consist of assessment via questionnaires post-hoc or during the task. We propose a Mobile Brain/Body Imaging (MoBI) approach for SA assessment to measure SA continuously using both body and brain dynamics. To this end, a 3D virtual environment was developed that presents target and distractor spheres (differing in color) moving towards the participant located in the middle of a virtual room. Participants must touch the target spheres using their virtual hand while avoiding the distractor spheres. Task difficulty is manipulated in stimulus discriminability, predictability, and color visibility (color visible permanently / only on fixation). The task allows recordings of performance, motion capture (mocap), eye gaze, electroencephalography, and subjective SA (SART) and workload (NASA-TLX). The multidimensional data will be analyzed focussing on behavior. We hypothesize that a continuous assessment of SA is possible based on mocap and eye measures which predicts the SART and correlates with performance.

Capturing quantitative user feedback using virtual questionnaires in virtual reality

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Virtual Reality (VR) technology is increasingly used as a tool in the research and product development process. In this respect, there is a high usage potential in the area of virtual prototype evaluations, due to various advantages such as spatial visualization and natural interactivity in immersive 3D worlds. However, deficiencies such as an insufficient usability in terms of human-machine-interactions reduces the efficiency and utility of VR technology. Especially the input modalities can have a critical influence. Accordingly, the question arises how quantitative user feedback can be collected during an evaluation in the virtual environment. As a result of the workflow, it makes sense to provide evaluation instruments in the VR. Studies also prove that leaving the virtual environment and the resulting media break have an unwanted influence on the results of questionnaire instruments. The paper presents an empirical user study that examines which input modalities are suitable for answering questionnaires in VR. The examined input modalities are handheld controller, gesture and voice control. The verification is based on the criteria of usability, effectiveness, efficiency and satisfaction and is carried out using objective and subjective parameters. Furthermore the work provides information about the design concepts and input modalities of virtual questionnaires.

Machine effectiveness made understandable: Integrated displays that inform operators about effectiveness components and possible interventions

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To maximize production outcomes, packaging machines work at extremely high speeds. However, high speeds also go along with increased risks of downtimes and product wastage, reducing overall machine effectiveness. In case of low effectiveness, operators often do not know how it comes about and what measures should be taken to increase it. Current human-machine interfaces provide insufficient support for such decisions as the information about machine effectiveness is either spread across isolated values or reduced to a single, calculated number that provides little information. Therefore, three concepts for an improved effectiveness display of a chocolate packaging machine were developed. They integrate several components of effectiveness in a single visualization, providing information about the contributors to effectiveness and their interplay. Moreover, they allow for a prognosis of the consequences of potential operator interventions to improve effectiveness. Two displays use geometric objects to interrelate temporal and quantitative components of effectiveness, representing changes as changes in size and/or shape. The third one uses graphs to predict effectiveness across the value ranges of its influencing factors. Formative evaluations with machine builders and operators revealed benefits of the displays but also a number of concerns in terms of data availability and the precision of predictions.

The Storm in your Head: Bringing Neurofeedback in VR

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On one hand, the use of Virtual Reality (VR) in some specific sectors necessitates a strong immersive experience (e.g. pain distraction in medicine [Hoffman et al., 2011]). One the other hand, biofeedback can enhance the user self-awareness, and guide them to modify their internal states [Frank et al., 2010]. A pilot experiment was undertaken to link neurofeedback with immersion in a VR context. In a repeated-measure protocol (i.e. with and without neurofeedback), participants were asked (1) to explore an island during five minutes without specific objectives and (2) to evaluate the feeling of immersion and presence. The weather in the VR world was changed randomly (condition 1) or according to their relaxation level measured using a portable EEG headband (condition 2). Our preliminary results show that immersion and presence do not depend on neurofeedback, but neurofeedback does cause a global decrease (across the five brain waves) of the power spectral density and increases the power spectral density share of the alpha waves compared to the others. This type of brain-computer interface therefore affects the user states without reducing the feeling of immersion and presence. We discuss the value of portable neurofeedback tools in VR-type applications.

Combining gaze-tracking and physiological measurements to assess the driver's state in automated cars

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With the advent of highly automated cars (SAE level 3), new uses are emerging. The driver can delegate the control of the vehicle to an automation system on certain parts of the road and can engage in non-driving activities. However, the driver must remain able to safely take over the control of the vehicle if automation cannot manage a situation and requires manual driving. To address the issue of driving monitoring, a study was conducted on a driving simulator. Four automated driving conditions were defined by combining two variables: the mental workload level induced by a non-driving task and the stress level induced by means of specific instructions. The diagnosis of the driver's internal state prior to take-over will be based on oculometric and physiological data (breathing, electrodermal activity and heart rate), looking at the relation between the two types of indicators. The results are being currently analyzed to determine if it is possible to predict the quality of the take-over using a multi-criteria driver's diagnosis.

Study about student pilots activity for designing a flight simulator with total visual immersion

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The development of an immersive flying simulator using virtual reality and different haptic feedback will be presented. Our main hypothesis is that an increase of immersion for the pilot inside his flight environment favorises the learning capability. Head mounted system allows the user to see in some ways that are impossible in actual professional fly simulator available for VFR formation. This increasing immersion also increases pilot involvement in those tasks and the creation of an important presence feeling. Those two factors can influence learning skills. The simulator will be conceived following a human-centered design process implying instructors and student pilots. The specification document used to develop the initial prototype will be defined on the bases of observations of the activity during ab-initio formation of pilots and their instructors. The method of semi-structured interviews based on critical incidents will also be used. This technique makes it possible to gather information in an effective and economical way on the skills necessary for the safe, effective practice of a task in a dynamic, complex situation. This poster will present the method followed to develop this simulator and results of the first study about the activity of pilots during their first lesson in planes.

Human behaviour modelling in tools for Air Traffic Management change impact assessment

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Air Traffic Management (ATM) is a high complexity field in which technical systems and human actors work cooperatively. It relies on a distributed architecture, where information and tasks are properly allocated by different agents in different phases. The proposed poster discusses the approach to Human behaviour modelling within EvoATM, a research project addressing the design and development of evolutionary agent-based model to support change impact assessment process in ATM. In EvoATM model the behavioural and cognitive aspects of the controllers are a critical part in the representation of new situations to test various architectural or procedural evolutions. On the base of a series of selected theoretical models, referring to the Human Activity Theory, Situated Actions Theory and Distributed Cognition, the most relevant Human Factors and contextual variables have been identified and described to be applied to a selection of ATM use cases and tasks. The poster will present the methodological approach to the human variables selection and the way in which they have been handled in order to match EvoATM modelling needs. This work has received funding from the SESAR Joint Undertaking with grant agreement No 783189 (EvoATM project) under European Union's Horizon 2020 research and innovation programme.

Conception of interfaces to represent functional relations in a packaging machine

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Ecological Interface Design (EID) supports operators in coping with complexity: By providing information about the work domain in a way that enables productive thinking, it allows human-machine systems to draw on human resources like adaption and flexibility. EID has been applied in different domains. The present work investigated whether it also is compatible with the characteristics of the packaging industry. To analyze this work domain and derive requirements for interfaces, observations in a food processing company as well as interviews with operators, engineers, and packaging experts were conducted. Based on the results, a network of functional relations associated with machine speed was created, linking it to its determinants and consequences. The interface should help operators to understand these relations and thereby enable them to properly adjust machine speed to current production constraints. To this end, three interface concepts were developed. One focuses on a concurrent presentation of all consequences at one particular machine speed, one on a continuous presentation across the whole range of possible machine speeds, and one on setting the determinants' values and their impacts on suitable speed ranges. Future work will need to address the domain-specific problem of low data availability and uncertainty in the process models.

Improving employees well-being by integrating human factors into work situations : the case of a digital service company

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The issue of well-being at work is a crucial factor for companies. They want to develop this positive state of mind for their employees as a key driver of performance and competitiveness in the long term. The objective of this study is to evaluate the personality traits work-related that can impact the well-being of employees. The study case takes place in a digital service company which is composed of project teams. In order to maximize the acceptability of such an approach, our incremental method is in several steps: 1) Employees self-assessment to determine their motivation types (intrinsic, extrinsic), coping strategies with stressful situations, desirability for control and soft skills; 2) Employees assessment by human resource as part of the integration and monitoring process; 3) Employees assessment by project manager-related to objectively determine the criteria affecting the employee's "activities – personality traits" adequacy; 4) Team simulation tests by taking into account results of 3 assessment types and compare them with actual project teams. Finally, we propose a project team building method to best adapt activities for each employee according to his or her personality traits and promote their well-being in work situations.

Interaction strategies on three-dimensional user interfaces with pointer devices

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Modern display devices, such as autostereoscopic displays, enable the perception of three-dimensional user interfaces without additional aids and can therefore easily be used in office environments. Such 3D user interfaces allow a better user performance in recognizing and classifying screen objects and enables a further way of structuring information. This increases the effectiveness of a graphical user interface by providing distinguishable spatial relationships between information elements and therefore, information density can be reduced. Overall, this leads to a better understanding of complex user interfaces for users. A common problem when using 3D user interfaces with desktop computing is the direct interaction with two-dimensional pointer devices, e.g. a computer mouse. When structuring information on several depth layers, the mouse interaction layer needs to be at least on the top level. In this situation, parallax effects will degrade the speed and the precision, i.e. the effectiveness, of pointer devices. We present a study with 20 participants to examine three alternative interaction strategies on three-dimensional user interfaces with pointer devices. All three conditions will be compared to conventional 2D interaction regarding precision, speed, and acceptance. Accompanying variables are visual function and fatigue questionnaires as well as socio-demographic data collected.

Eliciting strategies for diagnosing faults of packaging machines: A scenario-based study with maintenance technicians

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Faults are abundant in the food industry. As most of them lead to machine stoppages, they must be diagnosed quickly and thoroughly. Many faults result from interactions of machine states or settings with features of the product, packaging material, and environment. The daily work of maintenance technicians is to diagnose such faults, and the present study examined their diagnostic strategies: Four technicians from a chocolate production company were interviewed using two scenarios in which faults resulted from a combination of several component causes. Technicians received a broad symptom description and were asked how they would proceed to determine the causes. For each diagnostic action they named, the interviewer provided the respective outcome and asked technicians what they concluded from this observation and how it informed their subsequent actions. Most of the technicians' diagnostic actions concerned unmediated visual or haptic perception of machine components or product features. They mainly used symptomatic search strategies, which included a comparison with known symptom patterns. Technicians used a limited set of actions to start their diagnostic process, but concerning the sequence of strategies a large variety in individual technicians` actions was found. The results are discussed in relation to previous work on expert decision making.

Hazard perception abilities among surf and swimming-pool professional lifeguards and bathers

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ntroduction: This study examined surf lifeguards and patrons' surf hazard identification abilities and their eye scanning patterns. Surf and swimming-pool professional lifeguards were compared to a control group of Israeli students. Method: Participants observed 29 clips depicting real-time hazardous surf situations footage taken from a lifeguard tower perspective, while connected to an eye-tracker, and were asked to press a response button to any surf situation that they thought may endanger bathers. Eye-scanning patterns and performance in a hazard identification task were examined and analyzed. Results: Surf lifeguards paid more attention to physical features in the nearshore area that have a higher hazard potential for bathers (e.g., rip currents and channels). Moreover, surf lifeguards identified an overall larger number of hazardous situations compared to the two other groups. Lastly, the swimming-pool lifeguards and the control group members were more inclined to focus on the bathers themselves, regardless of the state of the nearshore and its physical characteristics. Conclusions: Demonstrating bathers' deficiencies in evaluating key, life threatening rip currents as surf hazard instigators, may contribute to the effort of producing public education programs as a major drowning prevention technique. Implications for public health policies are discussed.

Avoiding the overload: Design requirements for an interior HMI in mixed traffic

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Automated vehicles (AVs) will be introduced in mixed traffic soon and should increase the passengers' driving comfort. However, it is assumed that a lack of transparency about the interaction between AVs and vulnerable road users (VRUs) can lead to psychological discomfort in passengers, e.g. due to incomprehensible driving maneuvers or fear of collisions. To increase trust and psychological comfort, an interior HMI (iHMI) is proposed. We conducted a user focus group (n = 5) to identify relevant user requirements and therefore to avoid an information overload, especially in complex urban traffic scenarios. The results were clustered into four important requirements. Information about the capabilities of the system (regarding recognition of VRUs) was considered essential. Participants stated clear information visualization about recognized VRUs based on their driving relevance (due to intention, speed, direction etc.) to be important. Information about planned driving maneuvers in case of driving-relevance of a VRU and providing visual information were preferred. The findings have implications on the iHMI design for future AVs. The concept of driving relevance, for instance, seems to be suitable to prioritize information and thus achieving a clear, user-friendly visualization. Implications for user trust and psychological comfort have to be investigated in further studies.

Natural interactions on virtual reality: evaluation on the cognitive load

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Virtual reality (VR) has now become a key technology in many fields. Most devices that provide interaction in VR refers to controllers, but they generate some usability issues (limited maintenance

and interactions, difficult learning etc.). Current adaptability of new existing gestural devices (e.g. Leap Motion) provides a more “natural” way to interact in VR, i.e. more intuitive, facilitating learning and especially minimizing cognitive load. However, this last one is rarely taken into account in the literature on VR design and evaluation. To fill this gap, we propose a comparative study between gestural interactions in virtual reality (test group) and more traditional interaction devices, here controllers (control group), in order to evaluate their impact on two different user populations (experienced vs. novices). In the novice group, the expected results in the test group are: 1) decreased cognitive load; 2) decreased errors of use; 3) increased realization time; 4) increased detection errors. In the experienced group, the expected test group results are an increase in cognitive load, due to their conventional devices use expertise. If the results are confirmed, this method will increase the accessibility of VR use, with application fields such as health (cognitive remediation, motor rehabilitation).

Practice-oriented development of a user-centered assistance and safety system for supporting people with dementia

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Demographic changes and a completely changed age structure in our society particularly with regard to overaging result in increasing prevalences of geriatric diseases. According to the Alzheimer’s Disease International, worldwide an estimated 46.8 million people were affected by a dementia disease in 2015. Until 2050 the expected number of sufferers will be three times as high as it is now. New assistance and ambient living technologies might facilitate a longer self-reliant living in the domestic environment for dementia patients. Furthermore technically assisting systems can be seen as an opportunity for interaction between humans and new technologies particularly in times of dwindling personnel resources. The central objective of the project planned is the practice-oriented development of a user-centered assistance and safety system for supporting people with dementia based on intelligent behavioral analysis. It is the main aim of the system to improve the users’ safety, to provide interactive assistance for managing the everyday life necessities and to realize an informative participation for users, caregivers and relatives. Based on a structured user study with 30 dementia patients and caregivers using the Critical Incident Technique analyses of specific user needs and requirements are provided as a basis for determining support and safety functions of new assistance for an aging society.

E-Health Interface: Evaluate the impact of health data visualization on physiological and emotional responses

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Currently, the practice of e-health is undergoing important growth, whether in the field of telemedicine or mobile-health. In this service, interface communication takes place between individuals, hospitals and connected health devices. In particular, individuals can have direct access to health or well-being information without medical support. Our objective is to determine if an unaccompanied visualization of health information on an interface can generate emotional and physiological responses on users. Indeed, physiological changes may distort the observed data and mislead the user about his/her health. Then emotion and stress can modify judgment about the displayed data. In the longer term, they may have an impact on the psychological and physical health of the users. In order to evaluate user responses to health data visualization, we conducted an experiment to compare reactions to different types of data displayed: physiological data of the user, physiological data of another person, and weather data. We measured subjective emotion and stress; as well as physiological changes: cardiac, respiratory and electrodermal activities, to the different types of data. The influence of the user profile was also analyzed, in terms of age, gender, mood and anxiety state, health anxiety trait, interface and e-health usage.

The effect of Cognitive Load when responding to Silent Failures

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Automated vehicle systems (AVs) are developing rapidly but cannot yet safely respond to all scenarios, meaning that there will be situations where AVs fail without explicitly notifying the driver. Improving understanding of how human 'drivers' respond to so-called 'Silent Failures' is important to ensuring the feasibility and safety of AVs. It is likely that a significant factor influencing whether the driver can successfully monitor and respond to the AV's trajectory is the degree to which they are focussed solely on the AV or distracted by other tasks. Task engagement is often manipulated experimentally by varying cognitive load. Increased cognitive load has been reported to reduce gaze exploration, delay reaction times, and diminish steering corrections. Here we used highly controlled and repeatable driving simulator conditions to examine how cognitive load interfered with human capabilities responding to silent failures. A series of automated driving trajectories around bends were generated that 'failed' at various time points (requiring the participant to take-over control). The experiment parametrically varied failure severity and had a concurrent cognitive task that was used to increase cognitive load. The results show that increasing cognitive load impacted steering responses, which was particularly evident for cases where there were severe AV failures.

Unified modelling of detection of and recovery from steering automation failure

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Many automated vehicle systems (AVs) continue to be dependent on a human operator monitoring and acting as a backup 'driver' (SAE levels 2-5). A key safety issue is whether the human operator is able to detect and take over in cases of automation failure, when the AV itself does not detect it

('Silent Failures'). Here, we present a computational model of the way in which humans respond to failures in automated steering based on visual inputs and the manner in which they recover a safe trajectory after taking over steering control. The model predicts both reaction times and trajectories for individual trials. The empirical results and model predictions demonstrate that the magnitude of required steering corrections is tightly linked to the time it takes to detect the failure. The magnitude of the required steering correction profoundly affects the nature of corrective manoeuvre and likelihood of a smooth and safe recovery. This finding suggests that steering control should not be modelled independently of monitoring the state of the automated vehicle. We advocate a modelling approach to predicting take-over quality which incorporates both state estimation of the AV as well as the subsequent steering response.

The effect of active steering control demand on gaze behaviour

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Automated Vehicles (AVs) often require a human driver to take over manual steering control. Where one looks during manual driving is crucial for steering successfully, however, AVs may disrupt gaze patterns: drivers sample more widely from the scene and look to the road ahead less frequently than during manual driving. Gaze disruption could impair subsequent steering. In most studies of control transitions there are multiple differences between the automated and manual driving periods that could also influence gaze behaviour (such as variations in trajectory), which makes it difficult to determine precisely how gaze patterns (during automation) influence manual steering (on take-over). The present study solves this issue by creating automated driving periods that replay the driver's own steering trajectories. Gaze behaviours were recorded in conditions where visual and haptic stimuli were matched across automation and manual modes, allowing the relationship between planning steering and gaze behaviours to be isolated. Whilst gaze patterns appeared remarkably similar across driving modes, during automation there were subtle differences, e.g. looking further away from the future path. These data suggest that the incoming visual input has a major contribution to gaze behaviours, but that planning steering actions also influences where you look (and when).

Deciding when to correct: threshold vs accumulator models of steering action initiation

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Vehicle control requires complex sensorimotor actions. To safely keep in lane a driver needs to monitor error development and initiate steering corrections that are appropriately timed. However, the perceptual mechanisms determining how a driver decides when to initiate a correction is currently unclear. The literature on perceptual-motor decision-making suggests two potential alternative mechanisms: (i) perceptual evidence (error) satisficing fixed constant thresholds (Threshold), or (ii) the integration of perceptual evidence over time (Accumulator). Using computer generated virtual environments a steering correction task was designed to distinguish between these mechanisms. Drivers steered towards an intermittently appearing 'road-line' across brief, repeated trials that produced perturbations to the relative trajectory, causing errors that required correction. Threshold and Accumulator accounts predict different response patterns for these conditions: a threshold account predicts a fixed absolute error response across conditions regardless of the rate of error development, whereas an accumulator account predicts that drivers will respond to lower absolute errors when there has been more time over which to integrate evidence. The results suggest that steering corrections are in line with an evidence accumulation account of decision-making, and so we propose that steering models should integrate perceptual error over time to better match human perceptual performance.