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Editorial: Connecting researchers for pushing an interdisciplinary research field

Stefan Brandenburg, Lewis Chuang, & Martin Baumann

Since the early 1940's, Human Factors has been an interdisciplinary research field. Engineers, psychologists, computer scientists, physicists, etc. met to enhance the safety and the productivity of systems that are centered on human-machine interactions (cf. Bernotat, 2008). Tremendous gains have been made in our understanding and in the design of Human-Machine Systems. Nonetheless, many interactions between humans and machines continue to be sub-optimal (Wickens, Hollands, Banbury & Parasuraman, 2012). One reason is that technology is constantly evolving and presents a moving goalpost for human factors. In our times, technology is ubiquitous and represents an integral component of our daily lives. With increasing autonomy, it has become more powerful and complex. Given the growing complexity of technological developments, it is paramount for Human Factors researchers to share ideas, to identify common problems and common theoretical concepts underlying human performance in human-machine systems from different domains in a constructive and fruitful discussion of their research projects.

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The Berlin Summer School Human Factors aims to provide such a forum for junior scientists to discuss their PhD projects. It promotes the transfer and communication of interdisciplinary skills, relevant to Human Factors research. Post-graduates conducting active research in the field of Human Factors, Human-Computer or Human-Machine interaction can also present their research for critical feedback. The Summer School differs from other workshops by giving presenters the opportunity to adapt their presentation format to the stage of their work. Presenters can, for example, choose between a 20-minute presentation followed by a 25-minute discussion and a focus group that starts with a 5-minute impulse talk followed by a 40-min. group work (e.g. brainstorming, moderated discussion). The objective of the summer school is to promote each of the PhD thesis that is presented by solving a specific problem, generating ideas, or proving help with specific methods. Therefore, the summer school aligns with the long history of interdisciplinary work in the field of Human Factors.

This year's topics included aviation, neurophysiology, human-computer interaction, driving, the simulation of virtual environments, attention, and the integration of senses. This is reflective of the tradition of Human Factors in entertaining a

diversity of research questions, while always having in its core, a concern for the human user.

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Applications of Eye-Tracking for user state recognition and adaptive content manipulation in Virtual Environments

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The aim of this thesis is to explore the possibilities of using Eye-Tracking as a means of accessing user state information while engaged in a Virtual Environment and to use this information to provide adaptive environments, depending on the users' state.

First, reliable means of user state recognition via eye tracking in virtual environments are explored, with an emphasis on detection of onset of Simulator Sickness, attentional shifts and emotional reactions. Gaze paths are recorded during engagement in virtual environments and, additionally, emotional and physiological responses traced. Based on Machine Learning approaches, a classification of distinct states will be developed. These classified states will then be correlated with the emotional, attentional and physiological responses to ensure validity. Based on these findings, applications for implicit adaptations of the environment to the users' state are implemented. These adaptations might focus on generating an environment that reduces potential

triggers of Simulator Sickness or on responding to emotional or attentional shifts.

Furthermore, known methods for eye tracking in non-virtual environments, such as smooth pursuit based input modalities, are adapted to 3D virtual spaces. The second application of user state recognition is accessing and directing attention shift in multi user VR-Enviroments within teaching contexts.

Comfort of Aircraft Cabins: Multidimensional Scaling, Explorative Interviews and Questionnaire Studies at the Hamburg Airport

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The **aim** of this study is the identification of important determinants influencing the comfort in an aircraft cabin. Factors of the environment - physical aspects like noise and psychological aspects like personal space - are examined.

A mixture of 3 methods is used:

1. First, 10 pictures of aircraft cabins are presented in the combination of pairs of 45 pictures. The one-dimensional presentation of the pictures is fitting best with the assumption that the one big factor is enough space.

2. Second, students were asked in interviews about the comfort in an aircraft cabin. 20 categories were found: space/ leg room (23%), sitting comfort/ flight attendants (14%), Inflight entertainment (11%), eating / drinking (10%), security (9%), cleanliness (4%), design (3%), toilets (2%), temperature (4%), sounds (2%),

pressure/ turbulences (1%), odor/ air quality/ lighting/ smoking areas/ cost-benefit ratio (0.3%).

3. Third, questionnaires of five-point scale items of the satisfaction with their last flight are filled out of passengers at Hamburg Airport. It is hypothesized that different aspects influence the comfort in an aircraft cabin: comfortable airlines, the duration flight and fear of flying.

What is the profit for aircraft manufacturers and companies of this study?

Phases of laparoscopic learning: How cognitive processes influence technical skill acquisition throughout the learning curve.

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Minimally invasive surgery (MIS) or also referred to as laparoscopy, revolutionized the manner in which surgical procedures are carried out today. Laparoscopy refers to a highly technical form of surgical technique, whereby small incisions are made, through which a viewing device and other surgical equipment are inserted. The sole nature of such a procedure is dependent on the interaction between the surgeon and his technical equipment, inflicting significant cognitive strain on the surgeon. Thus unsurprisingly, the notoriously difficult procedure has a long and steep learning curve (LC), suggesting that not every student will reach skill competence by the end of training. Although literature has shown that spatial cognition impacts laparoscopic performance and skill acquisition rate, we continue to lack the knowledge about the exact relationship between spatial cognition and technical skills throughout the LC. My

dissertations will longitudinally explore the LC of a novice on a laparoscopic simulator, carefully tracking each phase of learning, in relation to cognition and technical skills. The results of this study will help shed further light on human factors responsible for the identified steep and long LC, and will give us a better understand at to which cognitive processes promote successful skill acquisition.

The neurophysiology behind driver states in a complex, simulator-based traffic environment

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On a long car ride drivers are confronted with multiple demanding traffic situations which they have to respond to quickly and adequately. Though behavioural analyses have explained several underlying concepts of driver attention, the neurophysiological underpinnings of attentional processes are yet to be determined. In this study, attentional processes were investigated during an hour-long driving simulator session using a standard 32-channel EEG cap and a miniaturized EEG-system (cEEGrids) – the latter was used to ensure the measurement setup's applicability to real-road studies. Participants had to drive along a complex road network connecting highway, country road, and inner city driving sections. While driving they had to complete several demanding driving tasks (e.g. turning and overtaking manoeuvres). Spectral analyses of the EEG will be conducted over long time periods to investigate attention-correlated EEG-frequency-bands (alpha, beta, and

theta). Concerning the results, on the one hand this study will give information about cognitive driver states during car drives in a complex traffic environment. On the other hand, it will show whether the cEEGrids can validly depict the same amount of spectral EEG information during driving as the standard 32-channel EEG.

Human-Computer Interaction and Online Users' Trust and Distrust

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For most of us, the interaction with smartphones, game consoles or smart home systems, which are connected to the internet, became a part of everyday life. The aim of the dissertation project is to explain, why some of these systems or in particular some applications, like navigation or weather applications, are used and others provoke resistance. Therefore, the working model of Bär (2014) was extended. It will be examined, if the concepts of user experience (Mahlke & Thüring, 2007), trust and distrust could explain usage intentions and behaviours. Thereby, trust facets will be considered as benefits and distrust facets as costs during the system usage. Privacy concerns will form one of the distrust facets. A major goal is to develop a model to explain the privacy paradox, by weighing the benefits against the costs. A laboratory study and a field test are planned, to examine the described assumptions and to test, if a risk analyses tool could nudge users to a more privacy protective behaviour.

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Auditory warnings for steering environments

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Sounds are often used effectively to capture and direct attention to reduce visual load. When parking, cars can, for example, signal the decreasing distance to an object by decreasing the interval between beeps. The design of auditory warnings can consider various types of sounds. Auditory icons are representative, natural sounds from our environment that do not have to be learned. Abstract auditory warnings are known as earcons. These synthetic sounds cannot easily be confused with environmental sounds but their association has to be learned. Depending on which type of sound is chosen, different parameters (e.g. intensity, sound dynamics, interval, stimulus-onset-asynchrony) can be modified. In this project, I investigate the ability to cue and sustain attention in steering environments using auditory looming warnings. Looming sounds are earcon-icon hybrid sounds because they are artificial sounds that incorporate a natural sounds' characteristic.

That is, looming sounds rise in intensity and thereby signal an approaching sound emitting object. Although previous research has shown that looming stimuli evoke an avoidance response in humans, we still do not know how well these salient sounds work in directing attention to peripheral events while steering. My research, therefore, investigates the effectiveness of cuing peripheral visual targets by a looming sound, a constant intensity sound, or a sound decreasing in intensity. I found that all three sounds were able to cue attention equally well. However, only the looming sound was able to sustain attention longer at the cued location. Further experiments showed that this was not due to the high end-intensity of the looming sound but indeed due to the rising intensity profile that conveys the time to contact.

Learnability of fully-automated driving

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The role of the driver is changing. In manual driving he is an active operator, in partial- automated driving he takes over a monitoring task. In fully-automated driving his role will change to be a passenger in the automated vehicle. This leads to some questions as the following:

Does the passenger need any information? How can the passenger get used to his new role? How does the passenger learn to drive fully-automated? How do requirements change with growing experience? Is it possible to transfer knowledge from one type of automation to another one?

Starting from a user-centered design perspective, user requirements concerning HMI design for different learning phases will be defined. Firstly, the user´s goals and needs will be investigated in the context of the first contact with a fully-automated vehicle. Secondly, relevant factors for the learnability of fully-automated driving will be analysed and realized as HMI-prototypes. Thirdly, the concept will be validated in field and/or

simulator studies. Based on these results, a learnability model for fully-automated driving will be developed

Superiority of the external focus is mediated by the functionality of the movement effect

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In several training studies it has been shown that focusing on the movement effect (=external focus) leads to better performance and learning outcomes than focusing on the own body and its movements (=internal focus; for a review see Wulf, 2013). It remains unclear whether these results can be generalized to all kinds of movements (e.g., Künzell, 2007). We investigated whether the superiority of the external focus is dependent on the functionality of the focused movement effect for the task (= functionality hypothesis). In an experiment, healthy participants (n = 48) stood on a Wii Balance Board and were asked to shift their balance according to a predefined shape. Visual information and feedback were presented on a screen in front of them. We manipulated four dichotomous factors: the attentional focus (by instructions, between subjects), the functionality of the movement effect (by the quality of the information on the screen, between subjects), the difficulty of the target shape (within subjects) and session (within subjects). For the simple target shape

and the second session, results were consistent with the predictions of the functionality hypothesis. We suggest that the body feedback was not functional enough for the difficult shape.

Analysis of Driver Actions in Highly Automated Driving

Fabienne Roche

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Since 'self-driving cars' are expected to become real in near future (Walker, Stanton, & Young, 2001) the topic has been much researched. While current research on highly automated driving focusses on takeover requests initiated by the system (e.g. Damböck, Farid, Tönert, & Bengler, 2012; Merat, Jamson, Lai, & Carsten, 2012; Naujoks, Mai, & Neukum, 2014) little has been done about driver initiated takeovers. But according to Vienna Convention (1968), the driver of a highly-automated car remains responsible for the car all the time, meaning that driver initiated takeovers are possible. These interventions could occur in case the driver believes the automation doesn't work properly. Depending on the dynamic situation and the driver action, the results of a takeover by the driver can be critical. The present project looks into the effects of driver initiated takeovers and how the driver can be supported by an assistance system.

The presented and first study of the project aims to determine the dimensions in which a takeover causes a critical situation. In order to create comparable conditions with different levels of risk,

several take overs are initiated by the system after automated drives in a driving simulator. The result of the study will be values of variables such as time headway which resulted in objectively and subjectively critical situations. Based on that an assistance system will be developed which is supposed to support and limit the driver interventions during an automated drive and which will be validated in the further process of the project.

Risky behavior of vulnerable road users (VRUs) in traffic

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Cyclists and pedestrians are injured and killed in traffic accidents in far higher numbers than vehicle occupants. In 2014, 28% of cyclists as well as 28% of pedestrians were found to be guilty in their accidents (Bundesanstalt für Straßenwesen, 2015); many more are found to be partially contributing to the accidents by unruly behaviour. For effective and resource efficient reduction of these accidents, it thus seems promising to change the VRUs' behaviour. Therefore, the reasons and motivations for risky behaviours in VRUs should be analysed and then addressed.

A preliminary case-control-study for cycling accidents in Braunschweig showed that cycling on left cycling paths is risk-enhancing. Observations also showed that cycling without light in the dark is a common offense. Accident data shows that heavily drunken cyclists are often to be found in accidents (Statistisches Bundesamt, 2015). Three online surveys examined the motivations behind those behaviours and were not able to predict them with the help of the Theory of Planned Behaviour (Ajzen, 1991). Feeling disadvantaged in traffic, technical obstacles, and

not believing their behaviour to be risky, were often reported in the surveys. A subsequent survey on rule knowledge in cyclists showed, that more than half of the cyclists did know less than half of the traffic rules asked (Huemer & Eckhardt-Lieberam, 2016). For cyclists, information about regulations, risks and critical situations seem to be the most important factors for successful campaigns to enhance safety.

For pedestrians, the most common accident is while crossing the road. In 2014, most of the at-fault pedestrian were reported to "cross the road without attending traffic". Here, observational studies are being conducted to investigate, if and how distraction by technical devices may play a role in the accident causation.

Peoples' Affect and the Movement of their Body

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In 1950, Kafka postulated that (Ur-)Emotions always go along with spontaneous body movements. These body movements can manifest in two possible ways, depending on the point of reference. First, people approach pleasant objects and they avoid unpleasant objects. Here, the object is the frame of reference. Second, people bring pleasant objects closer to them or they push away unpleasant objects. Now the person is the frame of reference. Only few studies experimentally examined whether spontaneous body movements of the first kind are a valid measure of peoples' affect (i.e. Raab et al., 2013). The present study therefore asks two questions: A) Is there a relationship of affect and body movements when participants view affect inducing pictures? B) Does this relationship depend on the participants' knowledge about it? In other words: do people react spontaneously with body movements when experiencing affect, or is it an arbitrary movement? The results of a first study show that affect and body movements have a medium relationship.

However, people seem to use body movements purposefully to indicate their affective status. There are no spontaneous body movements as proposed by Kafka (1950). The talk will present the detailed results of the study and some implications for the assessment of user affects in human computer interaction. The discussants will be asked to help thinking about the next experiment to further examine the properties of body movements and their relation to peoples' affect.

DriveGOMS – A task based approach to driver modelling

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As a complex cognitive task, driving is still not well understood. Current theories about human driving behaviour often do not describe the driving task in a formal manner, which leads to a neglect of important details of human behaviour when executing the task. Further, they rarely consider motor, perceptual and cognitive functions in a unified framework. Usually also missing is the explicit treatment of the dynamic nature of the driving task. Psychological theories about driving mostly cannot predict quantitatively the driving behaviour of a specific person, e.g. regarding the time to execute an activity, or the specific order of actions or operations as parts of that activity.

We propose to apply the principles of the GOMS task analysis approach to the driving task (Card, Moran & Newell, 1983). Modelling on data from a driving simulator study, we attempted a decomposition of the driving task into goals, operators, and methods. Goals are what structures the task, and have been derived from thinking aloud protocols and eye tracking data. Operators have been modelled based on eye tracking data and

vehicle data. Finally, we clustered operators into methods, which can be seen as driving manoeuvres. The resulting models can be used to predict execution times of driving activities, as a formal description of empirical driving data, or to define normative models of driving activities.

Understanding Ambiguous Effects of Multimodal Feedback on Situation Awareness and Task Performance Using Bayes Sense Integration

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Task performance and situation awareness are in many teleoperation applications vastly inferior to non-mediated applications [1]. It has been suggested that multimodal feedback may improve these aspects. Nevertheless, the added value of multimodal feedback is not yet clear [2–4]. Hence, for efficient design of user interfaces, it is necessary to understand the effects of haptic, auditory and visual cues and implications of multimodal feedback on task performance and situation awareness. The present research investigates the use of Bayes Sense Integration [5, 6] in order to better understand the value of combining haptic, auditory and visual feedback in different contexts. Bayes Sense Integration describes the resulting estimate and its standard deviation from information in several modalities combined by a priori knowledge [7–9]. Secondary data ($n = 48$) analyses of a static target acquisition task show that bi-modal combinations of visual and haptic information are integrated. Yet, the combination of

visual with auditory information does not seem to be integrated. An investigation of a combination of haptic with auditory information also suggests that no sensory integration took place. Overall, the results give a first insight into the interaction of haptic, visual and auditory information in multimodal feedback in telerobotic applications and may explain why multimodality may fail to improve operator performance and situation awareness in some circumstances.

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Psychological view on demands and potentials for industrial workers in times of Industry 4.0

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The increasing digitalization and interconnection of the processes in modern factories change the setting for the workers fundamentally. Nevertheless, the factory worker will still carry a key role and should be integrated wisely into the future automated systems. Mental states are already broadly investigated in human-machine interaction. For the working context, the potential of assessing and adapting production to the mental state of the worker in real-time could be a possibility to enhance performance and reduce the risk of errors or absence. Therefore, suitable interfaces need to be developed that allow the communication between the worker and the automated factory as well as provide relevant information about the worker in order to adapt dependent processes. This dissertation aims to investigate possibilities to assess mental states of workers in real-time that are relevant to the production process as well as define specific requirements for such solutions. In a first study, we examine the possibility to capture mental workload based on physiological data recorded by a smartwatch. Later, our findings

will be validated in a factory environment in cooperation with an industrial partner.

Usability in kleinen Softwareunternehmen verankern: Evaluation und Weiterentwicklung eines Vorgehensmodells

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Nutzer sollten durch Software beim effizienten und zufriedenstellenden Erfüllen von Aufgaben unterstützt werden, die für sie wichtig und relevant sind. Für Kunden von B2B-Software wird die Usability ihrer betrieblichen Anwendungen mit steigender Digitalisierung von Wirtschaft und Geschäftsprozessen immer erfolgskritischer und zum wesentlichen Effizienzfaktor. Gerade bei kleinen und mittleren Softwareherstellern (Software-KMU) hat diese Erkenntnis und Anforderung jedoch meist noch nicht zu einer (nachhaltigen) Berücksichtigung von Usability-Aktivitäten bei ihren Entwicklungsabläufen geführt. Diese Problemstellung führt zur Forschungsfrage, wie bei Software-KMU eine solche Innovation ihrer zentralen Geschäftsprozesse initiiert und deren Anpassung begonnen und nachhaltig etabliert werden kann. Die Wirkung von Usability-Pilotprojekten mit Software-KMU wird untersucht. Führt eine Teilnahme an Usability-Aktivitäten, das Kennenlernen zeit- und kostensparender Methoden sowie

schnelle Erfolgserlebnisse in Form von Produktverbesserungen unmittelbar zu einer veränderten Einstellung gegenüber Usability und einer Akzeptanzerhöhung sowie zur Intention, künftig Usability-Aktivitäten durchzuführen? Zusätzlich wird in spezifischen Studien die entsprechende Wirkung untersucht von a) Usability-Wissen durch einen Workshop sowie b) das Kennenlernen von Effizienz und Nutzen einer anforderungsgerechten, praxistauglichen Nutzertestmethode.

Vor dem Hintergrund der Theorie zu Change Management und der Psychologie organisationaler Veränderung werden die Ursachen untersucht, warum die Vorgehensweise mit Pilotprojekten, Methodenvermittlung und Nutzenerfahrung zu einer entsprechenden Veränderung der Entwicklungsprozesse geführt hat oder diese ausgeblieben ist. Hierbei wird insbesondere die Rolle der Geschäftsführung und Entscheider beleuchtet. Im Ausblick wird diskutiert, durch welche Kommunikation und Argumente diese überzeugt werden können, substantielle Ressourcen in die Veränderung ihrer Organisation (nutzerzentrierte Prozesse und Kultur) zu investieren. Das Thema Return on Investment (ROI) von Usability-Aktivitäten steht im Fokus dieser Betrachtung.