

OPERATOR-CENTERED & MODEL-BASED DESIGN FOR CRITICAL HMIS: APPLICATION TO THE NEW CSG OPERATIONS CENTER FOR REUSABLE LAUNCHERS

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Abstract: Text in English

Designing usable HMIs is a complex activity involving multiple stakeholders with potentially conflicting objectives. ISO 9241 part 11 ^[1] defines the usability property (composed of contributing factors called efficiency, effectiveness and satisfaction) while ISO 9241 part 210 ^[2] defines the User Centered Design process which makes explicit involvement of end-users in the various development phases (needs analysis, design, evaluation, ...). Unfortunately, these standards mainly focus on simple, walk-up and use systems such as mobile apps and would thus miss important properties such as learnability of the HMIs. HMIs deployed in critical contexts (such as launcher control centres) present specific differences with respect to the walk-up and use systems including but not limited to: the impact of a failure of the HMI as well as of the operator may have catastrophic consequences, the operators' work may be complex requiring high levels of concentration as well as specific competences and skills, the operators work as a team (of various sizes) that need to collaborate efficiently in order to reach the missions' goals, ...). These differences call for specific processes and tools to guarantee the presence of specific properties such as usability, user experience and learnability. In the final paper we will present a model-based process to design and evaluate critical HMIs. The models include a task model capturing the work that each operator has to perform as well as the cooperation between operators (and its applicability to satellite ground segments has been demonstrated in ^[3]). Beyond, this task notation integrates concepts such as knowledge and skills (to be mastered by operators) and thus supports analysis of learnability and assessment of training needs as demonstrated in ^[4]. With the arrival of reusable launchers, operational concepts and in particulier, Flight Safety operations are changing. At the CSG, **Europe's Spaceport**, studies are currently taking place in order to anticipate the impacts on the Flight Safety Officer (FSO) missions and work in order to provide "usable-by construction" & "learnable-by construction" Human Machine Interface design. Within the context of the **CSG-NG** (Guiana Space Centre - New Generation) project, financed by **ESA** and **CNES**, a new Operations Centre (**CDO**) is being developed. **CALLISTO** (Cooperative Action Leading to Launcher Innovation in Stage Toss-back Operations) is a single stage and reusable demonstrator, propelled by rocket engine and developed jointly by the German Aerospace Center, the French Space Agency, and the Japanese Aerospace Exploration Agency. The **CALLISTO** project brings new constraints on the FSO HMI including very short reaction time to manage potential deviations and high impact decision-making on vehicle inhibition in case of unacceptable deviations. In the final paper we will demonstrate how a hardware and software HMI has been designed in order to address all the challenges above including assessment of workload and ensuring operator performance.

References:

- 1 International Standard Organization: ISO 9241-11. Ergonomic requirements for office work with visual display terminals (VDT) – Part 11 Guidance on Usability (1996).
- 2 International Standard Organization: ISO 9241-210: Ergonomics of human-system interaction – Part 210: Human-centred design for interactive systems, Geneva
- 3 Célia Martinie, Philippe A. Palanque, David Navarre, Marco Winckler, Erwann Poupart. Model-based training: an approach supporting operability of critical interactive systems. ACM international conference on Engineering Interactive Computing Systems, EICS 2011: 53-62
- 4 Célia Martinie, Philippe A. Palanque, Elodie Bouzekri, Andy Cockburn, Alexandre Canny, Eric Barboni. Analysing and Demonstrating Tool-Supported Customizable Task Notations. Proc. ACM Hum. Comput. Interact. 3 (EICS 2021): 12:1-12:26 (2019)