NewSpace:
The Emerging Commercial Space Industry
ISU MSS 2017

Gary Martin
Director of Partnerships
NASA Ames Research Center
At the end of this lecture you should be able to:

1) Describe the areas in which entrepreneurial companies are developing new markets
2) Name a few companies that are examples of the commercial space revolution
3) Discuss how governments and private investments can facilitate the birth of this new industry
WHY IS THIS LECTURE IMPORTANT?

• We are at a turning point in the history of space exploration and development – the cusp of a revolution, new industries are being born that use space in many non-traditional ways
• The established state run industrial space sector is no longer the only game in town
• Increased competition and new capabilities will change the space frontier forever
• Everyone interested in working in the space sector will be effected
1. Regimes for NewSpace Opportunities
   - Suborbital
   - Orbital
   - Deep Space
2. Example NewSpace Companies
3. The Role of Government
4. The Role of Private Industry
WHAT IS NEWSPACE?

From Wikipedia:

“NewSpace—formerly alt.space; also "new space,"[1][2] entrepreneurial space, and "commercial space"[3][4][5][6]—are umbrella terms for a movement and philosophy[7] encompassing, but substantially broader than, an emergent, somewhat more visible and defined, private spaceflight industry. Specifically, the terms are used to refer to a community of relatively new aerospace companies working to independently (of governments and their prime/major contractors, i.e., Old Space) develop faster, better, and cheaper access to space, space and spaceflight technologies, and space missions, as a threshold matter; and designers and advocates of such underlying space and spaceflight concepts, architectures, systems, technologies, missions, programs, protocols, and policies.”

References
4. "Bachelor of Science in Commercial Space Operations". Embry-Riddle Aeronautical University (Bachelor’s Programs). Embry-Riddle Aeronautical University (Daytona Beach, Florida). Retrieved 2016-09-08.
SUBORBITAL

Description:
• Spacecraft reaches space 100 km (62 miles) or higher but does not have the forward velocity to go into orbit (e.g. 7.7km/s at 300 km)

Tourist Industry:
• Companies selling tickets for the suborbital experience from $250K (Virgin Galactic) to $150K (XCOR) per seat

Research:
• Microgravity (around 4 minutes)
• Upper atmospheric measurements
• Technology demonstrations
• Life Science experiments

Point-to-Point Travel:
• Travel from one location on Earth to another through space
• Challenging technical problems
• Long-term goal not a current focus
Regimes for NewSpace Opportunities

ORBITAL

Description:
• Low Earth Orbit (LEO) 180 – 3000km
• High Earth Orbit (HEO) – Geocentric 35,786km

Tourist Industry:
• Provides long periods of time in microgravity at ISS or on private space stations
• Space Adventures: 7 private citizens to ISS (8 missions – $20M-$52M per trip)

Research/Applications:
• Conduct experiments continuously in the orbital environment (microgravity and life sciences)
• Produce commercial products
• Launch small spacecraft from ISS

Satellite Servicing:
• Service satellites, put them in proper orbits, refuel, fix and upgrade systems

Earth Imaging:
• Natural resources, site development, crop monitoring, asset management…

Broadband:
Regimes for NewSpace Opportunities

DEEP SPACE

Description:
- Lagrange points, Moon, Asteroids, Mars and beyond

Tourist Industry:
- Ultimate in exotic experiences, Lunar and Mars

Research:
- Enabling Humans to be productive and happy in space; in-space economy
- Developing new materials and processes to create new markets and improve life

Mining and In Situ Resource Utilization:
- Examples: Propellants, metal & materials processing, and building materials

Servicing a space-based economy:
- Examples: 3D printing in space, space manufacturing

Settlement:
- Moving human civilization to Moon and Mars
Examples of NewSpace Companies

**Virgin Galactic**

- **HQ**: Las Cruces, New Mexico
- **Founded**: 2004 Richard Branson (Virgin Group)
- **Focus**: Space Tourism & Research; Low-cost small satellite launch
- **Cost**: $250K per seat, $10M per satellite
- **Major Partnerships**: Spaceport America in New Mexico, Y3, and Landrover
Examples of NewSpace Companies

SUBORBITAL and ORBITAL

HQ: Houston, TX

Founded: 2009 CEO Jeff Manber (MirCorp)

Focus: Sub-orbital (Blue Origins); On-orbit (and beyond) research and smallsat launch, ISS internal and external, and beyond

Cost: Variable based on hardware and services needed. Internal educational payloads start at $15K, deployment starts at $85,000 (1U CubeSat)

Major Partnerships: XCOR, Astrium, Schafer, Spaceflight Services, Ardulab, GOMspace, and Student S/F Exp. Program
Examples of NewSpace Companies

ORBITAL

HQ: San Francisco, California

Founded: 2010 Will Marshall, Robbie Schingler, Chris Boshuizen

Focus: Applications, Earth Sensing

Capacity: Launched over 179 smallsats, resolution (145 made it to orbit); 10 square feet resolution

Major Partnerships: Raised $183M in 5 years
Examples of NewSpace Companies

HQ: North Las Vegas, NV

Founded: 1998 by Robert Bigelow

Focus: Orbital stations

Capacity: BEAM 16m³ on ISS; BA330 has 330m³ of internal space

Cost: $25M for 110m³ for 60 days (1/3 of BA330)

Major Partnerships: NASA, SpaceX, Boeing, ULA
Examples of NewSpace Companies

**HQ:** Hawthorne, California

**Founded:** 2002 Elon Musk

**Focus:** Reusable transport to Low Earth Orbit (ISS), Geostationary Transfer Orbit (GTO), Mars

**Cost:** $62M Falcon 9 Full Thrust; Falcon Heavy $90M for 8mt to GTO

**Major Partnerships:** NASA Commercial Crew
Examples of NewSpace Companies

DEEP SPACE

Moon Express (ME)

**HQ:** Moved to NASA KSC, Florida

**Founded:** 2010 Bob Richards, Andy Aldrin

**Focus:** Lunar payloads, resource exploration, Google Lunar X Prize.

**Cost:** Initial cost ~$3M/kg

**Major Partnerships:** NASA innovative Lunar Demonstration Data (ILDD) program ($30M); Dynetics
Examples of NewSpace Companies

**DEEP SPACE**

**DSI**

**HQ:** Mountain View, CA

**Founded:** 2013, Rick N. Tumlinson, Daniel Faber, David Gump et al.

**Focus:** Asteroid Mining: Water & Rare Metals

**Implementation:** Prospector X – tech demo, Prospector 1 – mining demo

**Major Partnerships:** Luxembourg, NASA Asteroid Redirect Mission
Key question:

“What role should the government play in the commercialization of space?”
Established in 1915 by Congress
• Developed key technologies to enabled air travel to become effective, economical and safe
• Studied the problems of flight to identify and resolve risks that kept air travel from being safe and commercially viable
• Government worked closely with industry to fund studies that retired technological risks and enabled private enterprise to successfully create a new industry
# The Role of Government

## CHANGES AT NASA

<table>
<thead>
<tr>
<th>Program Characteristic</th>
<th>Early Space Age Approach</th>
<th>Commercial-Oriented Approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>Owner</td>
<td>NASA</td>
<td>Industry</td>
</tr>
<tr>
<td>Contract Fee-Type</td>
<td>Cost Plus</td>
<td>Fixed Price</td>
</tr>
<tr>
<td>Contract Management</td>
<td>Prime Contractor</td>
<td>Public-Private Partnership</td>
</tr>
<tr>
<td>Customer(s)</td>
<td>NASA</td>
<td>Government and Non-government</td>
</tr>
<tr>
<td>Funding for Capability Demonstration</td>
<td>NASA procures capability</td>
<td>NASA provides investment via milestone payments</td>
</tr>
<tr>
<td>NASA’s Role in Capability Development</td>
<td>NASA defines “what” and “how”</td>
<td>NASA defines “what” Industry defines “how”</td>
</tr>
<tr>
<td>Requirements Definition</td>
<td>NASA defines detailed requirements</td>
<td>NASA defines top-level capabilities needed</td>
</tr>
<tr>
<td>Cost Structure</td>
<td>NASA incurs total cost</td>
<td>NASA and Industry share cost</td>
</tr>
</tbody>
</table>
“Develop a robust and competitive U.S. commercial space sector”

&

“Energize competitive domestic industries to participate in global markets”

– NASA Act (as amended June 28, 2010)
NASA is to achieve this by:

- Purchasing and using **commercial space capabilities** and services to the maximum practical extent
- Actively exploring the use of **inventive, nontraditional arrangements** for acquiring commercial space goods and services
- **Refraining from** conducting U.S. Government space **activities that preclude, discourage, or compete with U.S. commercial space activities**
- Pursuing potential opportunities for **transferring routine, operational space functions to the commercial space sector** where beneficial and cost-effective.

June 28, 2010
The Role of Government

FAA Office of Commercial Space Transportation

Founded 1984, to:

• **Regulate** the commercial space transportation industry, *only to the extent necessary*

• **Encourage, facilitate, and promote commercial space** launches by the private sector

• **Recommend appropriate changes** in Federal statutes, treaties, regulations, policies, plans, and procedures:

• Facilitate the strengthening and **expansion of the U.S. space transportation infrastructure**
The Role of Government

WHY COMMERCIAL?

• Why Commercial?
  o Commercial companies must be competitive and
governments have other priorities (safety, jobs, etc.)
  o Example: comparison of SpaceX to NASA
Development Costs
    _ NASA initial estimates using its normal cost estimating
      software for Falcon 9 were 10 times more expensive than
      SpaceX actuals
    _ Even when NASA made adjustments its estimates were
      still 4 times more

• Conflicting goals
  o US Congress focused on jobs in their districts
The Role of Government

NASA PROGRAMS TO STIMULATE COMMERCIAL SPACE

- **Commercial Orbital Transportation Services (COTs) 2006**
  - NASA investment $800M produced 2 new launchers 2 new ISS cargo carriers

- **Commercial Crew Development (CCDev) 2009 – 2011**
  - Stimulate development of privately operated crew vehicles

- **Commercial Crew Integrated Capability (CCiCap) 2012 – 2014**
  - Advance multiple integrated crew transportation systems to LEO

- **Commercial Resupply Services (CRS-1) 2008 - present**
  - 20 missions for SpaceX and 10 missions for Orbital Sciences

- **Commercial Resupply Services (CRS-2) 2019 - 2024**
  - 6 missions each for SpaceX, Orbital Sciences and Sierra Nevada Corporation

- **Collaborations for Commercial Space Capabilities – SAAs**
  - Advance private sector development of emerging products and services commercially available to government and non-government customers

- **Flight Opportunities Program 2010 – present; Suborbital**
  - Commercial Reusable Suborbital Research Program (CRuSR) – supports commercial suborbital spaceflight by providing a steady, guaranteed market for research payloads
  - Facilitated Access to Space Technology (FAST) – funding microgravity research
Google Lunar X-Prize (GLXP) 2007 - 2016
- Eighteen teams currently in competition for $30M in prizes
- Land a robot on the Moon then travel more than 500m and transmits high definition images and video to Earth

NASA Innovative Lunar Demonstration Data
- Indefinite delivery/indefinite quantity (IDIQ) contracts totaling up to $30.1M

Crowdfunding
- Kickstarter: Lunar Space Elevator (Liftport Group), CubeSat Ambipolar Thruster (CAT) (UMich), Arkyd Telescope $1.5M (Planetary Resources) etc.
- Spire
**The Role of Private Industry**

### NEWSPACE INVESTMENTS (NSG 50)

<table>
<thead>
<tr>
<th>$200M-$2B</th>
<th>$20M-$200M</th>
<th>$2M-$20M</th>
</tr>
</thead>
<tbody>
<tr>
<td>SpaceX</td>
<td>Skybox</td>
<td>Dauria Aerospace</td>
</tr>
<tr>
<td>Virgin Galactic*</td>
<td>Spaceflight Industries</td>
<td>Planetary Resources</td>
</tr>
<tr>
<td>Blue Origin*</td>
<td>MapBox</td>
<td>OmniEarth</td>
</tr>
<tr>
<td>Vulcan Aerospace*</td>
<td>Spire</td>
<td>Satellogic</td>
</tr>
<tr>
<td>O3B</td>
<td>Moon Express</td>
<td>Astroscale</td>
</tr>
<tr>
<td>OneWeb</td>
<td>Spire</td>
<td>Nanoracks</td>
</tr>
<tr>
<td>Planet Labs</td>
<td>SpaceIL</td>
<td>XCOR</td>
</tr>
<tr>
<td>Cloudera</td>
<td>Kymeta</td>
<td>Rocket Lab</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Firefly</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reaction Engines</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accion Systems</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Orbital Insight</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ClearStory Data</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SpaceKnow</td>
</tr>
</tbody>
</table>

Crunchbase Data 2015  
(*) SVSC estimates  
Source: Sean Casey (SVSC)

**From 2005-2015 $12B in private investment**  
Source: Silicon Valley Space Center
The Luxembourg Government announced a series of measures to position Luxembourg as a European hub in the exploration and use of space resources (February 3, 2016).

- Luxembourg will develop a legal and regulatory framework confirming certainty about the future ownership of minerals extracted in space from Near Earth Objects (NEO’s) such as asteroids.

- Opening a €200 million ($225 million) line of credit for entrepreneurial space companies to set up their European headquarters within its borders (June 3, 2016).
You should be able to:

1) List some examples of areas where entrepreneurial companies are developing new markets;

2) Name a few companies that are examples of the commercial space revolution;

3) Discuss how governments and private industry can facilitate the birth of this new industry; and
Organizations Promoting NewSpace

**Students for the Exploration and Development of Space (SEDS)**
1980 founded by the same 3 founders as ISU, to promote space exploration and development.

**National Space Society**
1987 promotes living in and working in space. The organization is located in many countries.

**Space Frontier Foundation**
1988, dedicated to free enterprise and human settlement of the Solar System

**Space Access Society**
1992, dedicated to reducing the cost for commercial access to space.

**Commercial Spaceflight Federation**
2005, promotes commercial human spaceflight, high levels of safety, and shares best practices and expertise throughout the industry.
Emerging Commercial Space

REFERENCES


• Page 8: http://www.esa.int/Our_Activities/Technology/Building_a_lunar_base_with_3D_printing and two NASA Images.


REFERENCES cont.

- Page 18: NASA HQ Presentation 2014: ‘Why Commercial Space and Why are we doing it’; Phil McAlister HEOMD
- Page 23: Developing Cislunar Space Using the COTS Model, White Paper by Bruce Pittman & Dr. Daniel J. Rasky
- Page 25: NewSpace Investments: Sean Casey (Silicon Valley Space Center) from crunchbase.com