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THE UNIQUE CHALLENGES ASSOCIATED WITH BUILDING USEFUL SPACE-BASED SIMULATIONS

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ABSTRACT

The National Aeronautics and Space Administration (NASA) has faced incredible challenges throughout its history associated with flying humans in space safely and efficiently. NASA has relied heavily on modeling and simulation products to prepare for these missions and the challenges that must be overcome accordingly. However, building accurate models and simulations of complex vehicles in outer space, on the Moon, or on other astronomical bodies is especially challenging because of the uniqueness of those environments, which includes reduced gravity, intense and immediate temperature shifts, challenging radiation levels, high-contrast lighting challenges, and several other factors. Adding to the difficulty is the fact that, in general, space missions must be fully successful the first time they are flown. Unlike many industries that can afford to build and test numerous concepts and test articles through a series of successes and failures, space missions are simply too expensive and too hazardous to fail, especially human missions. "Failure is not an option" is an oft-repeated slogan associated with human space missions, and for good reason. As a result of these challenges, NASA has invested significantly in building modular, reusable simulation products that have been shared across multiple programs, thereby providing extensive use-history and reusable validation data, which ensures high quality while keeping costs down. These tools include a core simulation environment (Trick), an orbital dynamics package (JEOD), a multi-body dynamics package (MBDyn), and countless other tool suites designed to reduce the workload associated with simulating new vehicles in new space-based environments. Many of these tool suites have been released as open-source projects, others have not for a variety of reasons. NASA has also relied heavily on international standards where they exist, including High Level Architecture (HLA), an IEEE standard, and SpaceFOM, a SISO standard. These standards have ensured that we can build interoperability into our simulations without requiring our partners (domestic or international) to all use the same suite of simulation tools. We also seek out commercial simulation solutions wherever possible. There are excellent commercial visualization tools available, but commercial tools that model the complexities of space to the extent needed to ensure mission success are fairly limited. This presentation will explore some of the history of modeling and simulation at NASA, how those capabilities have been used to ensure mission success, how human space flight has evolved in its development and use of these simulation capabilities, future challenges that will almost certainly rely heavily on the current suite of simulation tools, and new innovations that will hopefully come to pass in the future.

SPEAKER BIOGRAPHY

MICHAEL MCFARLANE currently serves as the chief of the Simulation and Graphics Branch at NASA's Johnson Space Center. In this capacity, he leads a team that develops human-in-the-loop simulation capabilities as well as the tools used to build those integrated simulations. These simulations are used for a variety of purposes in support of human spaceflight, from early conceptualization through concept development, space vehicle development, mission planning, astronaut training, and real-time mission support. Prior to his current position, he was chief of NASA's Human Interface Branch, which develops and maintains

displays and controls, audio systems, visual systems, and wearable systems for human space missions. He has been working at Johnson Space Center for nearly 40 years on a wide variety of technical projects. He graduated with a bachelor's degree in Aerospace Engineering from the University of Michigan in 1988.