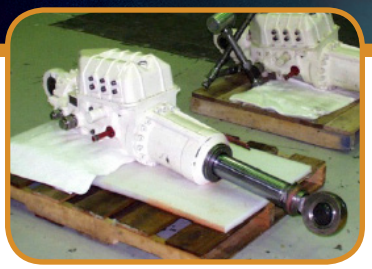
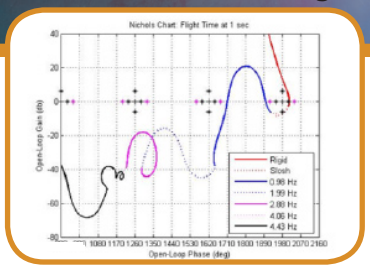
National Aeronautics and Space Administration

Marshall Space Flight Center
Flight Mechanics and Analysis

Engineering Solutions for Space Science and Exploration

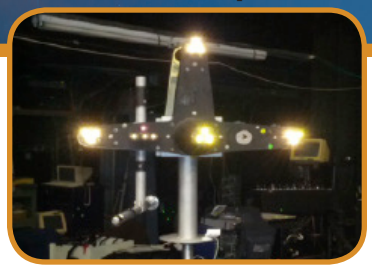


SRB Thrust Vector Control Actuator.



Nichols plot to assess stability and robustness of a control design.

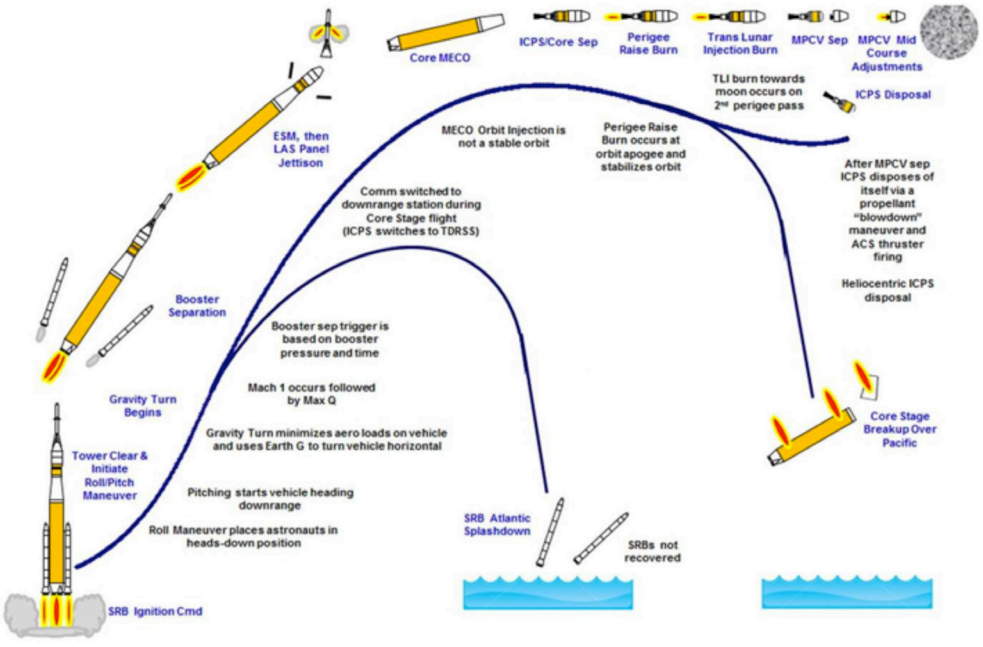
Augmenting Adaptive Control Testbed.



STS Video Guidance Sensor.

The Flight Mechanics and Analysis

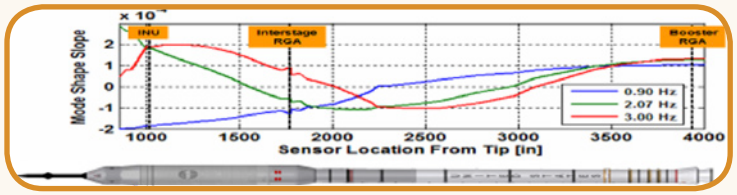
discipline is responsible for analysis, requirement definition, design, development, and verification of Guidance, Navigation and Control (GN&C) and Integrated Systems Health Management and Automation (ISHM) systems as well as Natural Environments definition; this includes the GN&C and ISHM systems and supporting subsystems for both launch vehicles and spacecraft. Responsibilities include design definition as well as advancement of supporting technologies. In addition to design definition products, the discipline is responsible for the delivery of flight mechanics analysis products such as reference trajectory designs, Monte Carlo simulation and 6 Degrees of Freedom (6DOF) simulations, and modeling and simulation of dynamic events such as liftoff clearance and stage separation. Expertise and experience is critical to exceptional performance and the Flight Mechanics and Analysis discipline utilizes a unique tool set, some of which were developed at MSFC. Those discipline tools include the Marshall Aerospace Vehicle Representation in C (MAVERIC), the Program to Optimize Simulated Trajectories (POST), the Stability Aerospace Vehicle ANalysis Tool (SAVANT), FRACTAL, TREETOPS, and the Global Reference Atmospheric Model (GRAM). This discipline also has a failure detection, diagnosis, and response capability to validate mission management algorithms. They lead the development of vehicle/mission specific natural environments definition, characterization, and analysis for both terrestrial and space environments. The discipline has developed and maintains multiple climatological and wind databases and range reference atmospheres for numerous launch sites around the country. Unique facilities include the Automated Lunar and Meteor Observatory (ALaMO) and the Meteorological Interactive Data Display System (MIDDS) room in the Huntsville Operations Support Center (HOSC).



SLS Flight Operation Timelines: Depict nominal and off-nominal preflight and flight event sequences.

Capabilities

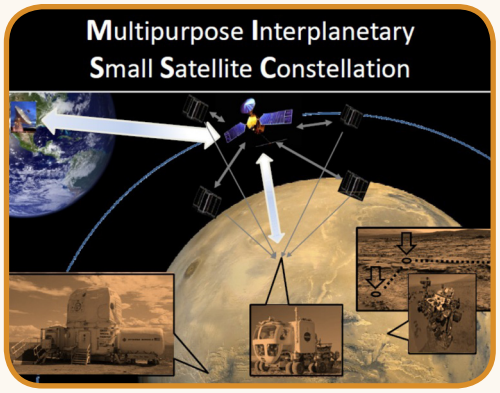
Control Systems Design and Analysis has the responsibility to define control system architecture and control algorithms. Personnel derive requirements for vehicle and subsystems and develop models to analyze vehicle performance in addition to guidance, navigation, and control integration. Applications include: Launch Vehicles, Spacecraft, Vibration isolation, Pogo stabilization, and Precision pointing.



Control/Structure Interaction Analysis.

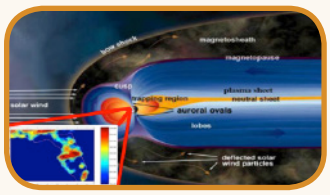
Guidance, Navigation & Mission Analysis has the responsibility to develop, specify, design, model and verify guidance and navigation systems for vehicles from cubesats to heavy lift launch vehicles. In addition, this discipline has deep expertise in ascent trajectory design, optimization and whole-vehicle simulation – both 3-DOF and 6-DOF – using a wide array of in-house and industry standard tools. In-space orbit design, mission analysis and mission planning skills within the discipline are also broad and strong, running the gamut from low-Earth orbit, to rendezvous and proximity operations, lunar, asteroid and interplanetary missions, with special experience in solar sail and tether dynamics. Finally, the Guidance, Navigation & Mission Analysis provides detailed, multi-body 6-DOF dynamics analysis for critical events from pad lift-off/tower clearance through all stage and hardware separations.

FASTSAT – showing nadir payload deck and CubeSat deployer



Multi-Spacecraft Autonomous Positioning System (MAPS).

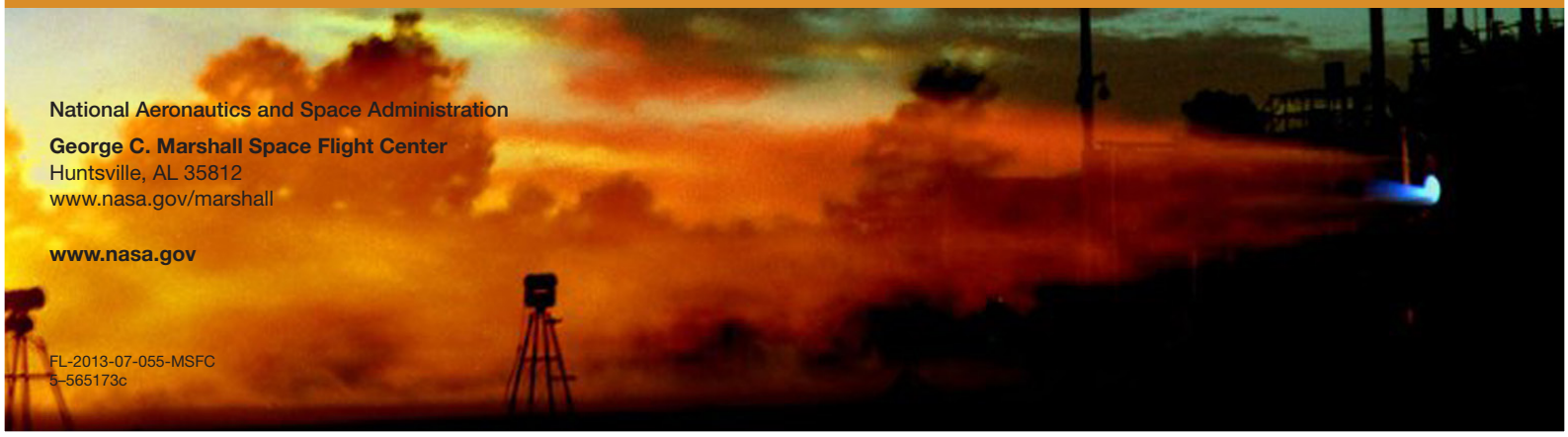
Integrated Systems Health Management (ISHM) & Automation has the responsibility to design, and verify architectures and sensing techniques to effect nominal operations and to contain, prevent, detect, diagnose, respond to and recover from off-nominal conditions that may interfere with normal operations of ascent vehicles and spacecraft. Personnel coordinate and integrate system models and functional scenarios, system sensitivities, critical parameters, and critical models to design system state management.



Terrestrial and Space Natural Environments.

Natural Environments has the responsibility to define the natural environments to be used in the design of unique ascent vehicles and spacecraft that will meet mission specific performance requirements. These environments include ionizing radiation, plasma, meteoroids, neutral thermosphere, thermal environment, solar activity, atmospheric wind dynamics, surface weather, and planetary environments. This discipline has the responsibility to assess ionizing radiation effects of electronic/avionics parts and conduct spacecraft charging analysis for MSFC and NASA programs. The Agency-level Meteoroid Environment Office that has responsibility for the U.S. meteoroid environment models, both sporadic and shower environment, and is located within the Natural Environments group.

For more information, please visit www.nasa.gov/centers/marshall/about/business.html



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