EMU Suit Performance Simulation

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Introduction: Designing a planetary suit is very complex and often requires difficult trade-offs between performance, cost, mass, and system complexity. To verify that new suit designs meet requirements, full prototypes must be built and tested with human subjects. However, numerous design iterations will occur before the hardware meets those requirements. Traditional draw-prototype-test paradigms for research and development are prohibitively expensive with today's shrinking Government budgets.

Personnel at NASA are developing modern simulation techniques that focus on a human-centric design paradigm. These new techniques make use of virtual prototype simulations and fully adjustable physical prototypes of suit hardware. This is extremely advantageous and enables comprehensive design down-selections to be made early in the design process.

Objectives: The primary objective was to test modern simulation techniques for evaluating the human performance component of two EMU suit concepts, pivoted and planar style hard upper torso (HUT).

Methods: This project simulated variations in EVA suit shoulder joint design and subject anthropometry and then measured the differences in shoulder mobility caused by the modifications. These estimations were compared to human-in-the-loop test data gathered during past suited testing using four subjects (two large males, two small females).

Results: Results demonstrated that EVA suit modeling and simulation are feasible design tools for evaluating and optimizing suit design based on simulated performance. The suit simulation model was found to be advantageous in its ability to visually represent complex motions and volumetric reach zones in three dimensions, giving designers a faster and deeper comprehension of suit component performance vs. human performance. Suit models were able to discern differing movement capabilities between EMU HUT configurations, generic suit fit concerns, and specific suit fit concerns for crewmembers based on individual anthropometry.