SPACE OPERATIONS SYMPOSIUM (B6)
Human Spaceflight Operations Concepts (1)

Author: Mr. Christian Knorr
Airbus Defence and Space Ltd, Germany

Prof. Mark Neerincx
TNO, The Netherlands
Dr. Leo Breebaart
The Netherlands
Mr. Frederic Reiter
Space Applications Services NV/SA, Belgium
Mr. Mikael Wolff
European Space Agency (ESA), The Netherlands

EXPERT TOOLS TO SUPPORT CREW AUTONOMOUS OPERATIONS IN COMPLEX HUMAN SPACECRAFT

Abstract

During long duration human space missions, the current concept of operations, heavily relying on ground control and ground support, will not be valid anymore due to e.g. the long communication delays. The crew will need to take more autonomous decisions which can be very challenging and even critical in case of an emergency occurring when ground support is not available. This paper shows how to design decision support tools for autonomy, providing an example requirements engineering, prototyping and evaluation process. It also describes an initial concept and requirements baseline of expert tools to support autonomous crew operations.

Based on a situated Cognitive Engineering approach, the ETECA study project performed an analysis phase including a summary of current and emerging decision support tools (technology perspective), the definition of usability requirements based on existing models and frameworks (human factors perspective) and end-user interviews with three astronauts (operational perspective). Based on the outcomes of these activities an initial requirements baseline has been defined and justified by use case descriptions that address the operational, human factors and technological aspects of envisioned missions. From these descriptions essential decision support functions – so-called 'core functions' – and their associated testable claims have been derived.

In a second phase a subset of the requirements has been implemented in a proof-of-concept demonstrator which has been evaluated by experienced operations personnel (end-user evaluation) and usability experts (cognitive walkthrough), both following a representative scenario of space system failure.

Both evaluations produced many comments regarding the usability, effectiveness and efficiency of the system. They both confirmed the basic principles of the demonstrator nevertheless they identified several areas of improvement which mainly address minor user interface issues or core functions and requirements which have not been implemented in the demonstrator. The improvements identified by the expert walkthrough have been captured and categorized for further considerations. The observations, questionnaires' answers and interview results elicited during the end user evaluation have been consolidated to derive common suggestions.

The ETECA project provided a validation of (a) the situated Cognitive Engineering methodology, (b) a requirements baseline for crew decision support, and (c) a proof of concept. The results indicate a confirmation of the defined requirements baseline. The proposed improvements of the demonstrator

suggest that autonomous crew operations can not rely on individual tools but rather a complete concept of complementary functions.