

# Space: The New Frontier!

*By Stephen Baird*

*Hotel guests would see the sun rise 15 times a day and use Velcro suits to crawl around their pod rooms by sticking themselves to the walls like Spiderman when they were tired of floating around in zero gravity.*

**T**he high cost of space transportation is generally perceived as one of the biggest obstacles, if not the biggest, to the growth of space commercialization, tourism, and exploration. In the simplest of terms: it's too expensive! And that's mainly because launch vehicles are expendable—either entirely, like satellite launchers, or partly, like the space shuttle. Civil space agencies, entrepreneurs, policy makers, legislators, satellite operators, and others continue to focus on the extremely high cost of space transportation. Even though they have many different reasons for being interested in launch costs, they all share the same goal—lowering the cost of transporting payloads, including humans, into space.

History was made on October 4, 2004 when SpaceShipOne, the first privately funded space ship, successfully flew to the brink of space and back for the second time in five days, capturing the \$10 million Ansari X Prize. The X

Prize Foundation is an educational nonprofit institute whose mission is to create radical breakthroughs for the benefit of humanity. The successful achievement of the “X Prize” has sparked a new wave of public interest in the use of space for commercial purposes. At the same time, a new approach to the government's procurement of space services has stimulated renewed interest and investment in entrepreneurial space ventures. The most prominent example of this is NASA's (National Aeronautics and Space Administration) Commercial Orbital Transportation Services (COTS) program, which aims to use commercially available space vehicles to transport crews and cargo to low-earth orbit, primarily the International Space Station (NASA, 2007).

A growing number of privately funded companies are now poised to establish a robust commercial space transportation industry. This new space business frontier affords entrepreneurial opportunities to engage profitably in low-earth orbit, between the earth and the moon and on the lunar surface itself. Energy, transportation, media, manufacturing, tourism—all these and many more industries hold significant potential as many new private sector initiatives vie to develop space and space infrastructures without funding from NASA or other government agencies. Free enterprise is the key to space exploration if it is to become a daily reality in a world that to date has seen fewer than 500 astronauts.

## Space Transportation

Space transportation capabilities—encompassing spaceports and delivery systems to and from space—are the critical foundation upon which access to and the use of space



depend. The space transportation industry consists of many elements, including launch vehicle manufacturers, operators, suppliers, and spaceport facilities. It serves commercial markets as well as government needs. The growing demand for satellite-based services, from communications and broadcasting to navigation and remote sensing, have contributed to the development of a competitive, worldwide market for commercial launch services. Additionally, renewed interest in human space travel and low-cost access to space have attracted several entrepreneurial start-up companies to the scene (Office, 2007). Prior to the early 1980s there was no commercial space transportation industry. Only the United States launched commercial satellites, and these were launched on vehicles owned by the government, including NASA's Space Shuttle. Events of the 1980s, including the birth of a European commercial launch services organization (Arianespace), recognition of commercial space transportation's value by U.S. government officials, and

the ban of commercial payloads from flying aboard the Space Shuttle after the Challenger disaster, promoted the development of the space transportation industry in the United States. By the year 2002, U.S. commercial space transportation and the services and industries it enables accounted for more than \$95 billion in economic activity (Federal, 2007). Commercial launches today are provided by expendable launch vehicles, which are used only once. Many companies and entrepreneurs, however, are working to develop reusable launch vehicles that could be used multiple times. SpaceShipOne's rocket flights proved that the private sector could put humans into space and that private investors were willing to put millions of dollars into such feats.

### Spaceports

Another growing part of the commercial space transportation industry in the United States is the development of private or state-operated launch, reentry,

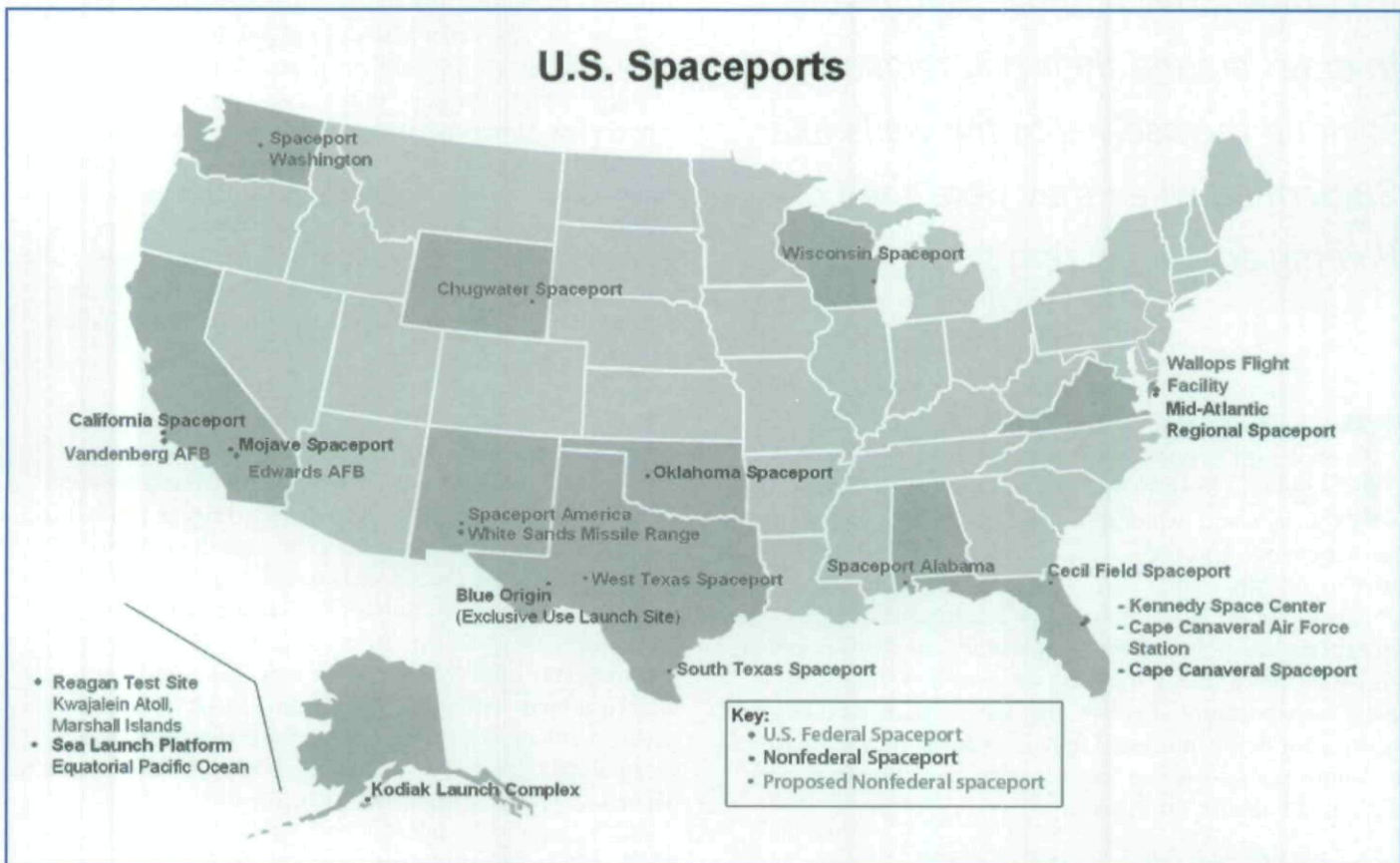


Figure 1. With six nonfederal spaceports already licensed and an additional eight in the process of applying for licenses, this map illustrates the spaceport boom, a highly visible sign of how quickly the commercial space sector is growing. Illustration courtesy of the Federal Aviation Administration — [www.faa.gov/about/office\\_org/headquarters\\_offices/ast/industry/media/spaceports.gif](http://www.faa.gov/about/office_org/headquarters_offices/ast/industry/media/spaceports.gif)



and processing sites known as “spaceports.” The spaceport boom is a highly visible sign of how quickly the commercial space sector is growing. The emergence of entrepreneurial space ventures has fostered demand for a separate class of space facilities devoted to commercial orbital and suborbital launches. Several states are developing commercial spaceports within their borders. According to the Federal Aviation Administration, the United States has six “non-federal” spaceports in operation—facilities not run by the military or NASA. Additionally, eight more nonfederal spaceports have been proposed and may be in development, while still others are springing up in Europe, Canada, Australia, China, and elsewhere (Federal, 2007). The six licensed spaceports in the United States are:

1. *California Spaceport at Vandenberg Air Force Base.* California Spaceport became the first commercial spaceport licensed by the FAA on September 19, 1996. Operated and managed by Spaceport Systems International, the Spaceport is a major provider of payload processing and launch services for both commercial and government users. In March of 2007 a government contract was awarded enabling California Spaceport to play an ongoing role in the “swords to plowshares” project of transitioning retired Peacekeeper missiles into launch vehicles for satellites (Spaceport, 2007).
2. *Spaceport Florida at Cape Canaveral Air Force Station.* Space Florida, created on May 30, 2006, consolidates Florida’s space and aerospace entities and coordinates all space-related issues. Spaceport Florida has an unmatched full-service transportation infrastructure for supporting commercial aerospace projects (Federal, 2007).
3. *Mid-Atlantic Regional Spaceport (MARS).* Virginia and Maryland have joined forces to operate MARS, located on Wallops Island and formerly known as the Virginia Space Flight Center, to offer a “one-stop shopping” place for low-cost, safe, reliable, user-friendly space launch facilities and services for commercial, government, and scientific/academic users, both foreign and domestic. The spaceport plans to continue building its reputation for small-to medium-sized low-earth orbit (LEO) launches and to eventually host cargo delivery and space tourism flights (Mid-Atlantic, 2007).
4. *Kodiak Launch Complex on Kodiak Island, Alaska.* The Kodiak Launch Complex is operated by the Alaska Aerospace Development Corporation and is advertised as one of the best locations in the world for polar launch operations due to its wide launch azimuth and unobstructed downrange flight path. KLC’s location and low-cost operations are suitable for launching telecommunications, remote sensing, and space science

payloads into low-earth polar orbits. On September 28, 2007, a mock warhead fired from KLC was successfully intercepted by an antimissile interceptor launched from Vandenberg Air Force Base (Federal, 2007).

5. *Mojave Air and Spaceport in California.* The Mojave Spaceport became the first inland launch site licensed by the FAA on June 17, 2004. It is also the first facility to be licensed in the United States for horizontal launches of reusable spacecraft. It is the only spaceport from which there have been privately-funded human spaceflights. Besides being a general-use public airport, Mojave has three main areas of activity: flight-testing, space industry development, and aircraft heavy maintenance and storage. Mojave is also involved in developing plans for a crash fire rescue response facility that would provide immediate support for reusable launch vehicles (RLVs) that land with technical difficulties or crew medical emergencies (Federal, 2007).
6. *Oklahoma Spaceport.* After seven years of development, the Oklahoma Spaceport became the sixth commercial spaceport licensed by the FAA in June 2006. The Oklahoma Spaceport specializes in horizontal takeoffs and landings of RLVs. The spaceport is the first inland launch site to use the National Airspace System (NAS), an advantage that eliminates the possible conflicts of military airspace and operations (Oklahoma, 2007).

These spaceports can provide space transportation service providers and their customers with an alternative to traditional U.S. federal launch sites and ranges operated by either the U.S. Air Force or the National Aeronautics and Space Administration (NASA). Although commercial spaceports are still in their infancy, the steady growth in the number of vehicles under development that aim to serve both the commercial orbital and reusable suborbital launch sector promise significant markets. This growth combined with the ongoing spaceport infrastructure improvements indicate that the outlook for U.S. commercial spaceports is strong and poised to expand over the next five to ten years. Overall, some three dozen operational spaceports are spread out around the planet, each one poised and ready to take advantage of the promise of scheduled spaceliners blasting off with ticketed passengers onboard.

## Space Tourism

“Spaceflight has been almost exclusively a spectator sport since it began, but now the gates are about to be opened for public participation,” remarked Patricia Smith, Associate Administrator for the Office of Commercial Transportation at a conference in Washington on March 28, 2007. A number of companies are at work to develop



reusable launch vehicles to be used to carry people to space, thereby creating a commercial space tourism industry. The establishment of a profitable space tourism industry depends on the development of vehicles capable of launching people into space, returning them to earth, and being turned around quickly for another launch. These vehicles will have to be designed with reliability, safety, and comfort in mind. Before 2004, no privately operated manned spaceflight had ever occurred. The only private individuals to journey into space went as space tourists in the Space Shuttle or on Russian Soyuz launch vehicle flights to Mir or the International Space Station. All private individuals who flew to space before Dennis Tito's self-financed International Space Station visit in 2001 had been sponsored by their home governments. Those trips included U.S. Congressman Bill Nelson's January 1986 flight on the Space Shuttle *Columbia* and Japanese television reporter Toyohiro Akiyama's 1990 flight to the Mir Space Station. To date, space tourism opportunities are limited and very expensive, with only the Russian Space Agency providing transport, and flights being brokered by the only company to have sent paying customers to space, U.S.-based Space Adventures, Ltd., headquartered in Vienna, Virginia and operating in conjunction with the Federal Space Agency of the Russian Federation and Rocket and Space Corporation Energia. Space Adventures facilitated the flights for the world's first private space explorers: Dennis Tito who flew in 2001; Mark Shuttleworth, a South African computer millionaire, in 2002; Gregory Olsen, a trained scientist, followed in 2005; Anousheh Ansari, an Iranian American, in 2006; and Charles Simonyi, an American billionaire of Hungarian Descent, the latest to join the space club in 2007.

Eric Anderson, president of Space Adventures, has remarked that, "Countries around the world are just realizing the enormous commercial possibilities of space tourism." The market potential for suborbital spaceflights alone, Anderson suggests, is estimated at \$1 billion annually. Suborbital spaceflights will offer millions of people the opportunity to experience space travel. By the end of the decade, in addition to the International Space Station—one flight line of business for Space Adventures—"we envision operational suborbital spaceflights and the launch of the first commercial circumlunar spaceflight" (David, 2007). Space Adventures is not the only company selling tickets to space. When Virgin Galactic (a company founded by Richard Branson in partnership with Burt Rutan of Scaled Composites to take tourists on brief trips to the edge of space), was ready to bring their space travel venture to the paying public, they recognized the important role that travel agents would play in the sales process, and they chose

to work with just one agency network—Virtuoso, whose consultants are renowned for selling experiential travel. Sir Richard Branson has said that more than 200 passengers have confirmed their reservations for spaceflight at a cost of US \$200,000 each, and that some 85,000 people have expressed interest (Schwartz, 2008).

On January 24, 2008, at a press conference held at the American Museum of Natural History in Manhattan, Sir Richard Branson, owner of Virgin Galactic, along with Burt Rutan, the creator of SpaceShipOne, declared that, "2008 will be the year of the spaceship." The two were in New York to show detailed models of the bigger SpaceShipTwo and its carrier airplane, WhiteKnightTwo. WhiteKnightTwo is a two-fuselage, four-engine plane that will ferry the smaller spacecraft high into the sky and then release it. The spacecraft pilot then fires the craft's rocket engine, which burns a combination of nitrous oxide and a rubber-based solid fuel, and shoots the vehicle upward to an altitude of more than 68 miles, the realm of space. Once in space, the pilot will activate the craft's innovative feathered wing, which will rotate into a position that greatly increases aerodynamic drag and slows the craft for a glider landing back at the spaceport. SpaceShipTwo will not require a space shuttle-like heat shield for atmospheric reentry as it will not experience the extreme aerodynamic heating experienced during reentry at orbital velocities. Virgin Galactic will be



Figure 2. Artist conception of a nonfederal commercial spaceport. Illustration courtesy of Rocketplane Kistler.



the first private space tourism company to regularly send civilians into space, training them for three days before their launch. Space flights will last approximately 2.5 hours, carry six passengers, and reach a speed of Mach 3. Officials at the press conference said that the WhiteKnight aircraft is 70 percent complete and that SpaceShipTwo is 60 percent complete. Test flights of both planes could occur this year. Passenger flights are not expected to begin before late 2009 or 2010 (Schwartz, 2008). Two other U.S.-based rocket companies, Rocketplane Kistler and SpaceX, are scheduled to begin testing new orbital vehicles this year. In 2006, NASA awarded nearly \$500 million to these two companies to develop and demonstrate "test vehicles" that could take cargo and crew to the International Space Station. If these prototypes perform, NASA has pledged to buy operational versions (Klerkx, 2007). SpaceX is also intricately involved with Bigelow Aerospace. Bigelow Aerospace is a North Las Vegas, Nevada space technology startup company that is

pioneering work on expandable space station modules. SpaceX's reusable Falcon 9 rocket, scheduled to be launched by the middle of this year, is planned to carry the prototype expandable module (based on the formerly NASA-owned Transhab design) Sundancer I, Bigelow Aerospace's first human habitable spacecraft (David, 2007). Bigelow Aerospace is ready to exploit its long-term business plan for space habitats. (See Figures 2 and 3.)

### Space Hotels

As an entrepreneurial space development company, Bigelow Aerospace has as its primary focus the development of habitable complexes for a multitude of space users. American motel tycoon Robert Bigelow's company, Bigelow Aerospace, launched its first inflatable habitat module, Genesis I, on July 12, 2006. Its second test module, Genesis II, was launched June 28, 2007, and plans are in place to launch the first commercial space station, Sundancer I or

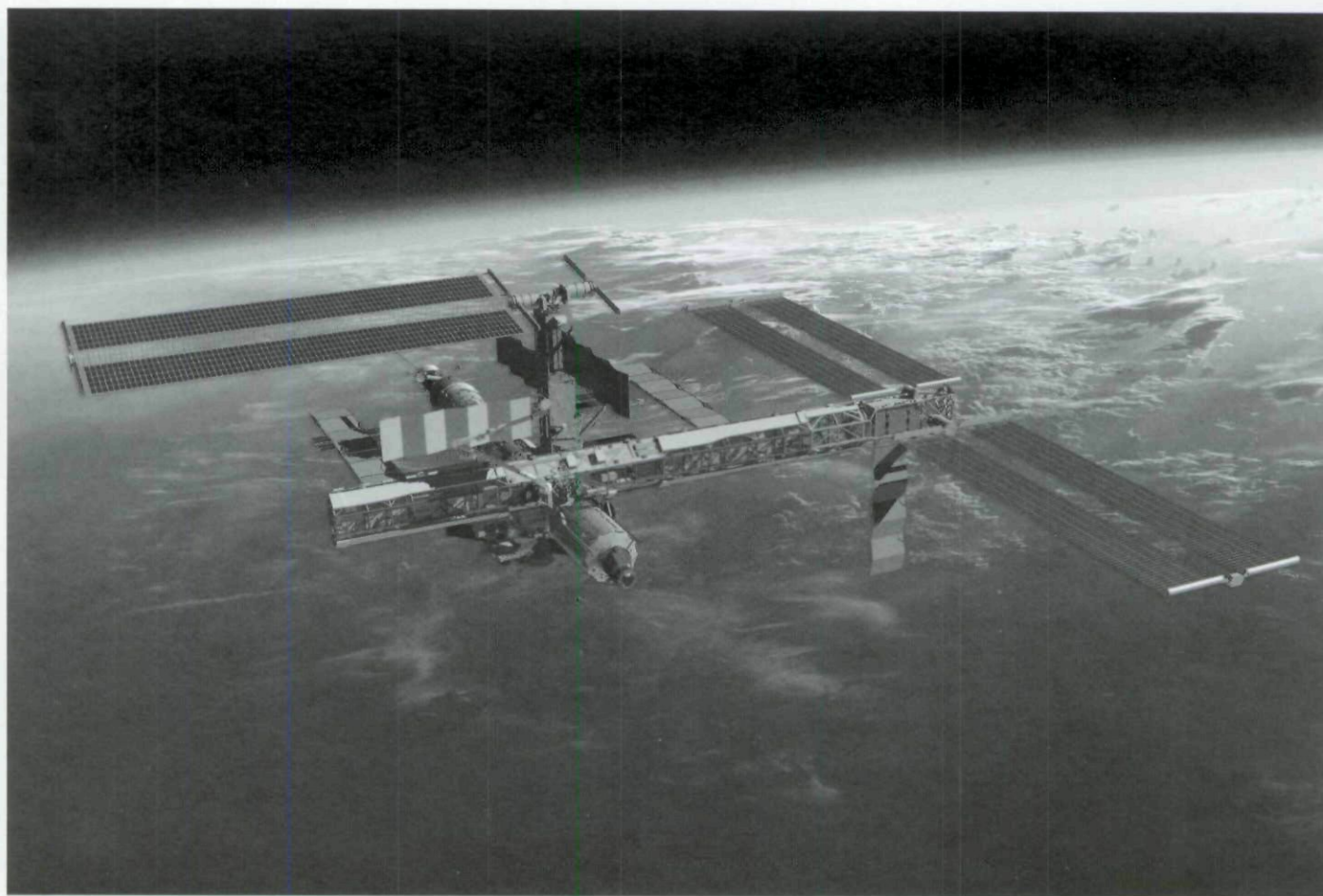


Figure 3. Artist conception of a privately funded spacecraft preparing to dock with the International Space Station. Image courtesy of Rocketplane Kistler.



Nautilus, by 2010. Genesis I proved that an expandable habitat can survive the rigors of the launch environment and validated Aerospace's fundamental designs and deployment strategy. The spacecraft remains in orbit and is operational today, continuing to produce invaluable images, videos, and data for Bigelow Aerospace. The Genesis II module sports a similar look as its Genesis I predecessor but carries an array of new sensors and avionics to monitor and control the spacecraft while in orbit. The sensors will watch over internal pressure, temperature, vehicle altitude control, and radiation levels. The Genesis modules are one-third-scale versions of Bigelow Aerospace's planned manned orbital space stations, expected to be launched in 2010. Bigelow Aerospace expects its space habitat modules to be used for activities like microgravity research, space manufacturing, and space tourism, with modules serving as orbital hotels. To promote private manned launch efforts, Bigelow has offered the \$50 million America's Space Prize for the first U.S.-based, privately funded team to launch a manned reusable spacecraft to orbit with the capability of docking with Aerospace's Nautilus space modules (Malik, 2007). Bigelow Aerospace isn't the only company planning on being in the Space Hotel business. An American company, Galactic Suite, Ltd., along with private investors in Japan and the United Emirates, have invested \$3 billion to turn science fiction fantasy into reality.

Galactic Suite will be an orbital hotel scheduled to be operational by 2012. Guests will pay \$4 million each for a three-day stay aboard the orbital equivalent of a three-bedroom boutique hotel. Before the flight, guests would get eight weeks of intensive training at a space camp located on a tropical island, and then board a private shuttle for their ride to a space hotel. Hotel guests would see the sun rise 15 times a day and use Velcro suits to crawl around their pod rooms by sticking themselves to the walls like Spiderman when they were tired of floating around in zero gravity. To take a zero-gravity shower, guests would enter a spa room in which cleansing bubbles of water float around, and when guests were not admiring the views from their portholes, they would take part in scientific experiments on space travel. Xavier Claramunt, the company director and a former aerospace engineer, has said that the market for orbital space travel could be substantial, calculating that there are 40,000 people in the world who could afford to stay at the hotel. Galactic Suite's plans depend on the development of a reliable, privately funded system to deliver payloads and people to orbit (Kazan, 2007).

Galactic Suite and Bigelow Aerospace won't have a monopoly on space hotels. Another company expressing

interest in constructing space hotels is Excalibur Almaz. Excalibur Almaz is a private spaceflight company that plans to orbit manned spacecraft by using modernized TKS space capsules and Almaz space stations, derived from the formerly secret Soviet space program. The TKS-derived space capsules resemble American Gemini capsules, but unlike the two-person Gemini, they are reusable and can carry three passengers or operate autonomously. They can launch atop any of several rockets of various space-launching companies, and they possess a Launch Escape System to ensure the safety of their passengers. The Almaz-derived space stations are closely related to the modules used to construct the International Space Station. Excalibur Almaz's space stations will feature the largest windows ever constructed for a spacecraft. Excalibur Almaz is based in Douglas, Isle of Man, with offices in Houston and Moscow. The company owns its spacecraft but contracts expert services, including refurbishment, launch, control, and recovery (Wikipedia, 2007).

If the technical and economic obstacles can be overcome, the market for space hotels could become huge. Informal polls taken by the companies currently in the process of developing space habitats for tourists indicate that a substantial number of people would love to visit space if the price came down. Among the main draws would be the fantastic view of the Earth, visible 24/7, and the experience of weightlessness, which has been described by astronauts as being extremely intense and mind-boggling.

## Summary

The idea that ordinary citizens will have the opportunity for spaceflight is a recent phenomenon being enabled by spirited entrepreneurs who are risking their own fortunes with bare-bones innovations and the vague promise of vast riches. Space entrepreneurs believe that they—not NASA or the aerospace giants—represent the true future of activity in space. Now they are poised to prove themselves by opening the heavens to private enterprise. Early space entrepreneurs were often science fiction enthusiasts with tremendous passion but few engineering credentials. Today's mavericks share that same passion but are backing it up with something that will make the difference: mountains of cash (Klerkx, 2007).

A private orbital habitat prototype is in Earth orbit, SpaceShipTwo is nearly complete and ready for launching, over 200 people have booked flights, and worldwide spaceports are standing by ready to launch into space a new type of space explorer—ordinary people ready to take one giant leap toward the stars. There is one more matter that



needs to be addressed: Spaceflight is inherently risky—*fly at your own risk!*

## Addressing Standards for Technological Literacy

Space tourism is cutting-edge technology. By exposing our future spacefarers to this technology, we will be supporting many of the standards set forth in *Standards for Technological Literacy*; for example, Standard 3. The relationships among technologies and the connections between technology and other fields can be explored as students investigate all the different industries and engineering processes involved in attaining cost-effective transport of humans and cargo into space. The Design Standards are addressed as students are exposed to each space entrepreneur company's design strategies for launching spacecraft and space habitats. As innovative concepts are brought to fruition, students will be amazed at the spin-off products that result, thus delving deeply into The Designed World (ITEA, 2000/2002/2007).

A logical place to have students begin their exploration and to generate excitement about the near-future possibilities of space travel would be the Internet. Several excellent websites are listed to help students get started:

- The X Prize Foundation and the Google Lunar X-Prize – [www.xprize.org/](http://www.xprize.org/)
- Lesson plans – [www.googlelunarxprize.org/lunar/education/learning-guides](http://www.googlelunarxprize.org/lunar/education/learning-guides)
- Life in Space: The International Space Station – <http://school.discoveryeducation.com/lessonplans/programs/iss/>

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