Abstract
Flight Dynamics Operations: Methods and Lessons Learned from Space Shuttle Orbit Operations
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The Flight Dynamics Officer is responsible for trajectory maintenance of the Space Shuttle. This paper will cover high level operational considerations, methodology, procedures, and lessons learned involved in performing the functions of orbit and rendezvous Flight Dynamics Officer and leading the team of flight dynamics specialists during different phases of flight. The primary functions that will be address are: onboard state vector maintenance, ground ephemeris maintenance, calculation of ground and spacecraft acquisitions, collision avoidance, burn targeting for the primary mission, rendezvous, deorbit and contingencies, separation sequences, emergency deorbit preparation, mass properties coordination, payload deployment planning, coordination with the International Space Station, and coordination with worldwide trajectory customers. Each of these tasks require the Flight Dynamics Officer to have congnizance of the current trajectory state as well as the impact of future events on the trajectory plan in order to properly analyze and react to real-time changes. Additionally, considerations are made to prepare flexible alternative trajectory plans in the case timeline changes or a systems failure impact the primary plan. The evolution of the methodology, procedures, and techniques used by the Flight Dynamics Officer to perform these tasks will be discussed. Particular attention will be given to how specific Space Shuttle mission and training simulation experiences, particularly off-nominal or unexpected events such as shortened mission durations, tank failures, contingency deorbit, navigation errors, conjunctions, and unexpected payload deployments, have influenced the operational procedures and training for performing Space Shuttle flight dynamics operations over the history of the program. These lessons learned can then be extended to future vehicle trajectory operations.

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The Flight Dynamics Officer is responsible for trajectory maintenance of the Space Shuttle. This paper will cover high level operational considerations, methodology, procedures, and lessons learned involved in performing the functions of orbit and rendezvous Flight Dynamics Officer (FDO) and leading the team of flight dynamics specialists during different phases of flight. To illustrate the operations concept of a FDO, a case study will be presented using a common simulated emergency of a shuttle fuel tank failure. The operational scenario will be used to illustrate the primary functions of the flight dynamics operations team including: onboard state vector maintenance, ground ephemeris maintenance, calculation of ground and spacecraft acquisitions, collision avoidance, burn targeting for the primary mission, rendezvous, deorbit and contingencies, separation sequences, emergency deorbit preparation, mass properties coordination, payload deployment planning, coordination with the International Space Station, and coordination with worldwide trajectory customers. Each of these tasks require the Flight Dynamics Officer to have situational awareness of the current trajectory state as well as the impact of future events on the trajectory plan in order to properly analyze and react to real-time changes. Additionally, considerations are made to prepare flexible alternative trajectory plans in the case timeline changes or a systems failure impact the primary plan. The evolution of the methodology, procedures, and techniques used by the Flight Dynamics Officer to perform these tasks will be discussed. These lessons learned can then be extended to future vehicle trajectory operations.