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Multipurpose Crew Restraints for Long Duration Space Flights

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Abstract

With permanent human presence onboard the International Space Station (ISS), a crew will be living and working in microgravity, interfacing with their physical environment. Without optimum restraints and mobility aids (R&MA's), the crewmembers may be handicapped for performing some of the on-orbit tasks. In addition to weightlessness, the confined nature of a spacecraft environment results in ergonomic challenges such as limited visibility and access to the activity area and may cause prolonged periods of unnatural postures. Thus, determining the right set of human factors requirements and providing an ergonomically designed environment are crucial to astronauts' well-being and productivity.

The purpose of this project is to develop requirements and guidelines, and conceptual designs, for an ergonomically designed multi-purpose crew restraint. In order to achieve this goal, the project would involve development of functional and human factors requirements, design concept prototype development, analytical and computer modeling evaluations of concepts, two sets of microgravity evaluations and preparation of an implementation plan. It is anticipated that developing functional and design requirements for a multi-purpose restraint would facilitate development of ergonomically designed restraints to accommodate the off-nominal but repetitive tasks, and minimize the performance degradation due to lack of optimum setup for onboard task performance. In addition, development of an ergonomically designed restraint concept prototype would allow verification and validation of the requirements defined.

To date, we have identified "unique" tasks and areas of need, determine characteristics of "ideal" restraints, and solicit ideas for restraint and mobility aid concepts. Focus group meetings with representatives from training, safety, crew, human factors, engineering, payload developers, and analog environment representatives were key to assist in the development of a restraint concept based on previous flight experiences, the needs of future tasks, and crewmembers' preferences. Also, a catalog with existing IVA/EVA restraint and mobility aids has been developed. Other efforts included the ISS crew debrief data on restraints, compilation of data from MIR, Skylab and ISS on restraints, and investigating possibility of an in-flight evaluation of current restraint systems. Preliminary restraint concepts were developed and presented to long duration crewmembers and focus groups for feedback. Currently, a selection criterion is being refined for prioritizing the candidate concepts. Next steps include analytical and computer modeling evaluations of the selected candidate concepts, prototype development, and microgravity evaluations.