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Designing Safety Critical Interactions: Hunting Down Human Error

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Abstract
Human error at the time of operation (i.e. when the system is in use) are implicated in most incidents involving safety critical systems. In many domains, control and command interfaces are composed of a multitude of devices and machines from different brands in different generations have been crammed together. The resultant bridging of functions across devices, the decision making, the overview, the handling of partially imprecise or conflicting information are often just offloaded to the human. Thus, there appears to be a need to shift the attention from avoiding human error (at operation time) to avoiding error during design. In this workshop, we aim to provide a forum to discuss such a paradigm shift and the implication on the methods and tools for designing and evaluating HCI technology in safety-critical environments.

Author Keywords
Design errors, human error, safety critical systems, transportation, energy, medicine.

ACM Classification Keywords
•Human-centered computing~Human computer interaction (HCI) •Hardware~Robustness~Safety critical systems •Hardware~Robustness~Fault tolerance~Error detection and error correction

Background

Safety Critical Environments, i.e., systems whose failure either endanger human life or cause drastic economic losses, form the technological backbone of today's society and are an integral part in such vastly diverse industrial sectors as automotive, aerospace, maritime, production, energy, health care, banking. Such systems are safety critical – human errors, technical failures, and malicious manipulation of information can cause catastrophic events leading to loss of life. Over many years, critical incidents have been analyzed in detail but was has been searched for was the human error [16].

Human machine interaction plays a crucial role in these systems, in which typically expert users are controlling and interacting with complex systems.

CHI and other conferences recognize the importance of addressing the problems raised by non-classical User Interfaces. For instance, over the last decade, CHI has been featuring paper tracks on "Beyond the Desktop", addressing the issue of context of use and interactive systems that were supporting operators in performing their work. However, little to no work was targeting user interfaces for command and control interactive systems. So far, safety-critical interactions have not been in the focus of CHI yet. Novel methods and designs for interactions in large and complex settings do appear regularly at CHI. On the other hand, conferences on formal methods or software engineering address the issues raised by the design of such system with a yet limited interest for the user interface part. Similarly, conferences on human factors or cognitive engineering mainly focus on the human side of these systems addressing high-level concepts such as automation, situation awareness in those contexts, but not with a focus on the human machine interaction per se, thus providing sub-optimal solutions with respect to current knowledge in the field of HCI.

The deployment of more and more complex command and control systems has not yet received widespread attention by researchers and academia. Investigations in HCI are often centered on specific single-to-narrow-purpose interface in a specific context. The multi-faceted complexity of application-oriented domains such as aerospace, maritime, health, production, or energy (see also Figures 3-5) and the general and fundamental challenges they pose to human interaction did not get in the focus of CHI to a sufficient degree.

One dimension of the complexity of these safety-critical systems lies in the integration of all these devices to constitute a usable (efficient, effective, and satisfying to use) system. Another dimension lies in the multiple stakeholders involved in the design, development, deployment, training, maintenance and certification of these systems.

The problems surrounding design of safety-critical interaction and safety-critical systems are receiving more and more public attention due to the increased deployment of these systems and the resulting failures. For instance, according to [1], in 2019 the US Navy has reported removing touch technologies from the command and control systems of battleships following the collision between USS John S. McCain and USS Fitzgerald. The architecture of John S. McCain bridge (Figure 3 of that paper) highlights the multiplicity of operator workstations and technologies.

[1] https://news.usni.org/2019/08/09/navy-reverting-ddgs-back-to-physical-throttles-after-fleet-rejects-touchscreen-controls



Figure 1. Nurse in an intensive care station monitoring alarms (c.f. also [15])



Figure 2 Ship bridge simulator environment studying safe navigation (c.f. also [13])



Figure 3 Human and machine interaction in a production line

In this workshop, we want to discuss practice, research, and current knowledge in the area of safety critical interactions. It is inspired by a very successful summer school on Safety Critical Interaction [[1]] and several events at CHI such as courses [[3]], workshops on the related topic of autonomous vehicles [[4]] or Special Interest Groups [[5]]. Similar events have been organized in other venues such as MobileHCI [[7]] and INTERACT [[2]]. These very well attended and successful events allow to expect a well-attended workshop especially with the proximity of Asia that has been facing a major accident in the energy domain [[8]].

Suitability for CHI

Many CHI attendees are product designers and developers vitally concerned with improving the performance of their applications. Some of them will have the opportunity to extend their application domain to safety related ones.

This workshop is of immediate and practical benefit to such attendees because it allows them to hear and share the latest research problems and current solutions on this area.

To this end, this workshop will have an emphasis on case studies the organizers have been working on. This will provide useful and usable information of shared interest for both the academic researcher and the practitioners.

Workshop goals

The workshop has multiple goals in order to inform HCI research and practice for the design of large command and control systems.

- Provide a forum for researchers and designers of human interaction and user interfaces with an interest in safety-critical interfaces
- Identify commonalities and discrepencies amongst different application domains with respect to safety critical interactions and interfaces
- Discuss potential for transferring knowledge from usually unrelated domains such as transportation, energy and medicine
- Present research on potential solutions in terms of methods and processes for assessing safety of critical systems
- Envision new interaction paradigms for safety critical interactions taking into account a broader view of issues as, for instance [[9]] where touch interactions are enhanced with dependable mechanisms
- Explore engineering issues related to safety, reliability, and security properties as well as certification
- Consider UX factors relevant to the design of interactions within critical systems as identified in [[10]] with a focus on UX and automation.

Participation

The workshop is intended for HCI, Human Factors, and safety critical systems researchers and practitioners, designers and developers. Workshop candidates have to submit a position paper (four pages in the CHI extended abstract format submitted via a submission system linked via the workshop website).

Organizers

We have comprehensive experience in the organization of conferences, workshops and summer schools in the area of safety-critical systems. This includes events at conferences such as CHI but also dedicated events such as the ATACCS (App. and Theory of Automation in Command and Control Sys) or the international summer school on HCI in safety critical environments [[1]].

Susanne Boll is Professor of Media Informatics and Multimedia Systems in the Department of Computing Science at the University of Oldenburg, in Germany. Her research interests lie in the field human computer interaction and pervasive computing with a strong application focus on safety-critical domains. Recently she has been working on interactive interface technology for ship bridges [12], multi-monitor environments [13], situation monitoring in large spaces [14], intensive care units [15].

Philippe Palanque is Professor in Computer Science at the University Toulouse 3. He is working on formal methods for engineering interactive systems and the application of such techniques to Higher Automation Levels in the field of Air Traffic Management, Interactive Cockpits of Large Civil Aircrafts [2] and Satellite Ground Segments [8]. He was chair of (Application and Theories of Automation in Command and Control Systems) ATACCS 2015 conference.

Alexander Mirnig is a Research Fellow at the Center for Human-Computer Interaction at the University of Salzburg, Austria. His research interests lie in interaction design in restricted environments, interaction with automation technologies, and Philosophy of Science. His current research focuses on human factors in automated public transportation [17], control transitions in semi-automated vehicles [20], and Machine Ethics [19].

Jessica Cauchard is an assistant professor in Industrial Engineering and Management at Ben Gurion University of the Negev, Israel. Her research interests lie in the fields of human computer interaction and ubiquitous computing. She has a strong interest in how people will interact with small autonomous devices in the future, such as drones [18] in collocated situations [24]. She investigates the role of collaboration in human and robotic environments [24].

Margaretha Lützhöft is a master mariner, trained at Kalmar Maritime Academy in Sweden. After leaving the sea, she studied for a Bachelor's degree in Cognitive science and a Master's in Computer Science. In 2004 she received a PhD in Human-Machine Interaction. Presently she is holding a position as Professor in the MarSafe group at the Western Norway University of Applied Sciences, and leader of the MarCATCH Research Centre. Her research interests include human-centered design and the effects of new technology [21] and the role that automation plays in the success and failure of navigation today [22] and the role of context [23].

Michael Feary is an aerospace technologist at NASA Ames research center where he leads the Aerospace Cognitive Engineering Lab. The ACE Lab investigates methods to improve the design and evaluation of complex, safety critical systems. The work centers on formal approaches to design and evaluation of human interaction with automated systems such as ADEPT tool [[26]]. He also organized events on automation at CHI such as [[5]].

Website

All the information about the workshop organization and program is published and updated on the workshop website https://sites.google.com/view/chi-ws-sci/welcome. The organizers have run several previous international events and have experience in setting up a professional Web page and advertisement of the workshop. It contains the call for participation including dates and author instructions and a link to a submission system for authors of position papers. It includes the background of each organizer and a detailed schedule of the workshop. Accepted position papers and presentations are available for download.

Time	Phases
09:00 – 09:10	Welcome and introduction to workshop goals and organization
09:10- 10:30	Position Paper Presentations I (presentations 10 min each incl. Q&A)
10:30 – 10:45	Coffee break
10:45 – 12:15	Position Paper Presentations II (presentations 10 min each incl. Q&A)
12:15 – 13:30	Lunch
13:30 – 15:10	Group discussions on 5 tables/themes (20 minutes slots for each participant on every table)
15:10 – 15:30	Coffee break
15:30 – 16:45	Presentation of results from each table (15 min each)
16:45 – 17:00	Exploration of future work (e.g., joint publication) and wrap-up
later	Joint workshop dinner (optional)

Table 1: Workshop schedule.

Pre-Workshop Plans

The call for participation (CFP) will be distributed via HCI-, Human Factors and Ergonomics Society and safety mailing lists (e.g., chi-announcements, systemsafety@lists.techfak.uni-bielefeld.de), social networks (e.g., Facebook groups and Twitter), as well as personal distribution lists based on workshops and conferences we have held. Accepted workshop position papers will be made available to all participants via the workshop website before the workshop to foster interactions during the workshop.

Workshop Structure

This will be a one-day workshop consisting of approximately 20 participants plus organizers. Table 1 provides an overview of the proposed workshop schedule.

Participants will be welcomed and introduced into workshop goals. The first half of the workshop-day will be dedicated to oral presentation of the position papers, reflections, and discussions on the presentations of each participant. Participants will be provided with a 10-minute slot each including Q&A. Presentations should be short, straight to the point and convey a clear message in line with the workshop objectives.

The second half of the workshop will be dedicated to participant discussions and collaborations. Participants will discuss challenges of safety critical interaction and interfaces from various perspectives. There will be five tables each hosting a specific topic (e.g., certification, global design, human error, human as hero, conflicts and tradeoffs between properties (e.g. UX, usability, safety, dependability etc.). Topics will be finalized based on position paper submissions and the discussion in the morning sessions. Each table will have a host (one of the organizers). After 20 minutes, every participant will move to another table to ensure that by the end of the workshop each participant has discussed each topic. Finally, a group session will be held, in which topic hosts will present results. In a wrap up phase potentials for a joint publication and/or a special issue on the topic will be discussed.

Post-Workshop Plans

Workshop results will be communicated both to communities and a general audience including a Poster at CHI. We plan to produce a report for publication in the ACM Interactions magazine and prepare a special issue in a selected journal (e.g. Interacting with Computers[2]) following the conference. This will depend of the quality of the contributions and of the output of the workshop. Workshop results will be made available through the workshop website and an email list to network with others will be created.

Call for Participation

Designing Safety Critical Interactions: Hunting Down Human Error is a one-day workshop at CHI 2020 in Hawaii, USA.

This workshop is aimed at researchers and designers in the field of human-computer interaction. In this workshop, we want to discuss practice, research and current knowledge in safety critical interactions and how to design for avoiding human error in future complex interactive systems. We will discuss how the design process and methods need to change or be adapted to avoid human error in safety-critical environments already at design time. What can be learnt from other domains for the design and evaluation of autonomous vehicles.

[2] https://academic.oup.com/iwc

To participate, a four-page paper in the CHI extended abstract format has to be submitted via the workshop website. Position papers should cover one of the following or related topics:

- interactive Systems for understanding and resolving critical situations
- Design for safety, reliability and security in interactive systems
- Designing for resilience in interactive systems
- Metrics for evaluating interactions in complex safety-critical systems
- Collaboration in safety critical environments
- The role of simulation and models for safety critical interaction design
- Participatory design and ethnography for safety critical interaction design
- Interaction across multiple devices from multiple brands in safety-critical environments
- commonalities and discrepencies amongst different application domains

The workshop is restricted to approximately 20 participants. Applications will be selected by workshop chairs, who will evaluate position papers based on their fit with the workshop theme, their originality, and their quality. The author of an accepted submission must attend the workshop, provide a short presentation, and register for both the workshop and for at least one day of the main conference.

Deadlines

- Position paper: February 11, 2020
- Notification: February 28, 2020
- Workshop at CHI2020: April 25th/26th, 2020

More Information:
https://sites.google.com/view/chi-ws-sci/welcome

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