10.3 Space Technology Spinoffs

spinoff a technology originally designed for a particular purpose, such as space technology, that has made its way into everyday use

If countries had never put money into space exploration, would your life be any different? You might be surprised to learn that there are many **spinoffs**, or offshoots, of space technology that you encounter in your everyday life—from the bar codes used to manage foods at your local grocery store to the cordless power tools in your home (Figure 1). In this section, we look at a few of these space technology spinoffs.

Figure 1 When *Apollo* mission astronaut-geologists were on the Moon, NASA developed a cordless tool for them to be able to drill core samples from beneath the lunar surface.

Canadarm Robotic Technology

Canada's own Canadarm robotic technology has been used in the design of prosthetic hands and to clean up radioactive waste and other toxic wastes. The space vision technology that controls the robotic movement of the Canadarm has been adapted to minimize the amount of pesticides used when spraying farm crops. Testing is now underway to use the same space robotics to conduct remote robotic surgery (telesurgery) (Figure 2). Recently, researchers at the University of Calgary and at McMaster University conducted experimental projects in which the surgeon directed medical staff from an operating console while conducting robotic surgical operations on patients hundreds of kilometres away in a hospital in North Bay, Ontario.

Figure 2 Researchers are adapting space robotic arm technology developed in Canada to create the Neuroarm. This will be a robot that uses miniaturized tools to conduct highly accurate surgeries.

Figure 3 The wing-like solar panels of a GPS satellite absorb radiation from the Sun, which is then stored in batteries.

Global Positioning Systems

People commonly use maps and compasses to determine exactly where they are on Earth and to guide them to where they want to go. In 1978, space exploration led to the development of the first satellite-based navigation system, called a global positioning system (GPS). Originally intended for military use, GPS technology was made available to the general public in the late 1980s. Today, a network of 24 GPS satellites orbit Earth twice daily (Figure 3). The system is used to determine latitude and longitude of receivers located anywhere on Earth, in any weather conditions, any time of day.

Three or more GPS satellites send a signal to a receiver on Earth, which uses triangulation to calculate its location (Figure 4). GPS handheld receivers (Figure 5) and those mounted in vehicles can also help people locate directions to a particular destination. All GPS satellites transmit continuously; a GPS receiver has to detect signals from at least three satellites to obtain an accurate positioning. GPS satellites transmit a code in their signals that indicates the precise time the signal was emitted. This is compared with the clock in the GPS receiver and allows it to reset its own clock so that it matches the time on the satellite's highly accurate atomic clock. The GPS receiver can then make accurate measurements of the distance between it and the GPS satellites.

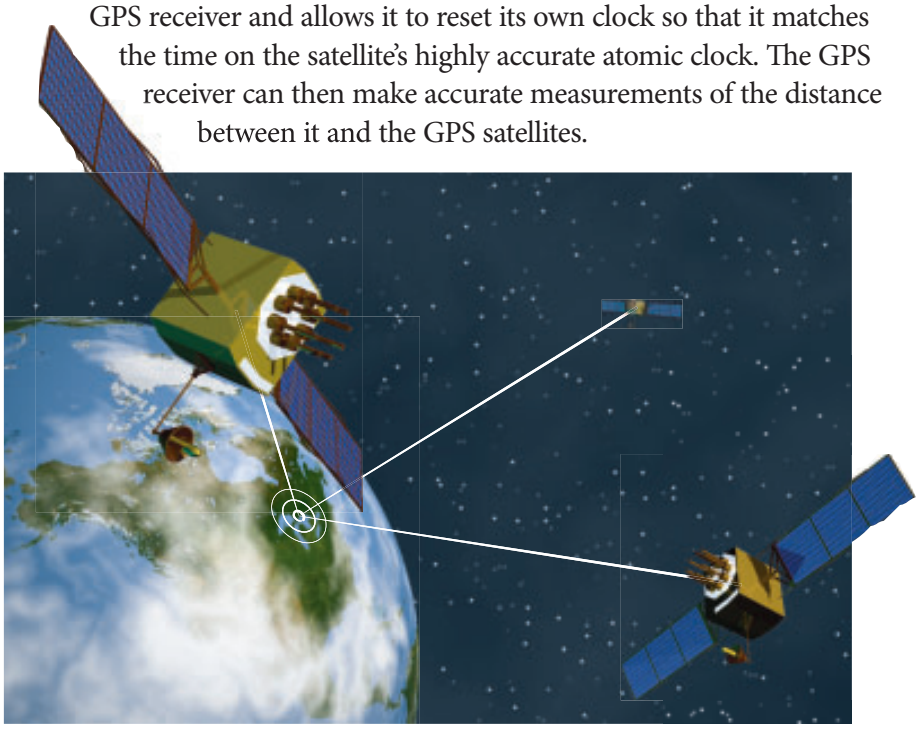

Figure 4 A GPS receiver's position on Earth can be accurately determined by using triangulation, which is the measure of the distance between the receiver and three orbiting GPS satellites.

DID YOU KNOW?

GPS Accuracy

How accurate are today's GPS receivers? Most receivers can locate an object's position anywhere on Earth to within a few metres. Certain high-end engineering and military units can locate objects as small as a few centimetres in diameter, or the size of a dollar coin. These accuracies depend on having a clear overhead sky with no obstructions.

Figure 5 A handheld GPS receiver

TRY THIS HOW DOES GPS WORK?

SKILLS: Observing, Evaluating

SKILLS HANDBOOK 3.B.

GPS technology has revolutionized navigation on Earth in the twenty-first century. Anyone with a GPS receiver can now accurately find his or her latitude and longitude anywhere on the planet as long as three GPS satellites can communicate with the receiver. In this activity, you will perform a simple exercise that shows how satellites are able to pinpoint the exact location of a person on the surface of Earth. You will also investigate the practical applications of this space technology.

Equipment and Materials: map of Ontario from your teacher; geometry compass

1. Look at the map of Ontario your teacher has given you. Imagine you are travelling in Ontario and have become lost.
2. The first satellite tells you that you are 340 km from Toronto. Looking at the scale on the map, determine how far that is on the map.
3. With a compass, draw a circle around Toronto that represents a radius of 340 km. The information from the first satellite tells you that you are somewhere along this circle.
4. A second satellite gives you the information that you are 800 km from Thunder Bay.
5. Draw a circle around Thunder Bay that represents a radius of 800 km. There are two points where the circles intersect.
6. A third satellite tells you that your location is 300 km from Timmins.
7. Draw a circle around Timmins that represents a radius of 300 km.
8. Determine your location.

A. Explain why you need a minimum of three satellites to determine your location using GPS technology. T/I

B. What kind of signal does the GPS satellite beam down to the receiver, and what information does it contain? K/U T/I

C. What determines the level of accuracy of locating an object on the ground? K/U T/I

D. If you had a GPS receiver on a cellphone, what might you use it for? A

RADARSAT

RADARSAT is Canada's first series of remote sensing Earth observation satellites. RADARSAT-1 has recently released the most detailed map of Antarctica ever created (Figure 6). From the RADARSAT map, scientists have been able to better study this mysterious continent, including information about how ancient ice-shelves are crumbling. RADARSAT-2 is a commercial radar satellite that resulted from a unique collaboration between government and industry. The satellite is used globally for marine surveillance, ice monitoring, disaster management, environmental monitoring, and resource management and mapping.

To learn more about RADARSAT,
GO TO NELSON SCIENCE

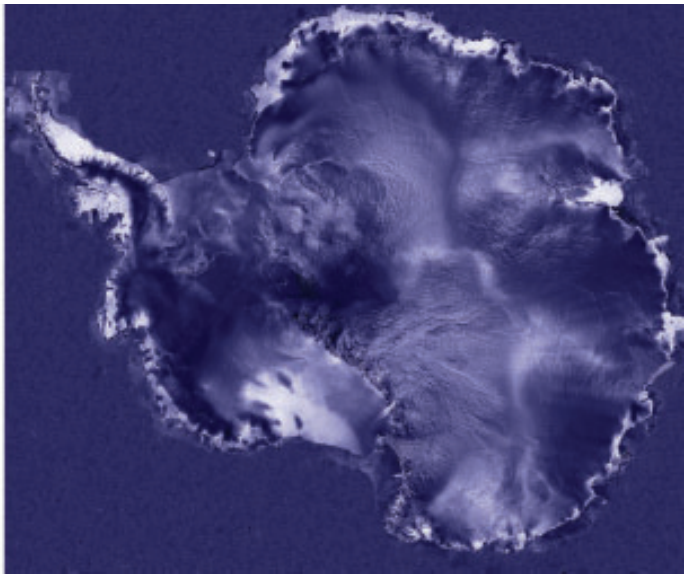

Figure 6 A high-resolution RADARSAT image of Antarctica. Earth's southernmost continent is so cold and inhospitable that much of it remains unexplored. From space, though, it is possible to map this entire region by radar by systematically noting how long it takes for radio waves to reflect off the terrain.

DID YOU KNOW?

UNISPACE

UNISPACE is the United Nations Conference on the Exploration and Peaceful Uses of Outer Space. UNISPACE is committed to using space technology to assist any country in the world during a major disaster. For example, during the flooding of the Red River in southern Manitoba in 2009, scientists used RADARSAT images to track the flooded area and collect data for future flood management. RADARSAT also monitored the flooding of the Yangtze River in China in 1998 and the rising waters in and around New Orleans caused by Hurricane Katrina in 2005.

SCISAT

Another Canadian satellite used to monitor Earth's environment is SCISAT. It was launched in 2003 to monitor the state of Earth's atmosphere over the Arctic. Canadian and international scientists are concerned about the ozone layer, which provides Earth with some protection from the Sun's harmful ultraviolet rays. Scientists are learning more about changes in our atmosphere as SCISAT measures how much ozone is in Earth's atmosphere and how much it is being reduced due to human-produced pollution.

Health Benefits

Some of the investments in space research and exploration by governments, companies, and universities result in technologies that can be used to monitor human health. For example, home blood pressure testing devices provide us with an immediate measurement of our blood pressure (Figure 7). This everyday technology is a spinoff of the device created by NASA to measure the blood pressure of astronauts during launches, when they are exposed to powerful forces and vibrations.

In sports medicine today, an athlete's internal body temperature can be monitored easily with an electronic thermometer pill that he or she swallows. The pill helps physicians know when there is danger of exhaustion or heatstroke while playing sports. This tiny device was first developed in the

Figure 7 The portable device used to monitor blood pressure is called a sphygmomanometer.

early 1980s by NASA to check the body temperatures of astronauts during spacewalks so they would not overexert themselves.

These are just two examples of the many inventions created for space exploration that provide effective ways to monitor people's health.

The Environment

The microgravity environment on the ISS is used to investigate various factors related to the environment (Figure 8). One such investigation examines how the energy industry can achieve more environmentally sound oil exploration. Researchers have sent samples of crude oil into space to figure out how oil behaves below Earth's surface. The results provide geologists with a better idea of the size of underground oil reserves. This information helps oil companies drill into them more accurately while minimizing the disturbance of the surrounding environment.

Figure 8 Astronaut Garrett Reisman examines the effects of microgravity on plant cell walls.

Our oceans and lakes are better protected from toxic oil spills thanks to a special technology developed through research carried out in space. In this technology, millions of tiny balls of beeswax are dumped into water polluted by an oil spill. The wax attracts the oil, which becomes trapped inside the balls. Instead of the oil destroying fragile ecosystems in and around the ocean or lake, it is contained and easier to clean up.

Improved Consumer Goods

Some technologies, such as personal computers, high-tech running shoes, dehydrated foods, and water purifiers, were developed for space exploration but are available to all today. Other space technologies have been adapted for use in consumer goods that have wider applications. Some examples are listed below:

- Aerodynamic technology has led to golfballs that can soar through the air faster and with greater accuracy.
- Fire-resistant fabrics were developed for spacesuits but have been adapted for use in suits for racecar drivers and hazardous material handlers (Figure 9).

Figure 9 NASA technology used in spacesuits worn by astronauts during spacewalks is being used to design fire-retardant suits worn by racecar drivers.

READING TIP

Explaining Relationships

While reading a text you might recall something you read or viewed in another text. For example, you may have viewed a documentary about Colony Collapse Disorder, in which massive numbers of honeybee colonies are dying off around the world. You can combine this fact with the information in the text and conclude that beeswax may not be available in the future in large enough quantities to use for oil spills in the oceans.

- Space technology created shock-absorbing helmets that have been adapted for use in sports or certain work environments (Figure 10).

Figure 10 Foam that NASA developed for aircraft seats is used to make protective helmets.

UNIT TASK Bookmark

You can apply what you have learned about everyday applications of space research to your work on the Unit Task described on page 446.

IN SUMMARY

- Technologies originally designed for space exploration have made their way into everyday use.
- GPS technology, common in many cellphones and vehicles, helps people navigate and determine their location.
- Canadian technologies such as RADARSAT and the Canadarm have led to the development of sophisticated applications in everyday life.
- Benefits to health and the environment have come about due to space technology.

CHECK YOUR LEARNING

1. What is the spinoff of space technology shown in Figure 11? K/U
2. Write a paragraph as if you were posting information on a blog, explaining the relationship between the Canadarm and the new field of robotic surgery. C A
3. How does the global positioning system (GPS) work? K/U
4. Why is GPS a valuable technology? A
5. What are five geographical features of Earth that are monitored by RADARSAT? Why are they being monitored? K/U A
6. Which layer of Earth's atmosphere do scientists study with the SCISAT satellite? What purpose does it serve? K/U A

Figure 11

7. Identify two instances in which the United Nations organization UNISPACE used satellites in space to help people on Earth with natural disasters. A
8. What are some of the advances that have been made in the field of health sciences due to space science technology? A
9. Identify two ways in which technologies invented for space exploration have benefited the study of Earth's fragile environment. A
10. Describe three objects people might find in their homes that use technology originally developed for the space program. Add one sentence of description for each object, explaining its origin. K/U
11. Describe two ways in which experiments in space have led to more environmentally friendly means of extracting oil and cleaning up oil spills. A