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# EXPLORATORY METHODS AND TECHNIQUES FOR SPACE TECHNOLOGY DEVELOPMENT AND SPACE MISSION CONCEPT DEVELOPMENT

**Abstract**

This paper hopes to fill a gap in literature by framing the current state of exploratory design methods and techniques within space mission development and laying the groundwork to begin utilizing a wider variety of these methods and accompanying techniques. The purpose of this paper is to review the ways in which design methods and techniques used in other fields may be used in support of the space mission concept development process and space technology development.

Designers are almost synonymous with the consumer product, automotive and entertainment industries. Fields such as Product Design, Transportation Design and Entertainment emphasize finding solutions to problems using exploratory design methods and techniques. Often, they are leaders in their organizations. However, there is not a direct appreciation or understanding of how to utilize these methods and techniques within aerospace. These methods have been shown to support mission concept development, however may also directly support technology development, as is seen in the consumer product industry. Evidence shows that these methods have sporadically been utilized by NASA for habitat design, software development and astronaut wearables.

This paper explores opportunities within the space mission concept development process where these techniques are currently used and develops a design library of methods and techniques used outside of Aerospace that may be supportive of technology development. The current Pre-Phase A concept development process is mapped along with exploratory design methods used in other industries. Design Thinking is a heuristic problem solving method that can be applied to many fields. Human Centered Design and User Centered Design have been utilized for architecture and software development; these same tools could also be used to help inform the design of long term human habitation system on planetary surfaces. The Imagineering process is instrumental in theme park development; this paper argues it should also inform design of robotic science missions such as Mars Sciences. Science Fiction Thinking is a method of extrapolating future technology. How can this type of thinking inform the design of systems that aim to detect life in locations such as the liquid oceans on Europa and Titan? Techniques that are instrumental throughout these methods, such as storyboarding, sketching and prototyping are also defined. Interviews with employees within aerospace, consumer products and entertainment may shed light on opportunities and barriers to utilizing these techniques.