59th International Astronautical Congress 2008

SYMPOSIUM ON STEPPING STONES TO THE FUTURE: STRATEGIES, ARCHITECTURES, CONCEPTS AND TECHNOLOGIES (D3.)
Novel Concepts and Technologies for the Exploration and Utilization of Space (2.)

Author: Ms. Claire Baker
Defence Science and Technology Organisation (DSTO), Kensington, Australia, claireu.baker@gmail.com

Dr. Neelam Naikar
Defence Science and Technology Organisation (DSTO), Melbourne, Australia,
neelam.naikar@dsto.defence.gov.au
Prof. Mark Neerincx
TNO Defence, Security Safety , Soesterberg, The Netherlands, mark.neerincx@tno.nl

ENGINEERING PLANETARY EXPLORATION SYSTEMS: INTEGRATING NOVEL TECHNOLOGIES AND THE HUMAN ELEMENT USING WORK DOMAIN ANALYSIS.

Abstract

The realisation of sustainable space exploration and utilisation requires not only the development of novel concepts and technologies but also their successful integration. Hardware, software, and the human element must be integrated effectively to make the dream for which these technologies were created a reality.

Work Domain Analysis (WDA), the first phase of Cognitive Work Analysis, is becoming widely used for the holistic analysis and design of complex, sociotechnical systems. WDA has been successfully applied in numerous domains including nuclear power, medical, and defence. While WDA has the potential to provide innovative solutions in the space domain, almost all previous applications of WDA have been for extant systems or systems with a similar extant predecessor.

Currently, novel technologies in the space industry are rarely extant, and if a similar predecessor exists, there is usually limited working experience with its systems. The application in this paper was performed to determine whether WDA is useful as a holistic design tool for original technologies without extant predecessors or operational experience. Specifically, WDA was applied to the Mission Execution Crew Assistant (MECA), a first-of-a-kind system designed for the Mars environment. MECA is intended to be a distributed support system that enhances the capabilities of human-machine teams to cope autonomously with unexpected, complex, and potentially hazardous situations.

The aim of the WDA, which utilised a methodological approach developed in Australia, was to ensure that the MECA Requirements Baseline (RB) completely and accurately describes a system that can be used to support astronauts in Mars exploration. Through analysis of the Mars environment, WDA produced an Abstraction-Decomposition Space (ADS), a complete model of the Mars surface environment at varying levels of detail and abstraction. This ADS was used to evaluate the existing RB to ensure that all technologies and astronauts can work cooperatively to achieve their goals in the defined environment.

The WDA was successful in ensuring that the MECA RB captured the system requirements for planetary exploration. It revealed that while technical mission requirements had been fully addressed, further specification around living requirements would be beneficial. The WDA application also provided an unexpected "spin-off" - a glossary that has found multiple applications throughout system design.

The future of WDA in the development of novel space systems lies in its extended application and in concept refinement. Further applications of WDA may investigate its integration with systems engineering techniques to take full advantage of the holistic mindset it encourages.