



M E C A
Mission Execution
Crew Assistant



Empowering Cognitive Capacities of Human-Machine Exploration Teams

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Evaluation of Crew Support during EVA



MARS 500 simulation of planetary mission

In the space domain, the plans for manned planetary missions set substantial challenges for providing crew support. There will be a need for a Mission Execution Crew Assistant (MECA) that supports groups of humans and machines acting in a distributed, autonomous but cooperative way. TNO, S&T, OK-Systems and EADS-Astrium are applying cognitive and software engineering methods to derive requirements and test prototypes for such a system.

The objective of MECA is to enhance the cognitive capacities of human machine teams during planetary exploration missions in order to cope autonomously with unexpected, complex and potentially hazardous situations.

Long-duration missions (e.g. to the Moon or Mars) require astronauts to collaborate and interact with complex computerized equipment and facilities: habitats, greenhouses, power plants, exploration vehicles, autonomous robots, and so on.

MECA will provide crew support that acts in this ubiquitous computing environment as an “electronic partner”, helping the crew to maintain and improve situational awareness, to determine a suitable course of actions to solve a problem, and to safeguard the astronaut from failures. To establish the required optimization of performance, workload, situation awareness, sense making and trust, emerging technologies are applied.

Examples of such technologies are multi-agent systems, automatic planning and scheduling, model-based health management, decision support, on-the-job training, and affective computing.

For the development of MECA, we apply a human-, task- and context-driven design and evaluation approach. According to the vision of the project team, both MECA and the humans will show mutually adaptive behavior, the effects of which should be well tested with realistic scenarios. Prototyping, simulation and testing are therefore essential to establish a sound and coherent set of requirements.





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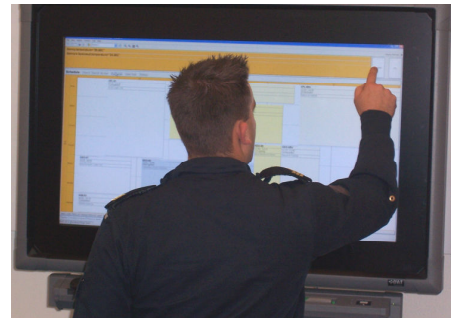


In the first phases of the MECA project, operational demands, human factors issues and state-of-the-art technologies were assessed and translated into a requirements baseline for a crew support system. Prototypes were tested with the human in the loop:

- A lab evaluation with virtual reality technology established a situated experience of astronauts on a planet. This provided the first empirical foundation of MECA requirements.
- In the MARS 500 mission simulation (Moscow), an isolated 6-person crew uses a custom MECA training and gaming prototype every week. It contains a diagnostic tool to measure psychosocial crew status, and a feedback mechanism to improve crew planning. A first study provided a method to train MECA's cognitive models and a refinement of the general requirements baseline.

In the current phase of the MECA project, more advanced functionality and a higher degree of operational readiness are being tested in analogue environments:

- A terrestrial test was conducted at a volcanic area in the Eifel mountains, simulating a habitat and Extra-Vehicular Activities on the surface of Moon or Mars. The prototype contained more advanced collaboration and resource management features for nominal and off-nominal operations. It supported the adherence to policies (obligations and authorizations) for task (re)scheduling and information sharing (e.g., notifications).
- An in-orbit test is intended on board the International Space Station, aiming to assist individual crewmembers in day-to-day activities.



MECA prototype



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