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## DRAFT WHITE PAPER

### *The Space Industry*

#### Introduction

The Aerospace Industry is evolving to commercialize flight beyond Earth's atmosphere. Nations have created audacious policies to permit private enterprise to visit celestial bodies for myriad purposes, including extracting elements rare to Earth. These elements are necessary for technology, transportation, telecommunications, and defense. Gaining access to rare Earth elements is becoming costlier and therefore the elements are becoming scarcer. China controls 95% of rare earth elements and United States has found itself in what has been characterized by industry pundits as a trade war. The two nations are have several times litigated their differences in WTO.

Technology is limited by the resources we have available. Copper wires were once state of the art means of transmitting energy and information. Fiber replaced copper – what will replace fiber?

#### Policy Background

There are two segments of the industry that are dominating investor confidence: Commercial Space Flight (SpaceX) and asteroid mining (Planetary Resources).

Since launching their surveying satellites in 2012, Planetary Resources has identified 11,000 near earth objects; more than 1000 are discovered each year. Estimates from Planetary Resources suggest 1500 are accessible using contemporary technology. It is estimated that each asteroid could yield \$100 billion in resources. The most optimistic projections suggest that \$1.5 trillion in resources is accessible.

The largest mining company of rare earth elements in the western hemisphere, MolyCorp, Inc. has undergone bankruptcy proceedings. Although the company emerged recently from Chapter 11 bankruptcy, the challenges of mining rare earth elements remain a barrier to markets and technological advancements. Additionally, terrestrial mining causes irreparable damage to land and natural resources.

#### Impediments and Unknown Challenges

The challenges of space mining, including the prospecting, extraction and refining of minerals in low gravity, may prove so costly to overcome that elements extracted from asteroids would not provide a price advantage over terrestrial sources.

#### Sectors

The industry is comprised of three primary segments: satellite manufacturing, support ground equipment manufacturing and launch. The global space economy reached \$314.17 billion in 2013, growing 4% from 2012. Industry estimates in 2014 indicate 24% of the economy is tied to government spending. The remaining 76% derives from commercial spending.

TeleCom  
Launch  
R&D

#### International Competition

China Policy

The purposes of China's space program are to "explore outer space and to enhance understanding of the Earth and the cosmos; to utilize outer space for peaceful purposes, promote human civilization and social progress, and to benefit the whole of mankind; to meet the demands of *economic development, scientific and technological development*, national security and social progress; and to improve the scientific and cultural knowledge of the Chinese people, protect China's national rights and interests, and build up its national comprehensive strength."

#### European Union Policy

"The main aim of the EU's space policy is to use space-related technology to tackle some of the most pressing challenges today, such as fighting climate change, helping to stimulate technological innovation, and providing socio-economic benefits to citizens."

#### Luxembourg

Announced in June 2016 that the nation would [develop a legal framework](#) for the commercial exploitation of space resources, the first such set of laws in Europe. Luxembourg, via the Ministry of the Economy, has developed a space policy whose main objectives are to:

- Contribute to the diversification and sustainability of economic activities in Luxembourg;
- Consolidate and enhance existing skills in the field of telecommunications and media, and ground systems;
- Extend skills in the telecommunications and media sector;
- Give an international dimension to the activities through the access to international networks.

#### United States Policy

To facilitate a pro-growth environment for the developing commercial space industry by encouraging private sector investment and creating more stable and predictable regulatory conditions.

### Industry Leaders

#### **Boeing**

Throughout the last 50 years, the company has been integral in every major endeavor to escape Earth's gravity. From the first Mercury capsule, to the current International Space Station, Boeing promises to take humans and technology farther than ever before.

#### **Space X**

Designs, manufactures and launches advanced rockets and spacecraft. Founded in 2002 to revolutionize space technology, with the ultimate goal of enabling people to live on other planets.

#### **Moon Express**

Announced plans to visit lunar surface in 2017 for the purpose of mining rare resources. Permission granted by several US government agencies, including NASA, White House, State Department and Defense Department. The company plans to transport mined resources to earth by 2020.

#### **Planetary Resources**

Prospecting and Earth Observation. Builds the most advanced spacecraft available today for long term mission to mine asteroids, and near term mission to bring value to the global markets. Announced in 2012 plans to extract platinum from near earth asteroids. The company estimated a 30 meter wide asteroid could yield \$50 billion of platinum.

### Industry Externalities

Warehousing

Pollution and land use

### Industry Jobs

The types of jobs in the market today are engineering intensive. Examples include Power Systems, Thermal, Guidance Navigation and Control, Radio Frequency (RF), Avionics, Communication Systems, Electrical, Hardware Design, Software, Mechanical, Microwave, Environmental, Chemical, Propulsion, etc.

The industry also supports innumerable trade positions such as Welders, Drafters, Metallurgy, Facilities Management, and Electronics. Similarly, the industry supports positions in logistics, analytics and supply line. Many jobs require or prefer only an Associates or Bachelor's degree. Additionally, administrative jobs include receptionists, accountants and fiscal agents, operations management, custodial, etc.

The industry is estimated to create nearly 40,000 new jobs in 2016 alone. The Aerospace and Defense industry employs approximately 1.2 million people in the United States, with 3.2 million workers supporting the industry. A recent survey conducted by Payscale.com states that “highly experienced Aerospace Engineers pick up larger-than-average paychecks, bringing in \$128K, much more than the \$79K annually national average for others in this area of work. The median compensation for relatively untried workers is \$71K; in the five-to-10 year group, it's higher at around \$85K. Experienced professionals — those with 10 to 20 years in the field — see salaries in the six-figure territory, securing around \$102K on average. Seasoned veterans with 20 years under their belts enjoy a median income of \$128K.”

#### Industry Needs

- Land
- Permitting

#### Massachusetts Competitiveness

- Assets & Resources
  - Engineers and talent
  - Access to markets
  - Industry leaders

#### Case for Plymouth/South Shore

- Entergy Site
- Engineers
- Regional partners – colleges, industry leaders

#### Attachments

- A - Moon Express Press Kit
- B – USCC Report – China Dream, Space Dream

#### Annotated Bibliography: Mining

##### **Asteroid Mining Made Legal** – Independent UK

<http://www.independent.co.uk/news/science/asteroid-mining-made-legal-after-barack-obama-gives-us-citizens-the-right-to-own-parts-of-celestial-a6750046.html>

Private companies can now mine asteroids, after Barack Obama signed a major law that reverses decades of space law. US citizens are now able to obtain their own asteroids and mine resources out of them, and will be able to own the materials they find there.

##### **U.S. Commercial Space Launch Competitiveness Act (H.R. 2622)** – U.S. Government

<https://www.congress.gov/bill/114th-congress/house-bill/2262/text>

To facilitate a pro-growth environment for the developing commercial space industry by encouraging private sector investment and creating more stable and predictable regulatory conditions, and for other purposes.

##### **Space, the economy's new frontier** - CNBC

<http://video.cnbc.com/gallery/?video=3000535662>

Chris Lewicki, Planetary Resources CEO, and Peter Diamandis, XPrize founder & executive chairman, discuss how space exploration could provide an opportunity to unlock the secrets of the solar system while creating wealth.

##### **Asteroid Mining Will Be Trillion Dollar Business** – CNBC

<http://video.cnbc.com/gallery/?video=3000500435>

Planetary Resources co-founder and co-chairman, Eric Anderson says the “limitless resources” from space will help drive the world’s economy and prosperity in the future.

##### **Luxembourg to Invest \$227 Million in Asteroid Mining** – Fortune

<http://fortune.com/2016/06/05/luxembourg-asteroid-mining/>

The European nation of Luxembourg (size is equal to Dallas Metro area with a population at about 600,000) announced that it would [open a \\$227M \(U.S.\) fund](#) to entice companies focused on mining asteroids to locate there. Luxembourg’s economy minister said that the fund’s budget could expand if needed, and that it is aimed at making the country a global leader in space.

##### **Are Asteroids the Next Mining Frontier?** - Bloomberg

<http://www.bloomberg.com/news/videos/2016-03-09/are-asteroids-the-next-mining-frontier>

Chris Lewicki, Planetary Resources president and chief executive officer, discusses the future of mining for resources such as minerals and water in outer space.

### **Planetary Resources Raises \$21.1 Million in Series A Funding** – Planetary Resources Press Release

<http://www.planetaryresources.com/2016/05/planetary-resources-raises-21-1-million-in-series-a-funding-unveils-advanced-earth-observation-capability/>

Planetary Resources, Inc., the asteroid mining company, announced today that it has secured US\$21.1 million in Series A funding. The capital will be used to deploy and operate Ceres, an advanced Earth observation business that features the first commercial infrared and hyperspectral sensor platform to better understand and manage humanity's natural resources.

### **An Interview with CEO of Planetary Resources** – PCMagazine

<https://www.youtube.com/watch?v=FL2GPY1G-xg&feature=youtu.be>

As Humans venture out far away from the Earth into the solar system, they will need material resources to keep us going. Where do we get those from? One for-profit company, Planetary Resources, wants to be the one to make it happen.

### **The Silicon Valley of Space Start-ups? It Could Be Seattle** – New York Times

[http://www.nytimes.com/2016/08/02/science/seattle-space-flight-innovation-center.html?\\_r=1](http://www.nytimes.com/2016/08/02/science/seattle-space-flight-innovation-center.html?_r=1)

Spaceflight Industries, is one of a growing number of start-ups springing up in Seattle for the same reasons the area has been so hospitable to internet and software companies. "It's about software, big data, and it's about capital," said Jason Andrews, the chief executive of Spaceflight. No single spot can claim to be the Silicon Valley of such companies yet, but Seattle is on the short list of contenders, investors and entrepreneurs say.

### Annotated Bibliography: Policy

#### **U.S. Aerospace Industry Sees First Job Growth in Five Years** - Fortune

<http://fortune.com/2016/02/16/aerospace-defense-jobs/>

The U.S. aerospace and defense industry is poised to add 39,443 jobs in 2016, an increase of about 3.2% and the first job growth in the sector in five years, according to a study by Deloitte. The anticipated growth will be driven by a rebound in the U.S. military market, which lost about 185,000 jobs over the last five years due to budget cuts and the drawdown of military forces in the Middle East, the report said.

#### **Aerospace Engineer Salary and Wages** – Payscale.com

[http://www.payscale.com/research/US/Job=Aerospace\\_Engineer/Salary](http://www.payscale.com/research/US/Job=Aerospace_Engineer/Salary)

Highly experienced Aerospace Engineers pick up larger-than-average paychecks, bringing in \$128K, much more than the \$79K annually national average for others in this area of work. The median compensation for relatively untried workers is \$71K; in the five-to-10 year group, it's higher at around \$85K. Experienced professionals — those with 10 to 20 years in the field — see salaries in the six-figure territory, securing around \$102K on average. Seasoned veterans with 20 years under their belts enjoy a median income of \$128K.

#### **US Sues Chinas at WTO Over Minerals Export Taxes Again** – Forbes

<http://www.forbes.com/sites/timworstall/2016/07/14/us-sues-china-at-wto-over-minerals-export-taxes-again-and-is-likely-to-win/#72e2a72d5831>

China imposes duties of 5 percent to 20 percent on exports of nine raw materials, including antimony, cobalt, copper, graphite, lead, various magnesia compounds, talc, tantalum and tin, which it said were key inputs into US industries, including aerospace, cars, electronics and chemicals.

#### **Chinas Plans More Than 20 Space Launches in 2016** – Phys.org

<http://phys.org/news/2016-01-china-space.html>

China announced a new flight schedule that will blend civilian and military missions. Using new rocket technology, the Chinese government will launch new satellites, and is preparing for a manned lunar landing by 2025.

#### **Is China's Race to Space a Military Ploy?** – CNBC

<http://www.cnn.com/2016/02/18/chinas-space-missions-in-2016-tied-to-military-ambitions.html>

China spends \$2 billion to \$3 billion on its space program annually, a fraction of the \$19 billion [NASA](#) will spend this year. Although China remains decades behind the U.S. in terms of space technology and know-how, it has managed to fast-forward innovation by leveraging existing technologies and its inexpensive labor and material markets.

#### **Chinas Dream, Space Dream: China's Progress in Space Technologies and Implications for the United States**

– U.S.-China Economic and Security Review Commission

[http://origin.www.uscc.gov/sites/default/files/Research/China%20Dream%20Space%20Dream\\_Report.pdf](http://origin.www.uscc.gov/sites/default/files/Research/China%20Dream%20Space%20Dream_Report.pdf)

China views the development of space power as a necessary move for a country that wants to strengthen its national power. For China's military, the use of space power can facilitate long-range strikes, guide munitions with precision, improve connectivity, and lead to greater cohesion across its armed forces. *Economically, space technologies can create markets for new technologies and result in "spin-off" technologies for commercial uses that will make its industry more competitive.* Politically, space power provides "carrots and sticks" that China can use to influence the international situation. By placing much of its space program in a 15-year development program and providing ample funding, the Chinese government provides a stable environment in which its space program can prosper.

China's rise as a space power also appears to have potential negative economic consequences for the United States, although that impact will be felt more in the long-term. China has embraced its space program as a driver of economic growth and technological advancement that can help change its economy from a low-cost manufacturer to a high-tech competitor. According to Chinese analysts, investments in space technologies can produce a ten-fold return.

**China Space Activities 2011** – Information Office of the State Council, People's Republic of China

[http://www.gov.cn/english/official/2011-12/29/content\\_2033200.htm](http://www.gov.cn/english/official/2011-12/29/content_2033200.htm)

**5 years after crisis, U.S. remains dependent on China's rare earth elements** – Environment & Energy Publishing

<http://www.eenews.net/stories/1060011478>

China started restricting its exports of rare earth elements in 2006 and accelerated in 2010, when it cut the export quota by 40 percent. By mid-2011, a combination of panic and speculation had driven prices through the roof. Neodymium, an ingredient in everything from hybrid car batteries to headphones, had risen from \$42 to \$283 a kilogram. Samarium, used in the making of missiles, spiked from \$18.50 to \$146. The impact was felt directly among energy manufacturers, such as in lighting, where rare earths such as cerium and europium are used as coatings that improve the energy efficiency of bulbs. In a year and a half, prices for cerium oxide rose more than 3,500 percent and europium by 630 percent, according to a presentation by lighting manufacturer Osram Sylvania Inc.

**U.S. Tangles With China Over Rare-Earth Export** – Time Magazine

<http://science.time.com/2012/03/13/raring-to-fight-the-u-s-tangles-with-china-over-rare-earth-exports/>

The U.S. — along with the European Union and Japan — had filed a case with the World Trade Organization requesting talks with China over its export controls of the rare-earth minerals used in the high-tech and clean-tech manufacturing industries.