

## **QUANTIFYING ASTRONAUT TASKS: ROBOTIC TECHNOLOGY AND FUTURE SPACE SUIT DESIGN**

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Quantified astronaut task performance will lead to enhanced training, more efficient crew operations, and optimized mission planning. In order to systematically address the relationships between the astronaut, tasks to be accomplished, and environment, analytical models were developed in conjunction with pressurized space suit experiments and state of the art robotic technology. A joint angle and torque database was compiled for the Extravehicular Maneuvering Unit (EMU space suit), with a novel measurement technique using both human test subjects and an instrumented robot. Using data collected in the experiment, a mathematical hysteresis modeling technique was used to predict EMU joint torques from joint angular positions. The hysteresis model was then applied to extravehicular activity (EVA) operations by mapping out the reach and work envelopes for the EMU.

With better understanding of astronaut performance we can look ahead to future missions and propose both improvements to the current space suit as well as revolutionary new designs for partial gravity locomotion space suits. Concepts have been developed for a Bio-Suit System that could revolutionize human space exploration by providing enhanced astronaut EVA locomotion and life support based on the concept of providing a 'second skin' capability for astronaut performance. The Bio-Suit System would provide life support through mechanical counterpressure where pressure is applied to the entire body through a tight-fitting suit with a helmet for the head. This ongoing research is aimed at radical advances in our ability to understand, simulate, and predict capabilities of suited astronauts in a variety of scenarios.