



The Final Frontier

How Commercial Space Is Rapidly Becoming the Frontier

“We choose to go to the moon . . .” For those who remember John F. Kennedy’s famous May 25, 1961 speech pledging that the United States would go to the moon in a single decade, you might remember a tingling sensation up your spine. A man on the moon was hard to comprehend at the time, but on that day, the space flame was lit in the hearts of wannabe astronauts and engineers, and in those children who watched these space ventures, transfixed and inspired to explore space.

Those children are now adults. After six moon landings, we are again looking forward to another moon landing—though not from NASA. This time the mission is piloted by Elon Musk’s Space X’s Crew Dragon. With a contract from NASA, the commercial entity Space X has begun preparations for a space launch not yet determined. With their reusable Falcon 9 and Falcon Heavy rocket technology, Space X has already shown that they could do it cheaper than NASA. A lot has changed since the last moon landing in 1972. In 2018, commercial space companies are leading the way, using reusable rockets, inflatable habitat technology, and an entirely new vision for exploring the final frontier again.

BENEFITS OF SPACE EXPLORATION

Historically, space travel has been dictated by governments, primarily the U.S., Russia, and China. NASA has engineered the spacecraft, the crews, and initiated launches to space from capsules to space shuttles. Not only have we been on the moon six times, but NASA launched a thirty-year space shuttle program that encompassed 135 flights for 355 astronauts and docking with the International Space Station thirty-seven times.

We installed a vast number of satellites in lower and upper earth orbits that are responsible for GPS positioning and mapping and cell phone availability. Despite this, many think that space exploration is exorbitant.

Though they know the costs, most people don’t know the benefits of space exploration. That cordless drill you used when fixing something in your house—it came from the zero-impact wrench that Black and Decker created for the Gemini Project (NASA). Water filtration systems came from NASA’s silver ion technology built for Apollo missions (NASA, NASA City & Home). Light-based cancer therapies to solar panels to global mapping for climate change originated in space exploration. Plus, crucial scientific research and significant global partnerships have been formed outside the boundaries of politics and competition. Space exploration has been very, very good for us.

MAJOR PLAYERS IN COMMERCIAL SPACE

Now commercial space opportunities are taking us higher into lower and upper orbits as well as into deep space with possible exploration to Mars and various exoplanets. The major players—Elon Musk, Jeff Bezos, Richard Branson, and Paul Allen to name a few—keep pushing the envelope that Chuck Yeager once pushed wide open.

Recently, two recent books detail and provide fascinating accounts of their efforts: **Rocket Billionaires: Elon Musk, Jeff Bezos, and the New Space Race** by Tim Fernholz and **The Space Barons: Elon Musk, Jeff Bezos, and the Quest to Colonize the Cosmos** by Christian Davenport. These intimate accounts provide significant background into what motivates these men to pursue outer space.

According to Dr. Sonya A. H. McMullen, associate professor, College of Aeronautics, Embry-Riddle Aeronautical University, these new partners in space exploration are the great disruptors. “We are entering a new era,” she said. “Elon Musk is one that is heavily covered, either loved or hated because he is the great disruptor. Jeff Bezos is equally disruptive but more secretive about Blue Origin status. Paul Allen of Microsoft is funding part of the Spaceship One and Stratalaunch where they are putting two Boeing 747s together to launch rockets from.” Other disruptors, she says, are Richard Branson of Virgin Galactic and Robert Bigelow who is testing inflatable habitat technology.

With disruptors often come big business. A 2013 study by Kelly Whealan-George predicted that the global space industry would grow 18-40 percent by 2030 (Cesar, 2018). According to Dr. McMullen, “The amount of revenue generated by commercial space activities now exceeds that being spent by the world’s governments” (Cesar, 2018). While these gentlemen are not the first disruptors, space barons, or rocket billionaires to hit the



DR. SONYA A. H. McMULLEN

launch pad, they have clearly made it spine-tingling for those of us watching, and they are creating lots of chances for success.

OPPORTUNITIES IN COMMERCIAL SPACE

Opportunities for commercial space seem to be as limitless as the stars in the sky. The biggest market is satellites. Why? Large satellite technology of the Sputnik-type era is evolving into more miniaturized satellite electronics. This means that early companies—like HughesNet and Iridium (first pioneers in satellite technology) are competing with newer companies like Space X's StarLink, a Toronto startup called Kepler Communications, or Branson's One Web—to create smaller and faster satellites. Satellites are 77 percent of the global space economy, and because they have gotten smaller, production has increased by 47 percent in the past five years (Cesar, 2018).

Where are all of these satellites going? Many are going into lower earth orbit, says McMullen. Plus, with their smaller size, they are much less expensive and quicker to get into. "In the past, you had to think in advance about the satellite lifespan, and the end of that lifespan as three to four years. You had to produce the satellite, buy the launch, and get it there in time," said McMullen. "Now, it is still two years, but that time will shorten quite a bit which is good from a national security or economic standpoint. Imagine if you have a failure, or someone tries to distract your satellite; now you can replace it more quickly, so it acts as a deterrent for that kind of behavior."

SPACE DEBRIS

One problem that occurs with launches of more satellites is a multi-satellite populated orbit which means more disabled satellites. How serious is that? Currently, U.S. Strategic Command tracks over 23,000 human-made objects more substantial than a softball. Of those 23,000, approximately 1500 are functioning satellites. The rest are basically trash in the sky (Cesar, 2018).

As they say, "One man's trash is another's treasure." Cleaning up space debris is another commercial space opportunity. Among the options being explored at this time include the use of a harpoon, net, and a drag sail to capture and slow debris and the development of a reusable space tug that will be capable of snagging the satellite for service or refueling, and then maneuvering multiple aircraft in orbit (Pultarova, 2018) (Pinholster, 2017).

While debris can stay in orbit for thousands of years, cleaning up space debris is a critical issue. Satellites can crash to the ground like those from China which has lost 5,213 objects in space (Mosher, 2018).

It can also clog up space traffic, limit launch windows, cause a space traffic jam for crafts in orbit, or worse, tumble to Earth—making space debris a real hazard (Mosher, 2018). Either way, it is a huge problem, says McMullen. "Eventually, someone needs to say we will pay for it and clean it up. Though there have been a lot of great ideas, just not a lot of political will to get it done."

SPACE TOURISM

One exciting venture in commercial space is the flashiest of them all—space tourism. Do you want to travel into outer space? Be prepared to pony up approximately \$150,000 to \$200,000, or \$15,000 per minute. This ten to eleven-minute experience in outer space is only for the very rich and, thus far, seven private citizens have currently flown to space, paying tens of millions of dollars out of their pockets (Gerbus).

There is a perception that space tourism is an adventure for only the super- or semi-rich, says McMullen. In reality, says McMullen, the potential for humanity is greater if these efforts successfully reduce the costs of putting humans in space. "The potential for research, exploration, innovation, and manufacturing could radically enhance the quality of life for all mankind," said McMullen.

ASTEROID MINING

In James S. A. Corey's book, **Leviathan Wakes**, people living in the asteroid belt, called "Belters," mine asteroids to provide metals and other goods to those on Earth. Considered the working class of people in Corey's *Expanses* series, they mine the materials and send them back to earth, living on the asteroid rather than transporting back and forth to Earth. The same is true in Alastair Reynolds' book on comet miners called **Pushing Ice**. While the idea of mining an asteroid, a moving unstable object in outer space, should seem like science fiction, it is, in fact, a genuine possibility.

The author of **Asteroid Mining 101: Wealth for the New Space Economy**, John S. Lewis, is Professor Emeritus of Planetary Sciences at the Lunar and Planetary Laboratory of the University of Arizona and wrote the manual on asteroid mining. He explains in his book that mining an asteroid is no easy task. It is always moving. Its surface is uneven with a patchwork of craters, rocks, dust, and rubble while other areas are smooth as glass. It is often very irregular in shape, making landing a spacecraft on an asteroid difficult, plus it rotates on an often-unpredictable schedule. Solar radiation can be a problem, and its environment can be defined by "hard vacuum and low gravity" (Lewis, 2015). The idea of mining an asteroid, says McMullen, while very exciting, poses the big question of whether or not we can extract materials that we need to justify the cost of bringing everything we need into space to mine the asteroid.

According to Dr. Lewis, the payoff of mining an asteroid is worth it. "The biggest near-term payoff from an economist point of view, may be the ability of a nearby asteroid to provide structural metals, propellants, and photovoltaic devices for Solar Power Satellites at costs several times lower than lifting these materials from Earth." Presently, ideas about launching SPS components into space, he says, creates staggering launch costs and even possible environmental hazards. As a result, "launching



JOHN LEWIS

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100 to 1000 times less mass of mining and processing equipment promises a huge advantage for space-based power generation where in-space hardware is mined, processed, and installed in space,” said Lewis.

Lewis also believes that asteroid mining will increase the amount of human activity in space. By taking advantage of these resources already in place, the cost of space exploration, as well as the development of technology for processing materials, will also be cheaper.

Right now, two companies are leading the race for asteroid mining: Planetary Resources and Deep Space Industries. Planetary Resources plans to mine these natural resources, primarily water, from asteroids, converting water to fuel, and set up outposts in space to power space exploration by 2020 (Cesar, 2018).

SPACE: THE WILD WEST

With all these options being explored, several questions still exist. Will space development be regulated? Who owns what materials? So far, commercial space exploration and ventures are operated in a somewhat empty regulatory vacuum.

Most space exploration treaties are antiquated, dating back to the 1960s. Currently, the Outer Space Treaty of 1967 which was signed by 107 countries, prohibits countries from claiming any sovereignty over celestial bodies. While the United States has laid claim to ownership of space resources through the American Space Act of 2015, that only applies to companies owned by U.S. citizens.

“It is a Wild West out there,” says McMullen. “The industry would like to see protection from liability to reduce their risk. But we don’t want the government to make crazy restrictions,” said McMullen.

Opportunities in outer space are endless, especially on a commercial spectrum for those with the means and know how to do it. While the government is commercial space’s biggest customer right now, that may change. Soon, we may see interstellar traffic with people living in the cosmos. Remember that it started with the big disruptors. ■

MORE ABOUT COMMERCIAL SPACE

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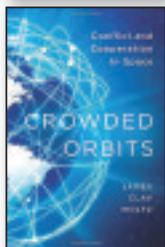
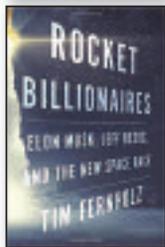
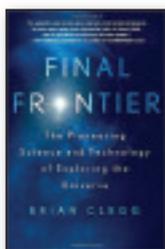
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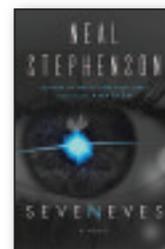
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