Virgin Galactic’s *WhiteKnightOne* carries *SpaceShipOne*, the spacecraft that in 2004 made the first privately funded human spaceflight in history. Space may become more accessible to more people in the coming decades.

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The greatest gain from space travel consists in the extension of our knowledge. In a hundred years this newly won knowledge will pay huge and unexpected dividends.

Wernher von Braun
Dennis Tito studied aeronautics at New York University, and for a while after graduation he worked for NASA. But his love of space was eclipsed by his desire to earn more money. So he left NASA and started his own company. That company today manages billions of dollars in investments.

Tito never lost sight of his desire to go into space, though. In 2001 he paid Russia something between $12 million to $20 million for the chance to fly to the International Space Station. Tito spent a week in space working on experiments. When he returned he said more people should go to space. He said in an interview before his launch that if artists such as musicians or writers could go up and express what they see, more people would be fascinated by space. He testified before Congress, urging for greater access to space for ordinary people.

The trip was not all a walk in the park for Tito. NASA strongly objected to it, saying the International Space Station was no place for amateurs. The agency refused to help train him alongside the Russian cosmonauts traveling with him. But NASA finally agreed only four days before launch that he could visit the space station.
Commercial Satellites and Launches

It's become commonplace to hear that another satellite has been launched into space. Indeed, NASA isn't even the only group of Americans sending satellites into orbit. Private companies have been building and launching them for years.

The Satellite Development of RCA, AT&T, and the Hughes Aircraft Company

When the earthquakes hit Haiti and Chile in 2010, people around the world instantly saw images of the destruction. You and your friends don't think anything of this. But 60 years ago, live television reports from the far corners of the world were a rare event.

Half a century ago, a newspaper journalist reporting from another country would send his or her article by underwater cable to an editor back in the United States. Today, that same journalist simply types up the story on a computer, hits the Send button, and a satellite almost instantly transmits it back to a US-based editor. TV news reporters transmit images by satellite routinely from places as far away as Afghanistan and China. Satellites have changed the way much in the world operates.

In the 1950s and 1960s several commercial companies began exploring ways to improve national and international communications using satellites. What began with enhanced radio and telephone communications now allows you to watch the World Cup live from South Africa.

RCA

RCA, or Radio Corporation of America, grew from the US government's recognized need for a domestic radio and telegraph company toward the end of World War I. The company owned the NBC radio and TV networks for many years. It eventually became instrumental in transmitting images from around the world, as well as from outer space, to eager audiences inside American homes.
RCA satellites broadcast the first images between the United States and Europe. They conducted the first radio communications between the United States and Latin America. An RCA camera filmed the first live pictures from space, during the *Apollo 7* mission. And an RCA radio, which astronaut Neil Armstrong carried in a backpack, was the first to transmit spoken words from the Moon back to Earth.

In December 1957 an *Atlas* missile took an RCA-manufactured satellite into space. This satellite delivered the first successful satellite radio relay to Earth. The company developed new technologies for NASA, and in 1962 sent six weather satellites into orbit.

In 1961 when NASA requested bids on a medium-orbit active communications satellite, RCA won the contract. It built three, named *Relay*. RCA designed them to have **redundancy**—duplication of each critical part. So each satellite had two sets of every major system of circuits. NASA launched *Relay 1* in 1962, and *Relay 2* in 1964 atop *Delta-Thor* rockets with the following goals in mind:

1. to test transoceanic—across ocean—communications
2. to measure radiation
3. to determine how much damage radiation might do to a satellite.

From their elliptical orbits the satellites successfully retransmitted television, telephone, and digital signals. When a part failed on *Relay 1*, mission control turned to one of its redundant parts, which fixed the problem. *Relay 1* went on to transmit live television signals of Winston Churchill’s honorary US citizenship ceremony from Britain to the United States in March 1963. The life expectancy of the satellite was a year. It exceeded expectations and worked for well more than two. *Relay 2*, with improvements over the first satellite, broadcast part of the 1964 Winter Olympics taking place in Innsbruck, Austria. NASA never used the backup satellite, *Relay 3* because of the success of the first two.
AT&T

AT&T—originally the American Telephone and Telegraph Company—was another commercial company involved in communications satellite development. It achieved many milestones. Unlike RCA, the business paid out of its own pocket to develop its medium-orbit satellite named Telstar. And it paid NASA $3 million to launch it. Telstar was 34.5 inches (84 centimeters) long and weighed 170 pounds (77 kilograms).

When it launched in July 1962, Telstar was the first privately sponsored satellite launched into space. Many other firsts would follow, including the first live television broadcast across the ocean to France. Also, Telstar was responsible for the first telephone call transmitted through space, from AT&T President Frederick Kappel to then–Vice President Lyndon Johnson. Like Relay, Telstar was a huge success. It even inspired a popular song. It went out of service on 21 February 1963. AT&T launched another satellite, Telstar II, which also was successful. But the company turned its attention away from satellites after that second experiment.

The Hughes Aircraft Company

While Telstar and Relay were big hits, their orbits around the globe called for expensive antennas on the ground. These antennas were costly because they constantly had to rotate to follow the satellite’s orbital path. Hughes Aircraft Company, yet another big player in developing commercial satellites, had an idea to bring the price down. It would place a satellite into geosynchronous orbit.
The famous American aviator Howard Hughes founded the company in 1935. In 1961 NASA awarded Hughes a contract to build its geosynchronous communications satellite, called Syncom. By 1964 two had operated successfully in space. Antennas could remain fixed in place on the ground as the satellites “remained in place” overhead.

Then in 1965 the company launched the communications satellite Early Bird. Hughes based its design on Syncom. A private company named Communications Satellite Corporation (COMSAT) had contracted with Hughes for Early Bird. The satellite, also known as Intelsat 1, was placed in synchronous orbit from Cape Canaveral on 6 April. In late June it sent its first transmissions back to Earth from 22,300 miles (35,700 km) up in space. It could deliver several kinds of signals, including telephone and television.

Early Bird weighed 85 pounds (39 kilograms). Engineers estimated it would work for 18 months, but it lasted four years. One of Early Bird’s important features was that it provided line-of-sight communications between Europe and North America. Line of sight in telecommunications refers to a clear straight path for transmitting between sender and receiver. Because satellites travel many miles above Earth they can pick up signals from over a massive area on the planet. An antenna placed on a mountain cannot reach nearly as far.

Furthermore, some signals, such as television signals, must travel in a straight line. A television signal cannot curve around the Earth. A satellite can receive and transmit signals in a straight line from its orbit in space to stations on Earth. But ground antennas don’t have that advantage.

COMSAT placed Early Bird on reserve status in January 1969 but brought it back briefly during the summer to help with the Apollo 11 landing on the Moon. It remains in orbit today, on inactive status.
The Commercial Use of Communications Satellites

COMSAT’s contract for *Early Bird* paved the way for more private companies to enter the satellite business. In 1964, about a year before *Early Bird’s* launch, COMSAT added telecommunications agencies from 17 other countries to form one large commercial satellite company. It was called the International Telecommunications Satellite Organization (INTELSAT). COMSAT remained this agency’s main manager, however.

Also by the time *Early Bird* launched, countries had placed ground stations around the globe to transmit signals to and from satellites. These Earth stations sat in the United Kingdom, France, Germany, Italy, Brazil, and France. INTELSAT formed, in part, to manage this new global telecommunications system.

In the beginning, COMSAT/INTELSAT mostly supported NASA operations. But as time went on, it took on a more commercial aspect as well. For instance, in 1969 the organization’s Intelsat III satellite series gave the Indian Ocean coverage for the first time. When this happened the world was for the first time globally connected via satellite. Only days later nearly 500 million people across the globe watched the Apollo 11 landing on the Moon because of these Intelsat satellites.

Furthermore, in 1976, COMSAT launched a new satellite series, Marisat. Marisat provided communication services to the US Navy, as well as to commercial shipping and other offshore businesses. In 1979 a United Nations body organized the International Maritime Satellite Organization (INMARSAT) to support communications on the seas as INTELSAT did on land. In the 1980s the Europeans launched satellites called Marecs, which were comparable to Marisat. In the beginning INMARSAT used both the US and European satellites before eventually launching its own in 1990.

Telesat Canada, a private Canadian company, produced the first domestic communications satellites. It named these satellites Anik. The first launched in 1972. RCA leased circuits on Anik to provide the same service to the United States until it developed its own satellite in 1975. Western Union developed the first American domestic communications satellite, Westar 1, which it launched in 1974. These satellites were all used at first for voice and data, but they quickly developed into prime carriers for television.

The costs of building and launching satellites have dramatically dropped over the years for both operators and consumers. For example, the circuits themselves, which are housed in satellites and carry telephone calls, once cost operators about $100,000 each. Now they have fallen to a few thousand dollars. And while customers used to pay about $10 per minute for a call, they now pay just pennies.
Antennas on the ground have also fallen in price and size. More-powerful satellite transmissions mean that Earth stations no longer need 100-foot (30.5-meter) dish reflectors at $10 million each (in 1960 dollars). By 1990, such dishes were usually about 15 feet (4.6 meters) across and cost only $30,000. In 2010, you could buy a 10-foot (three-meter) dish for as little as $879. And home antennas for satellite TV and radio reception cost even less.

**Commercial Launches for NASA**

In the past, NASA has been the owner and operator of spacecraft designed to transport humans and cargo to and from the space station. Now it's looking for help from private companies to provide those services.
NASA’s Commercial Crew and Cargo Program (C3PO) provides both funding and technology to help private companies develop safe and reliable space transportation. Currently its Commercial Orbital Transportation Services (COTS) has partnerships with US industry totaling $500 million for transporting commercial cargo. Likewise, it has invested $50 million for commercial crew transportation.

One company, Space Exploration Technologies Corp. (SpaceX), has developed two partially reusable launch vehicles, the **Falcon 1**, and the larger **Falcon 9**. The **Falcon 1** became the first privately funded rocket to reach orbit in 2008. It carried its first commercial payload into orbit the next year. **Falcon 9** completed a successful test firing at Cape Canaveral in March 2010. SpaceX is also developing the **Dragon** space capsule, which could carry astronauts and supplies to the International Space Station.

Another company involved is Orbital, which has developed several launch vehicles. The small **Pegasus**, itself launched from an airplane, has launched more than 80 satellites. **Taurus** has conducted six successful missions out of eight attempts, launching 13 satellites. The **Minotaur** has delivered 30 satellites into orbit. The **Taurus II** launch vehicle is scheduled to conduct its first mission in 2011.

Other companies developing space systems and technology include:

- **PlanetSpace**, which is developing launch vehicles and the **Silver Dart** orbital glider
- **SpaceDev**, which has supplied 2,500 devices on some 250 space missions
- **Bigelow Aerospace**, which has launched the **Genesis I** and **Genesis II** experimental spacecraft into Earth orbit
- **Well-known aviation and space technology companies such as Boeing, Lockheed Martin, and Northrop Grumman.**
The Possibility of Space Tourism

One price tag that’s out of this world and probably won’t drop anytime soon is a ride into space as a private individual. Space tourism is actually quite a new phenomenon. For those with enough money, paying a hefty fee to be a space tourist can be the way to go. As with satellites, the price will come down as technology improves. And this in turn will make space tourism accessible to more people.

The Growing Interest in Space Travel

Movies such as *2001: A Space Odyssey* fascinated ordinary people. It gave them a desire to travel to outer space. Until recently this was not an option. Those who traveled beyond the Earth’s boundaries were almost all career astronauts. Teacher Christa McAuliffe, who died in the *Challenger* explosion, would have been a notable exception—perhaps the first of many shuttle passengers who did not work full-time as astronauts.

When the Soviet Union broke up, its space program took a tremendous hit. To help raise revenue, Russia began selling seats on its *Soyuz* capsules traveling to the International Space Station (ISS). So far seven people have paid upwards of $20 million each to travel to the ISS. The first was American Dennis Tito in 2001. These seven people have performed experiments while at the International Space Station. Many object to the term “space tourist,” instead preferring “private astronaut.” The six men and one woman have been of various nationalities, including an Iranian-American, a Canadian, and a Malaysian, among others.

In March 2010 Russia announced that because NASA was retiring its space shuttles later in the year, it would suspend its space tourist program indefinitely. Without the space shuttles to carry crews back and forth to the International Space Station, Russia would need all available seats on *Soyuz* for cosmonauts and other astronauts.
Besides Russia, several private companies are developing the technology to take private citizens to outer space. The US government’s Federal Aviation Administration, tasked with ensuring safety in the air and enforcing aviation rules, will issue space launch permits to those companies taking off from the United States.

**Plans for Space Tourism**

Even if the Russians stop sending tourists into space, those who wish to reach toward the stars may soon have other options. A joint venture between American Burt Rutan and British billionaire Sir Richard Branson aims to offer the first commercial travel to space.

Aside from Rutan and Branson, however, other companies and groups are looking to expand service to space, much the way airlines shuttle people around the globe. Instead of traveling to the ISS, which is too expensive except for the mega-wealthy, these companies are working on vehicles to transport paying customers on suborbital flights. These trips would cost about $200,000 and last a matter of hours at most, including just a few minutes in microgravity.

*Spacecraft designer Burt Rutan (left) and British billionaire Sir Richard Branson (right) are behind efforts to offer commercial travel to space.*

© Joe C. Hong/AP Photos
Plans even include a commercial hotel in space at some point, where travelers could stop over. According to Reuters, the Galactic Suite Space Resort, based in Barcelona, Spain, says a three-night stay at its hotel will cost $4.4 million. The price includes an eight-week training course. During their stay, guests would see the Sun rise 15 times a day and travel around the world every 18 minutes. They would wear Velcro suits so they can crawl around their rooms by sticking themselves to the walls. The first pod in space would hold four guests and two astronaut-pilots.

The VSS Enterprise

If you Google Branson, you might wonder if there is anything he doesn’t do. The British billionaire has a successful airline, a mobile communications firm, a music line, and countless other ventures. At one time he even sold a cola he hoped would rival Coke and Pepsi.

CHAPTER 13  Commercial Use of Space
He has teamed up with Rutan to develop the first private commercial spaceship. It will travel from New Mexico to space. Rutan is well known as the designer of Voyager, the first aircraft to circle the globe without refueling. He also won a $10 million prize for his development of SpaceShipOne, the first privately built and manned spacecraft to reach outer space twice in two weeks.

The two men have joined to bring space tourism to non-astronauts. Branson and Rutan announced the joint venture in 2005. Since then more than 300 people have signed up to take part—and 80,000 more are on a waiting list. The first trip for VSS (Virgin Space Ship) Enterprise may launch as early as 2011. The spacecraft made its first successful test flight on 22 March 2010, and spent about three hours at 45,000 feet (15,000 meters). When it is ready for passengers, its voyage will begin in the Mojave Desert, where an airplane will lift off with the spacecraft. The two will travel together, reaching an altitude of 50,000 feet (15,240 meters). There they will separate, with a rocket motor thrusting VSS Enterprise to an altitude of 60 miles (97 km).

The tourists will experience weightlessness for a period of about four minutes. They will also be able to see the Earth curving below their windows.
Another commercial avenue for space exploration is mining asteroids and moons for their natural resources. These resources include everything from precious metals to water. Companies could make a lot of money extracting these materials if only a safe and cost-effective way could be found. These metals and other supplies could also support colonies on the Moon and perhaps even Mars.

In Chapter 12 you read about NASA’s NEAR spacecraft, which landed on the asteroid Eros in 2001. NASA scientists fired its engines for a controlled descent at only 5.28 feet (1.6 meters) per second. Engineers expected that the spacecraft would crash-land, but it survived and its instruments sent back details on Eros for more than two weeks. So human beings now know that a gentle landing on an asteroid is possible. But just how to get a manned mission safely to one of these orbiting objects is the next great leap.

CHAPTER 13  Commercial Use of Space
The Mineral Composition of Asteroids

A virtually endless supply of asteroids orbits in the Solar System. While most remain in the asteroid belt between Mars and Jupiter, a few now and then fly near Earth. In fact, sometimes they approach nearer than the Moon.

Scientists have a number of ways to study the composition of asteroids. They’ve orbited and landed on Eros. Back in 1991 NASA’s Galileo probe took dozens of photos of the asteroid Gaspara. Astronomers analyze in their labs meteorites that came from asteroids. And they rely on instruments that can read the way asteroids reflect sunlight. This reflected light helps scientists determine their makeup.

Scientists group asteroids into three categories. The most common are C-Types. These include 75 percent of the Solar System’s asteroids. The same elements make up these asteroids as make up the Sun, except that they don’t contain such unstable elements as hydrogen or helium. The S-Type includes 17 percent of the asteroids. These are made of nickel, iron, and magnesium. Finally, the remaining are M-Type, made of nickel and iron, but mostly iron.

Scientists also speculate that some asteroids may contain water and oxygen. Human colonies in space could use these necessities of life to survive. Furthermore, a number of asteroids might also be rich in such precious metals as gold or platinum.
The Estimated Mineral Wealth of Asteroids

It would not be practical at this point to collect the asteroids’ precious metals and other bounties and bring them back to Earth for use. Instead scientists hope to use the natural resources in space for things such as rocket propellant or developing space structures. The ability to use resources available in space would save the millions of dollars it would cost to transport them there from Earth. This would allow for greater exploration activity.

In any event, acquiring these metals would be challenging. You might wonder why anyone would want to go to such extremes to mine metals (Figure 1.2). The explanation is financial: Scientists estimate that the amount of minerals and resources asteroids contain would be enough to give every single man, woman, and child on Earth $100 billion. According to one estimate, an asteroid 0.62 miles (1 km) across might have about 30 million tons (27 million metric tons) of nickel and 7,500 tons (6,803 metric tons) of platinum, among other metals. This amount of platinum, which is a good deal more precious than gold, would be worth about $150 billion.

Private industry’s activity in space appears certain to grow in the future. Many people argue that having the private sector foot the bill for some space activities will save NASA and the US government money. They also argue that industry can carry out space missions more efficiently and at less cost.

It seems likely that the number of people employed by companies involved in space activities will also grow. The day may not be far off when people other than astronauts will routinely travel to space. If that comes true, you might even be one of them.
Lesson 1 Review

Using complete sentences, answer the following questions on a sheet of paper.

1. Why did NASA never use Relay 3?
2. How many people watched the Apollo 11 landing thanks to a satellite?
3. What is INTELSAT?
4. How many satellites has the Pegasus launch vehicle carried into space?
5. Why will Russia no longer take space tourists to the ISS?
6. What's the expected price tag that space tourists will pay when private companies begin taking them to outer space in the coming years?
7. Where will the VSS Enterprise launch from? At what altitude will it separate from the airplane launching it?
8. What elements make up an S-Type asteroid?
9. How much per person on Earth do scientists estimate the natural resources of the Solar System's asteroids are worth?

APPLYING YOUR LEARNING

10. In the early days of satellite development, the US government requested and funded several spacecraft. But AT&T went it alone with its Telstar satellite. Do you think governments should fund space activities, or should they leave it to private industry? Why or why not?