National Aeronautics and Space Administration

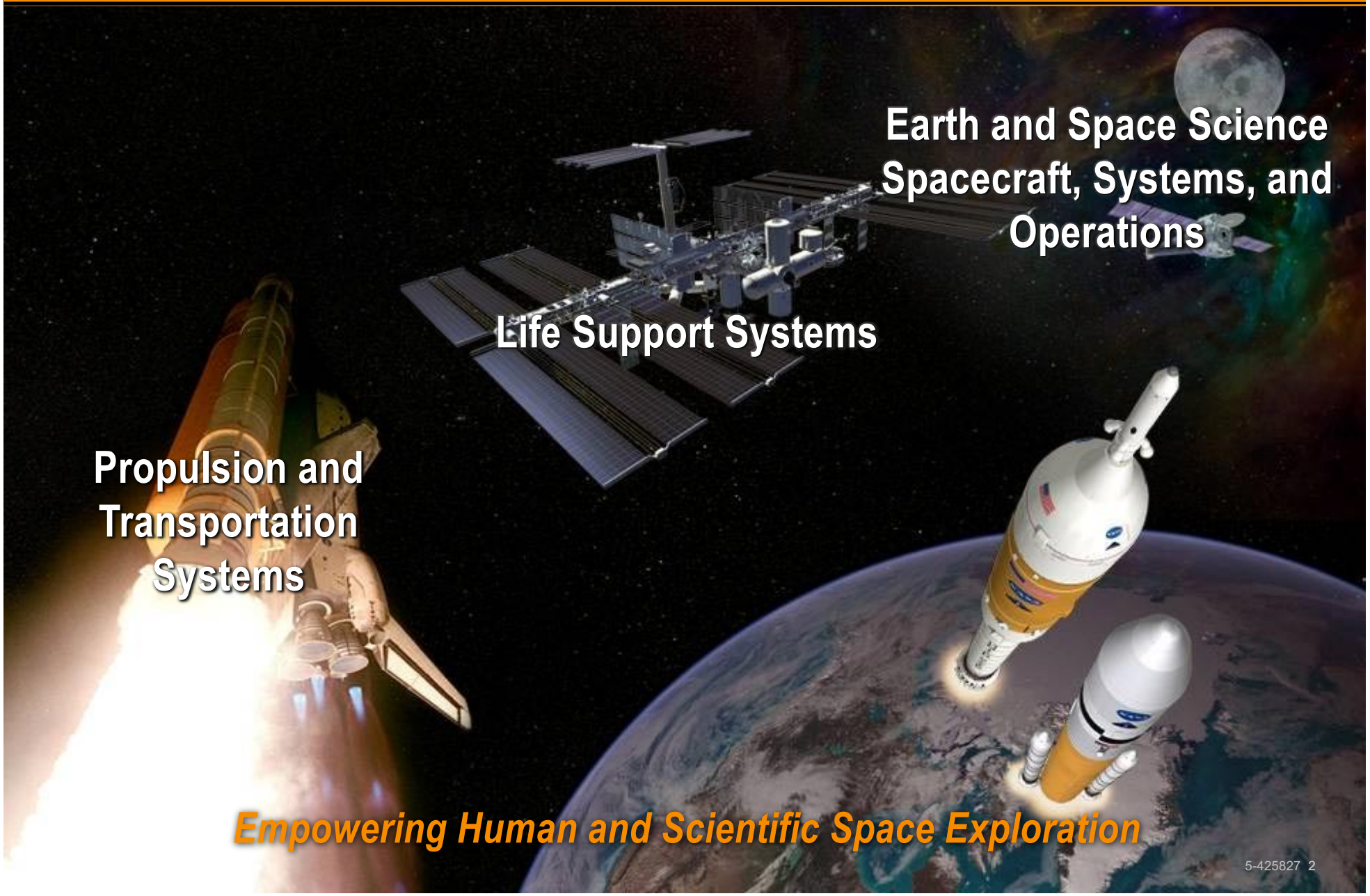
Marshall Space Flight Center

Powering the Future of Science and Exploration

marshall

www.nasa.gov

Marshall's Product Lines



Empowering Human and Scientific Space Exploration

Marshall Center Stats: From Exploration to Opportunity

$2.6 billion
budget in fiscal year 2008

6th largest
employer in the Huntsville - Madison county area

> 7,600
employees at Marshall
(2,634 civil service employees in fiscal year 2008)

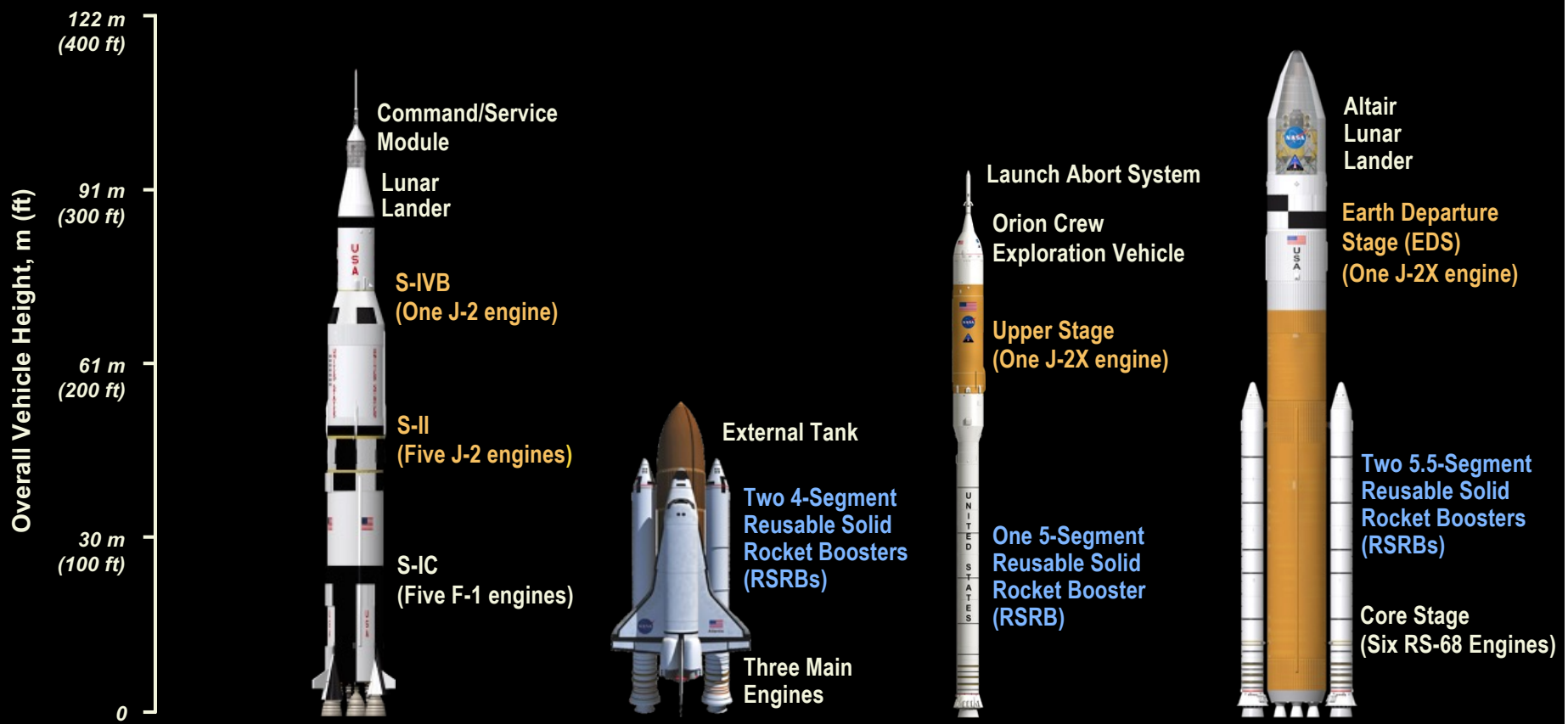
4.5 million
square feet of space in Huntsville

$1 billion
impact to Alabama economy

2.2 million
square feet of manufacturing space at Michoud Assembly Facility in New Orleans

Providing an Engine of Opportunity

Building on 50 Years of Proven Experience



	Saturn V	Space Shuttle	Ares I	Ares V
	1967–1972	*1981–Present*	*First Flight 2015*	*First Flight 2018*
	Height: 110.6 m (363 ft)	**Height:** 56.1 m (184.2 ft)	**Height:** 99.1 m (325 ft)	**Height:** 116.2 m (381.1 ft)
	Payload Capability: 44.9 mT (99,000 lbs) to TLI 118.8 mT (262,000 lbs) to LEO	**Payload Capability:** 25.0 mT (55,000 lbs) to LEO	**Payload Capability:** 25.5 mT (56,200 lbs) to LEO	**Payload Capability:** 187.7 mT (413,800 lbs) to LEO 71.1 mT (156,700 lbs) to TLI with Ares I 62.8 mT (138,500 lbs) direct to TLI

mT – metric tons
TLI – Trans-Lunar Injection
LEO – Low Earth Orbit

Propulsion and Transportation Systems

Shuttle Propulsion Sustaining Engineering

Main engines, external tank, solid rocket boosters

Transitioning to Ares/Orion for missions beyond Earth orbit

Best of Saturn and Shuttle technology used to develop future vehicles

Ares Design and Development

Successor to Shuttle for routine space access

Part of NASA's Constellation Program

First test flight is scheduled for 2009

Building and Sustaining Rockets, from Saturn to Shuttle to Ares

Life Support Systems

Current Work

- Producing clean air and recycling water
- Providing around-the-clock science operations support
- Making science experimentation possible in space

Future Work

- Exploration life support systems
- Radiation hardened electronics
- Altair Lunar Lander systems
- Lunar resources utilization

Payload Operations Center

Lunar Resources

Environmental Control & Life Support

Altair Lunar Lander

Working in Space

Pioneering Technologies for Living & Working on the New Frontier

Earth Science

Environmental Monitoring

- Understanding climate change and weather patterns

Weather Prediction

- Improving forecasts and weather warning times

Hurricane Research

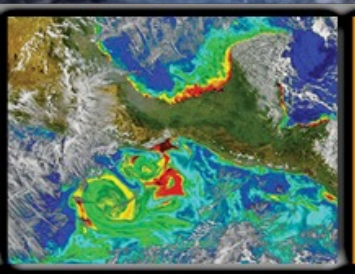
- Predicting the intensity and dynamics of storms

Global Hydrology & Climate Center

HIRAD

SPoRT

Environmental Monitoring



SERVIR

Engineering Systems to Better Understand Our Planet to Improve Lives

Space Science

Preparing for human return to the Moon

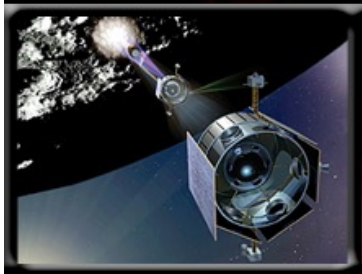
- Robotic missions to search for water ice and gather data
- Program office at Marshall

Learning about our solar system

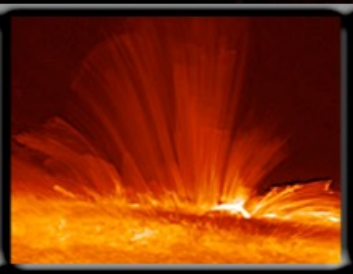
- Spacecraft to analyze the inner workings of the sun, planets, comets and asteroids
- Program management and instrument development

Learning about our universe

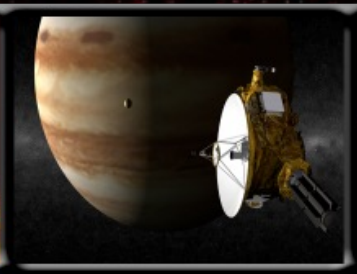
- Scientific instruments to reveal information about activity in deep space
- Management, design and construction



LCROSS



HINODE



Discovery/
New Frontiers

Chandra

JWST/
Marshall XRCF

Engineering Systems to Uncover Mysteries about Our Moon, Solar System, and Universe

Engineering Directorate Capabilities

Advanced Concepts

- Concept Definition, Integration, & Analysis
  - Earth-to-Orbit Transportation
  - In-Space Transportation
  - Planetary Surface Systems
- Mission Analysis
- Architecture Analysis
- Technology Assessments

Space Systems

- Systems Engineering & Integration
- Avionics
- Software
- Electrical Integration
- Mechanical Systems
- Fabrication & Assembly Services
- Environmental Control & Life Support Systems

Spacecraft & Vehicle Systems

- Systems Engineering & Integration
- Tank/Structures Design
- Loads & Dynamics
- Mechanisms
- Terrestrial & Space Environments
- Induced Environments
- Modeling & Simulation
- Guidance, Navigation, & Control

Propulsion Systems

- Propulsion Engineering
- Liquids & Solids
- Component Design
- Fluid Systems Design & Analysis
- Computational Fluid Mechanics
- In-Space Propulsion
- Nuclear Propulsion

Integrating Unique Expertise and Facilities

Engineering Directorate Capabilities *(continued)*

Mission Operations

- Operations Concepts
- Ground Systems
  - Design Development
  - Certification
  - Operation
- Flight Operations
  - Mission Design
  - Crew Procedures & Timelines
  - Flight Controller Cert.
  - On-board Facility Ops

Materials & Processes

- Metallics
- Composites
- Ceramics
- Environmental Effects
- Fracture & Failure Analysis
- NDE & Tribology
- Chemistry & Combustion Research

Test Lab

- Propulsion Testing
- Structural Testing
- Thermal Vacuum
- Shock & Vibration
- Acoustic
- Experimental Fluids Test & Development
- Advanced Instrumentation Application

Integrating Unique Expertise and Facilities

Engineering Directorate Capabilities *(continued)*

Resource Management Office

- Business Operations
- IT Resources
- Administrative Support
- Fiscal Accountability
- Business Processes
- Workforce & Resource Planning

Engineering Technical Management Office

- Integrated Engineering Tools
- Streamlined Processes
- Engineering Technical Standards Program
- Innovative Partnerships
- Technology Transfer
- Product Lifecycle Management

Chief Engineers Office

- Focal Point for Technical Excellence & Authority
- Cross-cutting Technical Leadership
- Senior Network of Systems Engineers
- Reps in Programs & Projects Supported

Integrating Unique Expertise and Facilities

Why Explore?

To uphold America's leadership through:

Technological advancement

Scientific discovery

Economic opportunity

National security



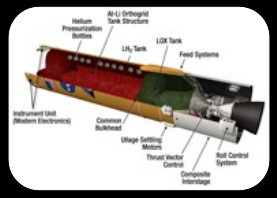


Engineering America's Leadership in Space

Backup

Product Lifecycle Management Model: Ares I

Manufacturing Engineering



Manufacturing

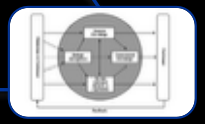
Product Engineering

People

Prototype

Information Platform

Technology



Processes & Practices

Concept Engineering

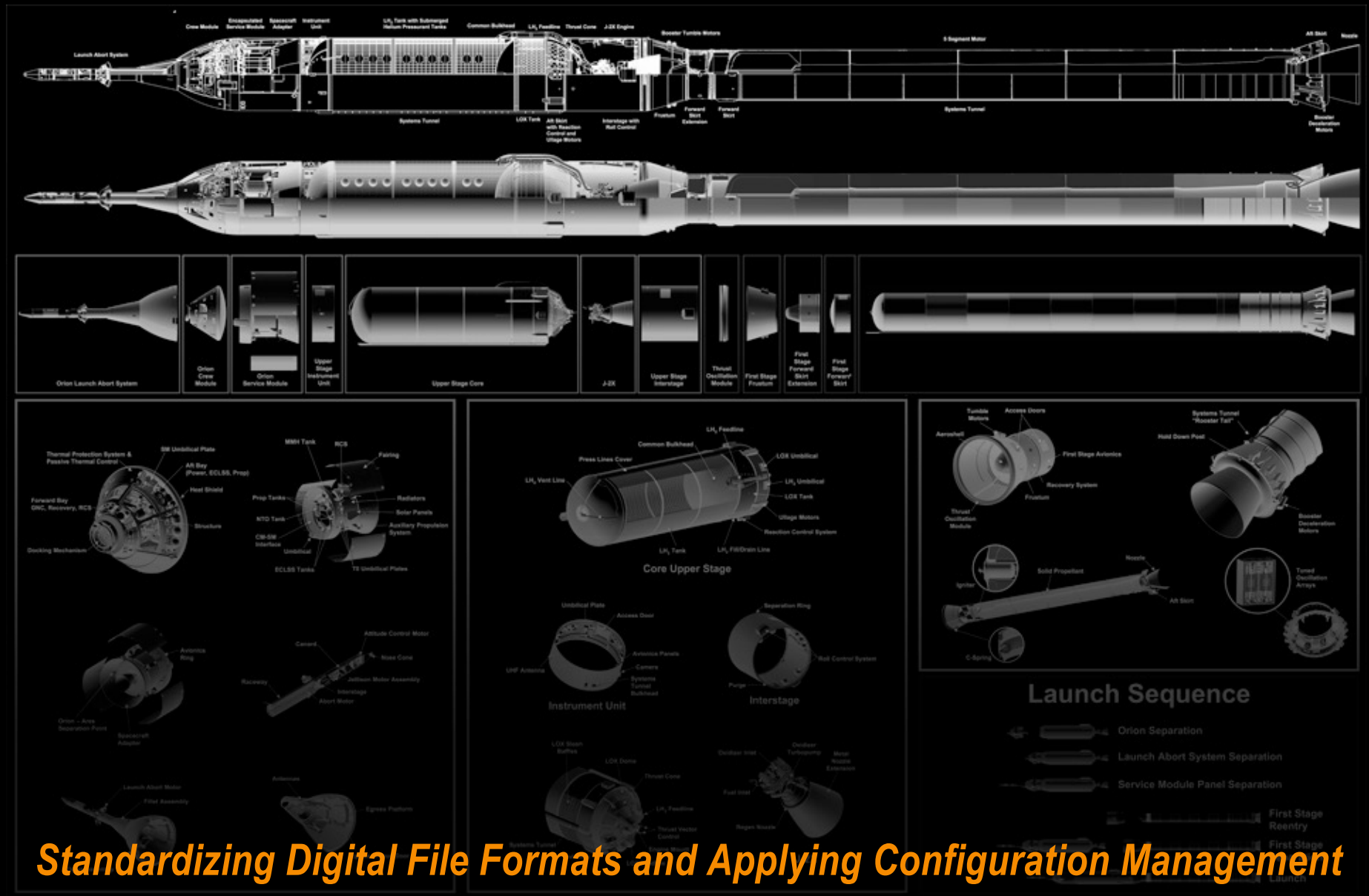
Operations

Requirements

Decommissioning

PLM Reduces Risk through Integration

Concept Engineering: Closing the Design Case



Standardizing Digital File Formats and Applying Configuration Management

Product Engineering: Checking the Digital Design

- Fit checks: form follows function
- Meet mandatory and desired requirements
- Check the 2-D design in 3-D
- Refine the math-based CAD model

Moving from Bits and Bites to Brick and Mortar

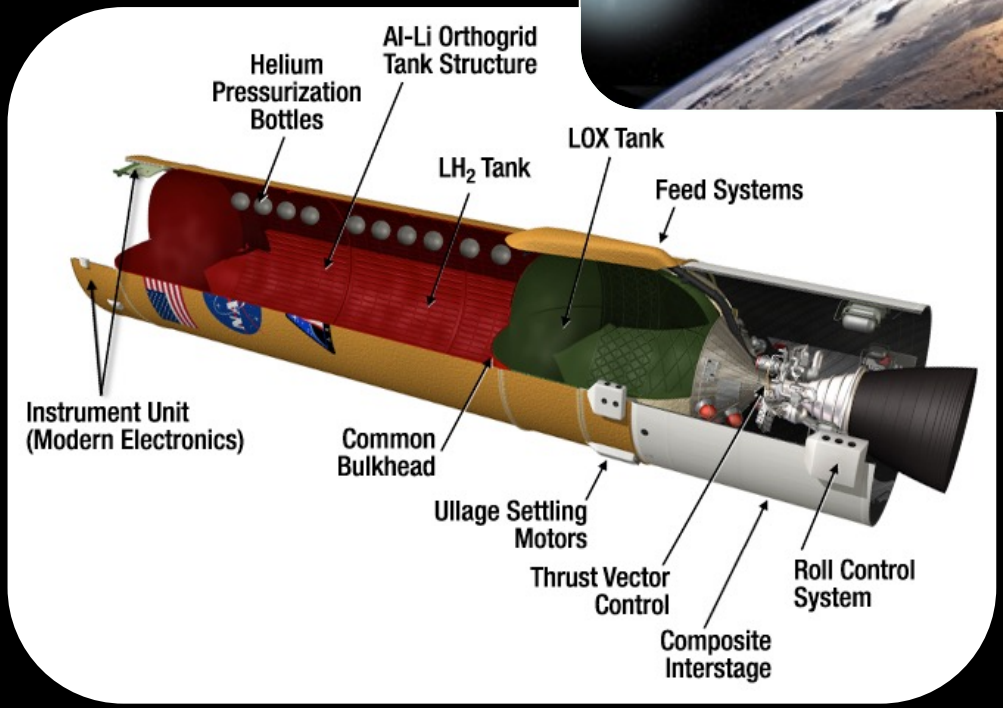
Manufacturing Engineering: Testing Before Building

- Ground support equipment specifications
- Assembly instructions
- Materials selection and process development
- Refine the math-based CAD model

Point of Most Return on Investment

Manufacturing: As-Built Design

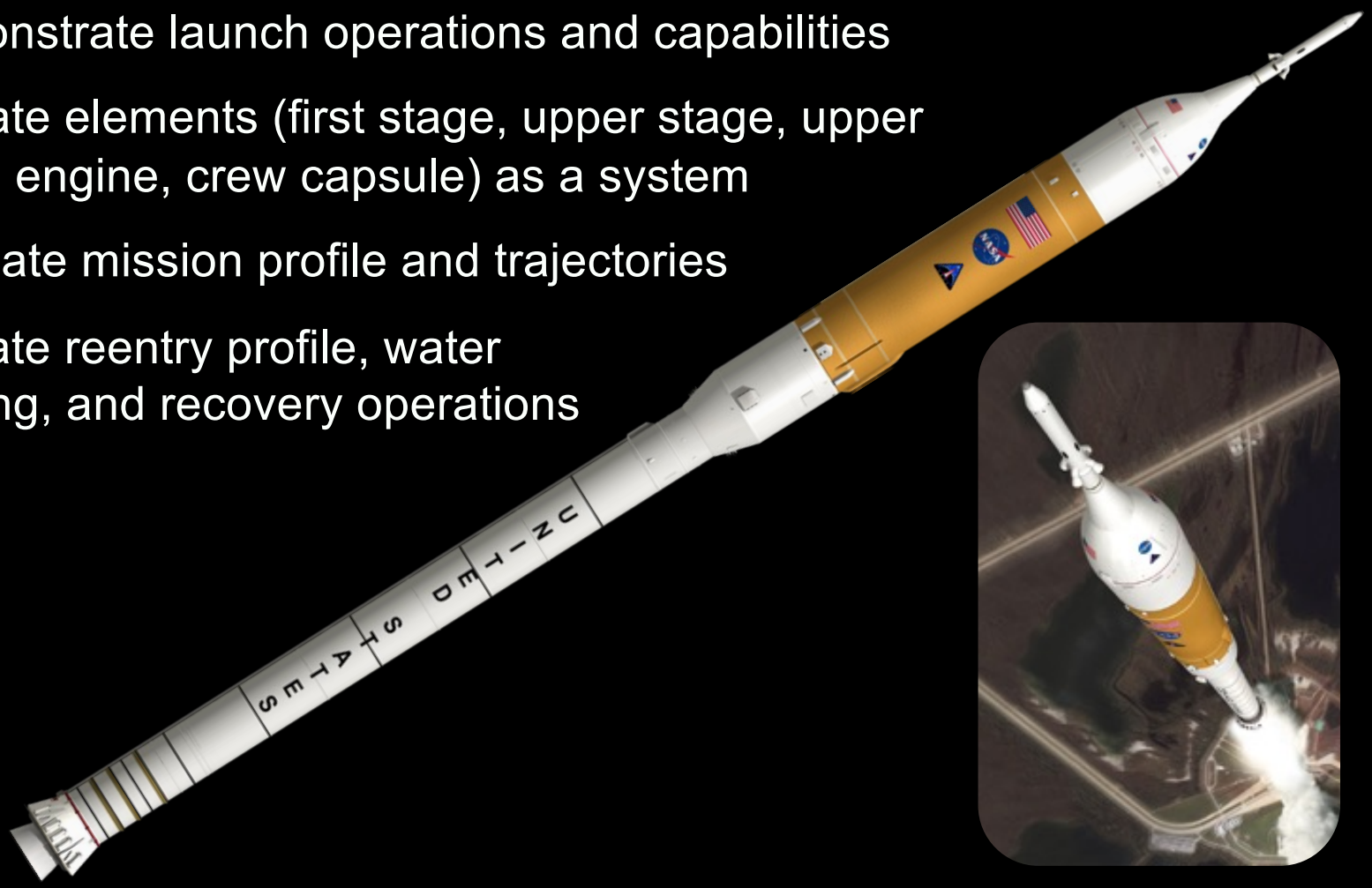
- Model-based design reduces time to fielding
- Quality issues are pre-addressed
- Cost reduction due to streamlined processes
- Retrofitting the Michoud Assembly Facility



Harnessing Unique Aerospace Facilities and Expertise

Prototype: Testing in Real-World Environments

- Demonstrate launch operations and capabilities
- Validate elements (first stage, upper stage, upper stage engine, crew capsule) as a system
- Evaluate mission profile and trajectories
- Validate reentry profile, water landing, and recovery operations



Flying on Auto-pilot to Validate Critical Systems in Real-World Scenarios

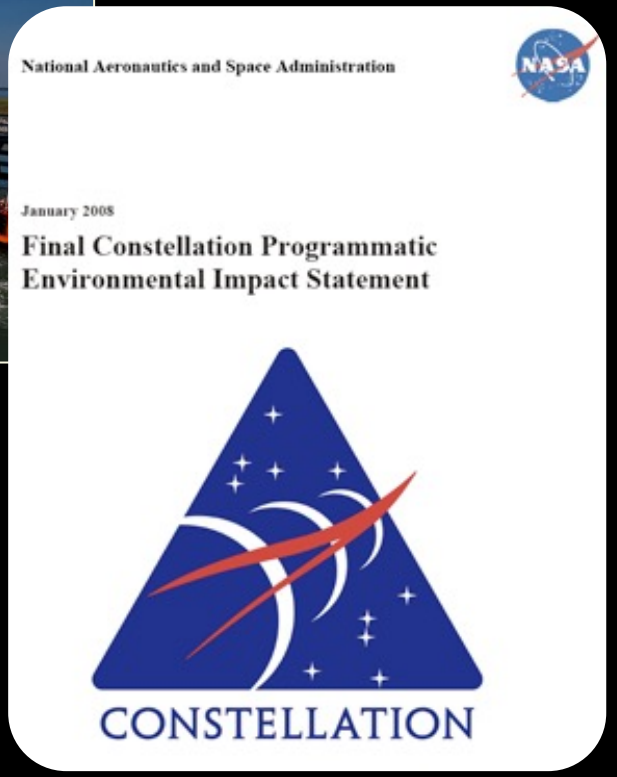
Operations: As-Maintained System

- 80% of costs determined during concept development
- Operability = availability + affordability
- Evolved expendable launch vehicle model
- Sustaining engineering

Reducing Complexity for Robust Launch on Demand

Decommissioning: The Real Cost of Retirement

- Disassembly drawings
- Efficient recycling and disposal planning
- Maximum reuse of materials
- Minimum use of toxic and hazardous waste



Factoring Environmental Concerns into the Design Trade Space