NewSpace: The Emerging Commercial Space Industry
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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.”

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Regimes for NewSpace Opportunities

**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

**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**

**NANORACKS**

**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 16m$^3$ on ISS; BA330 has 330m$^3$ of internal space

Cost: $25M for 110m$^3$ 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

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

Deep Space Industries (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?”
The Role of Government

NATIONAL ADVISORY COUNCIL FOR AERONAUTICS (NACA)

- 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

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<td><strong>NASA’s Role in Capability Development</strong></td>
<td>NASA defines “what” and “how”</td>
<td>NASA defines “what” Industry defines “how”</td>
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<td><strong>Requirements Definition</strong></td>
<td>NASA defines detailed requirements</td>
<td>NASA defines top-level capabilities needed</td>
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<td><strong>Cost Structure</strong></td>
<td>NASA incurs total cost</td>
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“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**
• 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)

$200M-$2B
SpaceX
Virgin Galactic*
Blue Origin*
Vulcan Aerospace*
O3B
OneWeb
Planet Labs
Cloudera

$20M-$200M
Skybox
Spaceflight Industries
MapBox
Spire
Moon Express
SpaceIL
Kymeta

$2M-$20M
Dauria Aerospace
Planetary Resources
OmniEarth
Satellogic
Astroscale
Nanoracks
XCOR
Rocket Lab
Firefly
Reaction Engines
Accion Systems
Orbital Insight
ClearStory Data
SpaceKnow

Crunchbase Data 2015

(*) SVSC estimates

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

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