Revolutionizing Access to Space

Space Exploration Technologies

Space Exploration Technologies
SpaceX Summary

- Founded in mid 2002 with the long term goal of providing high reliability, low cost human space transportation
- Initial target market is government & commercial satellites to minimize market risk
- Add human transportation capability as technology is proven
- Silicon Valley mode of operation – flat hierarchy, high engineer to manager ratio, rapid prototype iteration, best idea wins
- 250 employees
- Currently have 100,000 sqft of office and manufacturing space in Southern California
  - Moving to a Half million square foot facility in 6 months
- 300 acre propulsion and structural test facility in Texas
- Launch complexes in Kwajalein and Vandenberg
2006 Highlights

• SpaceX is ISO 9001 Certified
• Completed construction and activated Falcon launch site at RTS
• 4 Launch attempts with the final achieving lift off and ~30 seconds of powered flight
• Completed the government-led Falcon 1 Return to Flight investigation and vehicle upgrades
• Nominal F1 Return to Flight in January 2007
• Falcon 9 tooling 90% complete
• Falcon 9 engines, structure and avionics in fabrication
• Awarded NASA COTS
**McGregor Test Facility**

**Fairing Test Stand**
- lateral and axial loads
- 128 strain gages
- 32 deflection gages

**Vehicle Test Stand**
- lateral and axial loads
- up to 200 Klbs
- 128 strain gages
- 32 deflection gages
- LN2 and RP-1 tanking
- tank pressurization

**Thrust Frame Test Stand**
- axial load with gimbal
- TVC actuators
- up to 125Klbs
- 160 strain gages
- 32 deflection gages

**Merlin Test Stand**
- 3-axis load measurement
- 420 data channels
- 64 hi-speed channels
- 64 control channels
- Dev and Qual
- 1.5 MDC

**Kestrel Test Stand**
- Axial load measurement
- 356 data channels
- 32 hi-speed channels
- 64 control channels
- Dev and Qual
- 420 second MDC

**Large Scale Fabrication**

**Horizontal Test Stand**
- 100K axial load measurement
- 200 data channels
- 32 hi-speed channels
- 32 control channels
- Components Dev and Qual
- Thrust Chamber and pumps
- 1500 psi Lox and RP-1
Omelek Launch Facility
Lift Off—Marshall Islands March 2006
**Business Approach:**
Serve a current viable market while working towards Human space transportation

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<th>Vehicle</th>
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<td>DARPA Demo Launch 1*</td>
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<td>DARPA Demo Launch 2</td>
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<td>Swedish Space Corp</td>
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**Thirteen Launches Contracted**
Plus $100 Million AF IDIQ Falcon I Contract

* Launched
Falcon 9 Summary

- NASA man-rating factor of safety (1.4 for Falcon 9 vs. 1.25 for typical expendable launch vehicle)
- Nine Merlin engines provide engine out reliability similar to Saturn I & Saturn V
- Upper stage also powered by a Merlin
- 2007 SpaceX engine production will be greater than all US booster engine production combined
- Additional Reliability Factors:
  - 10 Engines per F9 flight results in high production rate and engine run time
  - High level of fault tolerance—man rated
  - Higher flight rate, which also lowers cost
- Basic F9 performance is ten tons to LEO
- Approx. $30 Million per flight all inclusive
- Multi-engine stage hold down firing in Q1 2007
COTS System Architecture

- Standard Falcon 9 booster
  - Identical to commercial LEO payload version
  - Human-rated when combined with a Dragon & LES
  - 8500 kg total payload capacity to ISS orbit
    - Allows ~3100 kg of cargo and/or crew total
- Dragon spacecraft
  - Identical whether cargo-only or crewed (except life-support & internal outfitting)
- Cargo accommodations
  - Pressurized cargo inside capsule
    - Standardized modular rack system, CTB/MLE based
  - Unpressurized cargo in the “trunk”
- Crew accommodations
  - Up to 7 crew per flight
  - Can trade mass between crew & cargo
Dragon Spacecraft

Engineering Model to be complete in February 2007

- Service Compartment
- Common Berthing Mechanism
- Solar Arrays
- Trunk (Unpressurized Cargo)
- Pressure Compartment (Cargo or 2-7 Crew)
- Heat Shield
- NTO/MMH Thrusters (RCS, OMS, and De-Orbit)
SpaceX is Here to Stay

- Customers are very supportive – unprecedented manifest for a new market entrant
- Completing the Falcon 1 organizational transition from development phase to operational phase
  - Focusing on process management, risk management and mission assurance
- Proceeding with the Falcon 9 development and qualification
  - Applying lessons learned from Falcon 1
  - First flight in 2008
- SpaceX is evolving from a purely development capability to both development and operational capability
Thoughts for Closing

- There is substantial public engagement in the space industry right now to leverage
  - COTS with public hope of commercial Spaceflight
  - Bigelow Aerospace’s recent on orbit success
  - Space Ship One’s historic X-prize win
  - Spirit and Opportunity

- Human Exploration and commercial orbital Spaceflight will not become a “near term” reality without ubiquitous space launches

- Fundamentally a state change for the industry is required to develop a broader marketplace
  - Must expand the market beyond governments and large corporations
  - Requires a new approach to working reliability & cost

- With the advent of the Space Entrepreneurs, and willingness to do business differently within the US government, the future for Space Exploration and commercial spaceflight is positive
Implementing the Vision

Space Exploration Conference
2006