Exploring Life Support Architectures for Evolution of Deep Space Human Exploration

Life support system architectures for long duration space missions are often explored analytically in the human spaceflight community to find optimum solutions for mass, performance, and reliability. But in reality, many other constraints can guide the design when the life support system is examined within the context of an overall vehicle, as well as specific programmatic goals and needs. Between the end of the Constellation program and the development of the "Evolvable Mars Campaign", NASA explored a broad range of mission possibilities. Most of these missions will never be implemented but the lessons learned during these concept development phases may color and guide future analytical studies and eventual life support system architectures. This paper discusses several iterations of design studies from the life support system perspective to examine which requirements and assumptions, programmatic needs, or interfaces drive design. When doing early concept studies, many assumptions have to be made about technology and operations. Data can be pulled from a variety of sources depending on the study needs, including parametric models, historical data, new technologies, and even predictive analysis. In the end, assumptions must be made in the face of uncertainty. Some of these may introduce more risk as to whether the solution for the conceptual design study will still work when designs mature and data becomes available.