Constellation
The New Vision for Space Exploration

Dale Thomas
NASA Constellation Program
October 2008
The Constellation Program was born from the NASA Authorization Act of 2005 which stated....

The Administrator shall establish a program to develop a sustained human presence on the moon, including a robust precursor program to promote exploration, science, commerce and U.S. preeminence in space, and as a stepping stone to future exploration of Mars and other destinations.
CONSTELLATION PROJECTS

Initial Capability
- Ares I
- Orion
- EVA
- Mission Operations
- Ground Operations

Lunar Capability
- Ares V
- Altair
- EVA
- Lunar Surface
EXPLORATION ROADMAP

- Initial Capability
  - Exploration and Science Lunar Robotics Missions
  - Research and Technology Development on ISS for Risk Reduction
- Commercial Orbital Transportation Services for ISS
- Space Shuttle Operations
  - Ares I and Orion Development
- Orion and Ares I Production and Operation
- Altair Lunar Lander Development
- Ares V and Earth Departure Stage
  - Surface Systems Development
  - Research and Technology Development on ISS for Risk Reduction
  - Space Shuttle Operations
  - Initial Capability Lunar Capability

Lunar Outpost Buildup

Year:
- 05 06 07 08 09 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
ORION: NEXT GENERATION PILOTED SPACECRAFT

Human access to Low Earth Orbit …

… to the Moon and Mars
Orion will support both space station and moon missions.

- Designed to operate for up to 210 days in Earth or lunar orbit.
- Designed for lunar missions with 4 crew members.
- Can accommodate up to 6 crew members for space station and Mars missions.
- Potential to deliver pressurized and unpressurized cargo to the space station.
APOLLO – ORION COMPARISON

5 meter diameter capsule – Apollo shape
- Significant increase in volume from Apollo (3.9 meter)
- Reduced development time and risk

Larger Crew Accommodations
- Lunar missions: 4 crew
- Space Station missions: 6 crew

Expanded Mission Capabilities
- Long Duration (6 months)
- State-of-the-Art Materials, Systems
EXTRA VEHICLE ACTIVITIES PROJECT: SPACE SUIT

- **Launch/Entry/Abort & Microgravity EVA Suit**
- **Lunar Surface EVA Suit**

- Suit Element provides hypobaric and hypoxic protection to the crew member while allowing the mobility to perform both intra- and extravehicular activities.

- To minimize EVA System mass and life cycle costs, the two suit configurations use common components as often as technically practical.

- Vehicle Interface Element provides a means by which the Suit Element interfaces with Constellation vehicles.

- Tools & Equipment Element includes tools and other equipment used during microgravity EVA and surface EVA.
GROUND OPERATIONS PROJECT

- Ground Processing and Testing of Integrated Launch Vehicles
- Launch and Logistics Services
- Post Landing and Recovery Services
- Elements
  - Solid Rocket Processing Element
  - Rotation Processing and Surge Facility
  - Spacecraft Recovery and Retrieval Element
  - Spacecraft Processing Element
  - Multi-Load Processing Facility
  - Vehicle Assembly Building
  - Launch Pad Element
  - Mobile Launch Element
MISSION OPERATIONS PROJECT: PLAN, TRAIN, FLY

- Operations infrastructure
  - Facilities, simulators, trainers, workstations, networks, software, documentation

- Operations products
  - Flight procedures, flight rules

- Operations teams

- Elements
  - Mission Control Center
  - Constellation Reconfiguration
  - Constellation Training Facility
  - Neutral Buoyancy Lab
  - Space Vehicle Mockup Facility
**Ames Research Center**
- Lead thermal protection system development
- Aero-Aerothermal database
- Ares abort simulators
- Software and Guidance, Navigation & Control support

**Dryden Flight Research Center**
- Lead abort test flight integration/operations
- Abort test booster procurement
- Flight Test Article development/integration

**JPL (Jet Propulsion Laboratory)**
- Thermal protection system support
- Mission Operations support
- Test and Verification support

**Glenn Research Center**
- Lead Service Module and Spacecraft Adapter integration
- Flight Test Article “Pathfinder” fabrication
- Ares I-X upper stage simulator lead
- Ares power thrust vector control and sensors lead
- J-2X engine altitude/in-space testing
- Systems Engineering and Integration support

**Langley Research Center**
- Lead Launch Abort System integration
- Lead landing system Advanced Development Program
- Ares I-X vehicle integration
- Ares aerodynamics lead
- System Engineering & Integration support

**Goddard Space Flight Center**
- Communications support

**Michoud Assembly Facility**
- Orion and Ares component mfging
- Rocket propulsion testing for Ares

**Marshall Space Flight Center**
- Home for Ares Project
- Ares I and V development and integration lead
- LAS and SM Systems Engineering and Integration support

**Johnson Space Center**
- Home for Constellation Program
- Home for Projects: Orion, Mission Ops, EVA, Altair and Lunar Surface Systems
- Lead Crew Module integration
- Orion spacecraft integration
- GFE projects management
- Flight Test Program

**Kennedy Space Center**
- Home for Ground Operations Project
- Ground processing
- Vehicle integration
- Launch operations
- Recovery operations

**Stennis Space Center**
- Rocket propulsion testing for Ares

**White Sands Test Facility**
- Orion Launch Abort System test site
Additional Companies with > $10M Contracts:
- American Synthetic Rubber Co. (KY)
- Ensign Bickford (CT)
- Kirkhill-TA Company (CA)
- Ladish Company (WI)
- Moog, Inc. (NY)
- Andrews Space, Inc. (WA)

University Contracts:
- Brigham Young University (UT)
- University of Illinois (IL)
- University of Texas – El Paso (TX)

Selected Subcontracts < $10M (currently more than 200 across 33 states & Puerto Rico):
- Northrop Grumman Systems (AL)
- Teledyne-Brown Engineering (AL)
- Magellan Aerospace Turbine (AZ)
- Curbell Plastics (AZ)
- Aero Spring & Manufacturing (AZ)
- Pilot Engineering (AZ)
- Shultz Steel Company (CA)
- Laurel Sheet Metal Prod., Inc. (CA)
- Standard Tool & Die Co. (CA)
- Rudell Carbide, Inc. (CA)
- Advanced Products Co. (CT)
- E.I. Dupont De Nemours & Co. (DE)
- Parker Hannifin Corp. (FL)
- Productivity APEX (FL)
- Global Equipment Co. (GA)
- Snap-On Industrial (IL)
- Varian Associates Inc. (IL)
- Smalley Steel Ring Co. (IL)
- The Caldwell Group (IL)
- Major Tool & Machine Inc. (IN)
- Dynamic Flowform Corp. (MA)
- Standex International (MA)
- Remmele Engineering, Inc. (MI)
- Hitchcock Industries, Inc. (MN)
- AV Chem, Inc. (MO)
- JPM of Mississippi, Inc. (MS)
- Turbocam, Inc. (NH)
- Software House International (NJ)
- United States Welding Corp. (NV)
- UFC Aerospace Corporation (NY)
- PCB Piezotronics, Inc. (NY)
- Special Metals Corporation (NY)
- Metalflex Manufacturing, Inc. (OH)
- PCC Structural, Inc. (OR)
- Stein Seal Company (PA)
- Electrolizing, Inc. (RI)
## Constellation Flight Test Campaign

<table>
<thead>
<tr>
<th>Year</th>
<th>Development / Qual LAS Flight Testing</th>
<th>Flight Article Production</th>
<th>Integrated ARES-Orion Launches</th>
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<tbody>
<tr>
<td>FY06</td>
<td><a href="#">Devt. LAS PA-1</a></td>
<td><a href="#">Ares I-X FT (1st stage test)</a></td>
<td><a href="#">Initial Operational Capability (IOC) Commitment</a></td>
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<td>FY07</td>
<td><a href="#">Max q Nom Abort AA-1</a></td>
<td><a href="#">Transonic Abort AA-2</a></td>
<td><a href="#">First Crew Flight to ISS (IOC)</a></td>
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<td><a href="#">Proto LAS PA-2</a></td>
<td><a href="#">Orion 1 Orbit Flight</a></td>
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<td><a href="#">Ares 1-Y Hi Alt Abort</a></td>
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Early 2009 Launch

Pad Abort -1

The first flight of the Constellation Program flight test campaign demonstrates:

- Safety - critical crew abort from the launch pad
- First in-flight of the Launch Abort System solid rocket motors, coordinated operation
- Parachute landing system
- Successful pathfinder for Orion system integration and ground operations procedures
ORION: CREW MODULE TEST ARTICLE
WEIGHT CHECK AND CENTER OF GRAVITY TESTING AT DRYDEN FLIGHT RESEARCH CENTER
ARES I-X: CREW LAUNCH VEHICLE TEST

- Ares I-X is a development test flight to support Ares I
- Ares I-X is the first integrated stack flight demonstration in the Constellation Flight Test Campaign
- Ares I-X is an uncrewed, sub-orbital development flight test
- Ares I-X will provide opportunity to test ground facilities and operations at NASA’s Kennedy Space Center
- Ares I-X is on track for a 2009 launch date
ARES 1-X: UPPER STAGE MASS SIMULATOR

FABRICATED SEGMENT IN TRANSIT TO KENNEDY SPACE CENTER
LUNAR REFERENCE MISSION

- Ares V liftoff; solid rocket booster separation
- Earth Departure Stage performs Earth orbit insertion
- Payload shroud separates to expose Altair
- Ares I liftoff; first stage and upper stage separate
- Upper Stage performs Earth orbit insertion; Orion separates
- Orion docks with Altair and Earth Departure Stage
- Earth Departure Stage fires for lunar destination
- Orion and Altair separate from Earth Departure Stage
- Lunar orbit insertion

- Altair separates from Orion and lands on the moon
- 4 astronauts conduct lunar activities
- Altair ascent stage lifts off from the surface
- Ascent stage and Orion dock for crew transfer
- Orion performs trans-Earth injection burn
- Orion and Service Module separate and re-enter Earth’s atmosphere
- Orion decelerates through Earth’s atmosphere
- Parachutes open; capsule descends for landing and recovery
LUNAR SURFACE SYSTEMS PROJECT

- Assess the feasibility of using the proposed transportation architecture to build a lunar outpost

- Surface mobility systems – explore the local area given the requirements of the mission

- Adapt outpost elements to different locations on the lunar surface

- Outpost configuration and capability used to evaluate Mars surface scenarios

- Capabilities of LSS –
  - pervasive mobility
  - mission flexibility
  - global connectivity
  - long duration
WHY THE MOON?

- Regaining and extending operational experience in a hostile planetary environment
- Developing capabilities needed for opening the space frontier
- Preparing for human exploration of Mars
- Discovering science