National Aeronautics and Space Administration

Marshall Space Flight Center
Mechanical Design, Analysis & Fabrication

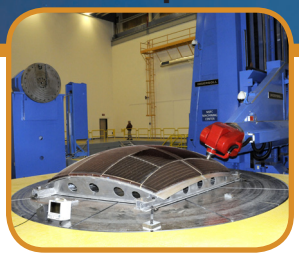
Engineering Solutions for Space Science and Exploration

Mighty Eagle–Lunar Lander Prototype

Transportation, Handling and Lifting Ground Support Equipment

Precision Assembly

Precision Cleaning Facility



7-Axis Machining Center

Mechanical Design, Analysis and Fabrication

Mechanical Design, Analysis and Fabrication provides in-depth engineering and fabrication for the development of structural, mechanical, and thermal solutions for aerospace instrument, vehicle, payload, ground support equipment applications.

Structural and Mechanical Design group designs experiment payloads, Ground Support Equipment (GSE) and Special Test Equipment (STE), satellites and spacecraft components and mechanisms, plus other hardware for space exploration and scientific missions. Design engineers have designed transportation, handling, and lifting GSE and STE to support various programs such as FasTrac Engine, X-34, Ares, Multi-Purpose Crew Vehicle Stage Adapter (MSA) and Space Launch Systems (SLS) Core Stage. They also have the expertise and experience in designing flight systems ranging from large vehicle structures for SLS, to International Space Station (ISS) environmental control and life support subsystem components to optical experiments for balloons and sounding rockets, as well as in designing and delivering test articles and breadboard units for diverse technology development efforts. In addition to employing the state of the art in computer aided design and engineering tools, the group also develops and utilizes multi-disciplinary optimization techniques in select design activities. The Analysis group performs dynamic, structural and thermal analyses for flight and ground systems to assess whether the designs are capable of withstanding applied forces, thermal gradients and other environments without failing. Structural areas include static analysis of stress, fracture and fatigue while dynamic analysis includes environmental and coupled-loads definition as well as multibody dynamics and particle damping and isolation, for situations that involve excessive vibration. The thermal areas encompass typical network-based conduction, convection and in-space radiation analyses, as well as fluid dynamic and multi-physics computations of existing and new concepts and flight hardware. Thermal engineers apply their expertise to the design and assessment of thermal control systems for atmospheric flight vehicles and payloads, small and micro satellites, ISS payloads and flight experiments like microgravity materials process equipment and space telescopes as well as lunar landers and rovers. The Fabrication group provides in-house fabrication capability for the Center, including flight hardware, prototype construction, and feasibility review of concepts. The machine shop, with floor space of approximately 35,000 ft^2, has the capability of producing very large, high precision parts. It contains machinery such as conventional lathes and mills, vertical turning lathes, computer numerical con-trolled (CNC) lathes, 3, 5, and 7 axes CNC mills, jig-borers, and CNC electrostatic discharge machines (EDM wire and plunge). The machine shop also includes a grind room for surface grinding and lapping to obtain ultra smooth surfaces finishes. The sheet metal shop encompasses approximately 16,000 ft^2 and contains a variety of metal fabrication equipment. The capabilities include bending, shearing, bonding, cutting, drilling, rolling, tube diameter, surface, tool, and thread grinding, jig, honing, and lapping. The group also provides fabrication and assembly capabilities for research development, test, and flight hardware. Capabilities include machining, sheet metal, welding, surface treatment, cleaning, and Multilayer Insulation (MLI) blanket manufacturing.

Space Vehicle Landing Stability and Multibody Dynamics

A key facet in the design and development of any vehicle intended to land on a space body, such as the moon, is its stability during landing. The Space Systems Department has a multibody design and analysis capability as well as a test rig with which a scaled model of the vehicle, a "Stability Test Lander" (STL), can be "tossed" and impact a deck to determine if it will land with stability or not. A 4-Bar Mechanism serves as a pendulum, which throws the STL, which is connected until release via an electromagnet.

Mechanical Development Facility provides a safe, controlled environment for the assembly and evaluation of development engineering and prototype hardware. The facility is used for breadboard build-ups, mechanical system checkouts/evaluations and in working with hardware mock-ups and performing fit checks. The facility contains basic metal fabrication equipment, providing designers and analysts the capability to manufacture a wide variety of test hardware. They also have the capability of producing rapid prototypes with a rapid prototyping machine, which is especially useful for checking fits and assembly clearances when modifying existing hardware. Plus the facility offers lab space and basic testing equipment such as thermal vacuum chambers and mechanical test equipment to perform early concept thermal and mechanical testing.

Fabrication Capabilities

Facility	Task	Specifications
Surface Treat/Painting Facility	Cleaning, conversion coating, passivation, etching, anodizing, abrasive blasting, multi-layer insulation blanket fabrication, and electroless nickel plating.	Chemical and rinse solution tanks: 8 6,000-gallon tanks 9 600-gallon tanks 45 200-gallon tanks 19 30-gallon tanks
Abrasive Blast Facility	Provides heat-treating process for development, flight, and test hardware.	4 heat-treat furnace 150–2,000 °F Endo- and exo-thermic atmosphere generators 100-ton hydropress 2 oil quench tanks 1 water quench tank
Precision Assembly	Assembly of mechanical parts	2,800 ft^2 100K clean room
Mechanical Inspection Facility	Precision dimensional development and inspection of aerospace hardware for high accuracy with unusual geometrics and a variety of sizes.	Linear, radial, parallelism, concentricity, and angularity with an accuracy of 0.0001 inch and 2 arc/second. Supermicrometer range: 0.0001^{-9} inch with 0.0001 inch accuracy.
Fabric Shop	Fabrication and assembly with wool, cotton, canvas, nylon, polyester, burlap, felts, etc.	200 ft^2 fabric shop
Precision Cleaning Facility	Process hardware that requires high degree of cleanliness such as MSFC-SPEC-164C, MIL-STD-1246C, Level 250 to 1,000.	30K clean facility including: 3 consoles capable of cleaning stainless steel and aluminum tubing up to 1.5 inch in diameter ultrasonic cleaner 3 parts washers 1 jet washer 1 vapor degreaser 1 vacuum drying oven
Welding Facility	Contains various manual pieces of welding equipment for joining aluminum, mild steel, stainless steel, and refractory materials.	8.400 ft^2 shop with the following: Computer Numerical Controlled (CNC) variable polarity plasma arc (VPPA) welding system high vacuum electron beam welding systems resistance seam welder
Heat Treatment Facility	Provides heat-treating capabilities in development, flight, and test hardware.	Facility includes: 4 heat-treat furnace 150–2,000 °F Endo- and exo-thermic atmosphere generators 100-ton hydropress 2 oil quench tanks 1 water quench tank
7-Axis Milling Machine Facility	World's largest 7-axis horizontal multi-access milling machine.	Machine is equipped with: 32 ft of X-axis travel 13 ft of Y-axis travel 12 ft of in-and-out Z-axis travel 2-axis milling head 100-horsepower spindle

Key Benefits

- Design, analyze and optimize mechanisms and structures experiment hardware, payloads, subsystems, spacecraft (traditional, small and micro satellites) and robotic or crewed planetary for atmospheric and space flight missions.
- Design component attachments to structural members.
- Design mechanical ground support equipment for transportation and handling of launch vehicles.
- Route electrical and mechanical (fluid) lines between components.
- Design and analyze composite primary and secondary structures.
- Analyze structural designs in terms of stress, fracture and fatigue, and strength verification.
- Define component and system vibration, acoustic and shock environments, and design, develop and evaluate mitigation and isolation approaches and techniques.
- Define thermal environments and behaviors and design and analyze passive and active thermal management systems.
- Fabricate large and small ground and flight hardware structures as well as instruments and components.

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

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George C. Marshall Space Flight Center
Huntsville, AL 35812
www.nasa.gov/marshall

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FL-2013-07-065-MSFC
5–565173f