Launching to the Moon, Mars, and Beyond

Presented to The Auburn Chapter of the American Institute of Aeronautics and Astronautics, September 30, 2008
Auburn University, AL

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What is NASA’s Mission?

♦ Safely fly the Space Shuttle until 2010
♦ Complete the International Space Station
♦ Develop a balanced program of science, exploration, and aeronautics
♦ Develop and fly the Orion Crew Exploration Vehicle (CEV)
♦ Return to the Moon no later than 2020
♦ Promote international and commercial participation in exploration

“The next steps in returning to the Moon and moving onward to Mars, the near-Earth asteroids, and beyond, are crucial in deciding the course of future space exploration. We must understand that these steps are incremental, cumulative, and incredibly powerful in their ultimate effect.”

– NASA Administrator Michael Griffin
October 24, 2006
Spacelab J - Huntsville and Decatur

Auburn 6
Alabama 1
♦ State of Alabama
  • 150,000 aerospace industry workers in the state
    - $6.16 billion annual payroll
    - Third highest average annual wage in the Nation behind VA and CA

♦ Huntsville, Al
  • 430 aerospace companies
  • Home to Redstone Arsenal
    - RSA – 8 major commands – soon 11 General Officers
    - 30,000 people come on site at Redstone each day
    - More than $35 billion in Federal procurements each year
  • Home to Marshall Space Flight Center
    - $2 billion annual budget
    - About 2500 Civil Service employees
    - About 5000 contractor employees
  • Need all disciplines of engineers
  • 2000 - 20,000 new jobs over the next five years (BRAC)
  • Baby Boomers are retiring – outnumber Gen X about 3 to 1
- Number of Civil Service Engineers (as of August 2007)
  - NASA – 9563
    - Johnson Space Center – 2230
    - Marshall Space Flight Center – 1650
    - Kennedy Space Center – 1264
    - Goddard Space Flight Center – 1414
- Disciplines
- Probably 3 to 4 times this number of contractor engineers
MSFC LEGACY
Today’s Journey

🔹 What is NASA’s mission?
🔹 Why do we explore?
🔹 What is our timeline?
🔹 Why the Moon first?
🔹 What will the vehicles look like?
🔹 What progress have we made?
🔹 Who will be doing the work?
🔹 What are the benefits of space exploration?
Why Do We Explore?

♦ Inspiration
- Inspire students to explore, learn, contribute to our nation’s economic competitiveness, and build a better future

♦ Innovation
- Provide opportunities to develop new technologies, new jobs, and new markets

♦ Discovery
- Discover new information about ourselves, our world, and how to manage and protect it
MAJOR NASA PROGRAMS

- Space Shuttle
- International Space Station
- Earth and Space Sciences
- Constellation Program
  - Crew Launch Vehicle
  - Cargo Launch Vehicle
  - Crew Exploration Vehicle
  - Crew Service Module
  - Earth Departure Stage
  - Altair Lunar Lander
  - Mars Transfer Vehicle
  - Mars Descent/Ascent Vehicle
- Lunar Precursor Robotic Program
  - Lunar Reconnaissance Orbiter (LRO)
  - Lunar Crater Observation and Sensing Satellite (LCROSS)
Earth and Space Sciences

♦ SERVIR

- A system that helps scientists and authorities in southern Mexico and Central America identify sudden changes in environmental conditions, mapping details of deforestation, forest fires, hurricanes and toxic algae red tides
- Beginning applications in Africa

♦ Hubble Space Telescope

- The visible/ultraviolet/near-infrared element of the Great Observatories astronomical program.
- STS 125 is the final servicing mission to HST
- Extend its life and increase capabilities

♦ Other Space Telescopes – Spitzer, Chandra, James Webb (2013)
Shuttle Processing
Rare Site – Two Shuttle on Pads
October 20, 2008
International Space Station
The Moon

♦ Lunar missions allow us to:
  • Gain exploration experience
    – Space no longer a short-term destination
    – Will test human support systems
    – Use Moon to prove ability to build and repair long-duration space assets
  • Develop exploration technologies
    – Launch and exploration vehicles
    – *In-situ* resource utilization
    – Power and robotic systems
  • Conduct fundamental science
    – Astronomy, physics, astrobiology, geology, exobiology

*Next Step in Fulfilling Our Destiny as Explorers*
There Are Many Places To Explore

We Can Land Anywhere on the Moon!
Our Exploration Fleet

What will the vehicles look like?

Earth Departure Stage

Ares V
Cargo Launch Vehicle

Orion
Crew Exploration Vehicle

Altair
Lunar Lander

Ares I
Crew Launch Vehicle
Journey to the Moon
Building on a Foundation of Proven Technologies

Launch Vehicle Comparisons

**Space Shuttle**
- Height: 56.1 m (184.2 ft)
- Gross Lift off Mass: 2,041,166 kg (4.5M lbm)
- 25 MT (55k lbm) to Low Earth Orbit (LEO)

**Ares I**
- Height: 99.1 m (325 ft)
- Gross Lift off Mass: 927,114 kg (2.0M lbm)
- 25.6 MT (56.5k lbm) to LEO

**Ares V**
- Height: 109.7 m (360.5 ft)
- Gross Lift off Mass: 3,374,975 kg (7.4M lbm)
- 63.6 MT (140 2k lbm) to TLI (with Ares I)
- 55.9 MT (123k lbm) to Direct TLI
- 143.4 MT (316k lbm) to LEO

**Saturn V**
- Height: 110.9 m (364 ft)
- Gross Lift off Mass: 2,948,350 kg (6.5M lbm)
- 45 MT (99k lbm) to TLI
- 119 MT (252k lbm) to LEO
Ares I Elements

Instrument Unit
- Primary Ares I control avionics system
- NASA Design / Boeing Production ($0.8B)

Stack Integration
- 927k kg (2.0M lbm) gross liftoff weight
- 99 m (325 ft) in length
- NASA-led

First Stage
- Derived from current Shuttle RSRM/B
- Five segments/Polybutadiene Acrylonitrile (PBAN) propellant
- Recoverable
- New forward adapter
- Avionics upgrades
- ATK Launch Systems ($1.6B)

Upper Stage
- 137k kg (305k lbm)
- LOX/LH₂ stage
- 5.5 m (18 ft) diameter
- Aluminum-Lithium (Al-Li) structures
- Instrument unit and interstage
- Reaction Control System (RCS) / roll control for first stage flight
- Primary Ares I control avionics system
- NASA Design / Boeing Production ($1.12B)

Upper Stage Engine
- Saturn J–2 derived engine (J–2X)
- Expendable
- Pratt and Whitney Rocketdyne ($1.2B)
Ares V Elements

Stack Integration
- 3.4 M kg (7.4 M lb) gross liftoff weight
- 110 m (360.5 ft) in length

Solid Rocket Boosters
- Two recoverable 5-segment PBAN-fueled boosters (derived from current Ares I first stage)

Core Stage
- Five Delta IV-derived RS–68 LOX/LH₂ engines (expendable)
- 10 m (33-ft) diameter stage
- Composite structures
- Aluminum-Lithium (Al-Li) tanks

Earth Departure Stage (EDS)
- One Saturn-derived J–2X LOX/LH₂ engine (expendable)
- 10 m (33-ft) diameter stage
- Aluminum-Lithium (Al-Li) tanks
- Composite structures, instrument unit and interstage
- Primary Ares V avionics system

Payload Fairing
Altair Lunar Lander
EDS
J-2X
Loiter Skirt
Interstage
RS–68
Orion Crew Exploration Vehicle

Launch Abort System

- Attitude Control Motor (Eight Nozzles)
- Canard Section (Stowed Configuration)
- Jettison Motor (Four Aft, Scarfed Nozzles)
- Abort Motor (Four Exposed, Reverse Flow Nozzles)

Crew Module

Service Module

- Encapsulated Service Module (ESM) Panels
- Spacecraft Adapter

Volume: 10.8 m³ (380 ft³) - 80% larger than Apollo
Diameter: 50 m (16.5 ft)
First full-scale rocket motor test for the Orion spacecraft

- Test of a solid rocket that will be used to jettison the craft's launch abort system
- Separates the craft's launch abort system from the Orion crew module during launch
- The Orion launch abort system is a larger solid rocket motor system that will provide a safe escape for the crew in an emergency on the launch pad or during the climb to orbit
- Completed March 2008
What progress have we made?

**Programmatic Milestones Completed**
- Ares 1 Systems Requirements Review
- Ares 1 Systems Definition Review
- Ares 1 Preliminary Design Review
- Contracts awarded for first stage, J-2X engine, upper stage, instrument unit, and Orion
- Ares 1-X test flight scheduled for Spring 2009

**Technical Accomplishments**
- First stage parachute tests
- Developing first stage nozzles
- J-2X test stand construction at Stennis Space Center
- J-2x injector and power pack tests
- Fabricating Ares 1-X hardware
- Wind tunnel tests

[www.nasa.gov/ares](http://www.nasa.gov/ares)
What progress have we made?

For more information go to www.nasa.gov/ares
Ares I–X Test Flight

- Demonstrate and collect key data to inform the Ares I design:
  - Vehicle integration, assembly, and launch operations
  - Staging/separation
  - Roll and overall vehicle control
  - Aerodynamics and vehicle loads
  - First stage entry dynamics for recovery

- Performance Data:

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<thead>
<tr>
<th></th>
<th>Ares I–X</th>
<th>Ares I</th>
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<tbody>
<tr>
<td>First Stage Max. Thrust (vacuum):</td>
<td>14.1M N (3.13M lbf)</td>
<td>15.8M N (3.5M lbf)</td>
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<tr>
<td>Max. Speed:</td>
<td>Mach 4.7</td>
<td>Mach 5.84</td>
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<tr>
<td>Staging Altitude:</td>
<td>39,624 m (130,000 ft)</td>
<td>57,453 m (188,493 ft)</td>
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<tr>
<td>Liftoff Weight:</td>
<td>834k kg (1.8M lbm)</td>
<td>927k kg (2.0M lbm)</td>
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<tr>
<td>Length:</td>
<td>99.1 m (327 ft)</td>
<td>99 m (325 ft)</td>
</tr>
<tr>
<td>Max. Acceleration:</td>
<td>2.46 g</td>
<td>3.79 g</td>
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Transfer to and from Mars in about 6 months – Mars surface stay about 18 months. Each human mission to Mars is comprised of three vehicle sets, two cargo vehicles, and one round-trip piloted vehicle. Planned 2.5-year mission
Down-to-Earth Benefits from the Space Economy

*NASA powers innovation that creates new jobs, new markets, and new technologies*

♦ **Personal Health**
  - Eye tracker for LASIK surgery
  - Breast biopsy system
  - 3D Imaging for surgery

♦ **Consumer Products**
  - Wireless light switch
  - Remote appliance programmer
  - Global Positioning Systems (GPS)

♦ **Environmental**
  - Water Filtration system
  - Environmentally friendly chemical cleanup

♦ **Security**
  - Stair-climbing tactical robot
  - Crime scene video enhancement

*Every Dollar Invested in Space is Spent on Earth*

For more information see http://technology.jsc.nasa.gov
NASA Explores for Answers that Power Our Future

*NASA powers inspiration that encourages future generations to explore, learn, and build a better future.*

- NASA relies on a well-educated U.S. workforce to carry out missions of scientific discovery that improve life on Earth.

- America’s technological edge is diminishing.
  - Fewer engineering graduates from U.S. colleges and universities
  - More engineering and science graduates in other countries

- The global marketplace is increasingly competitive and technology-driven.

- Students need motivating goals and teachers with information to share.

- NASA continues to develop educational tools and experiences that inspire, educate, and motivate.
Summary

♦ Human beings will explore the Moon, Mars, and beyond to encourage inspiration, innovation, and discovery.

♦ We must build beyond our current capability to ferry astronauts and cargo to low Earth orbit.

♦ We are starting to design and build new vehicles, using extensive lessons learned to minimize cost, technical, and schedule risks.

♦ Exploring the Moon will help us reach Mars and beyond.

♦ Team is on board and making good progress – the Ares I-X test flight is on schedule for April 2009.
Acknowledgements

♦ Thanks to the following MSFC persons for providing information included in this presentation:
  ♦ Joel Best, Jo Weddendorf, Tim Self, John McIntyre
  ♦ Melissa Walden
  ♦ And of course to the NASA video archives available on NASA websites