Geotechnology: The Impact of GPS

Picture this situation: you have just received your G1 driver's licence and are driving along a country road with your family, to visit relatives. You are driving carefully and the weather is good. Then it happens. One of your front tires blows, and your car swerves off the road and hits a large tree. The last thing you remember is the sound of breaking glass and the air bag exploding in your face. The next thing you remember are police and ambulance attendants freeing you from your wrecked car and taking everyone to the hospital. The doctors in the hospital tell you that everyone will be fine and that a prompt call for the ambulance was critically important in this outcome. You soon find out that no one actually phoned 911—rather, it was your car that called for help.

What happened was this. The car was equipped with a crash sensor. When this sensor was activated, it sent a message to the OnStar unit of your car. This unit has a built-in **Global Positioning System (GPS)** that was able to determine the exact location of the car. The OnStar unit in the car sent an emergency message to the nearest OnStar centre that there had been an accident at a particular location, serious enough to deploy

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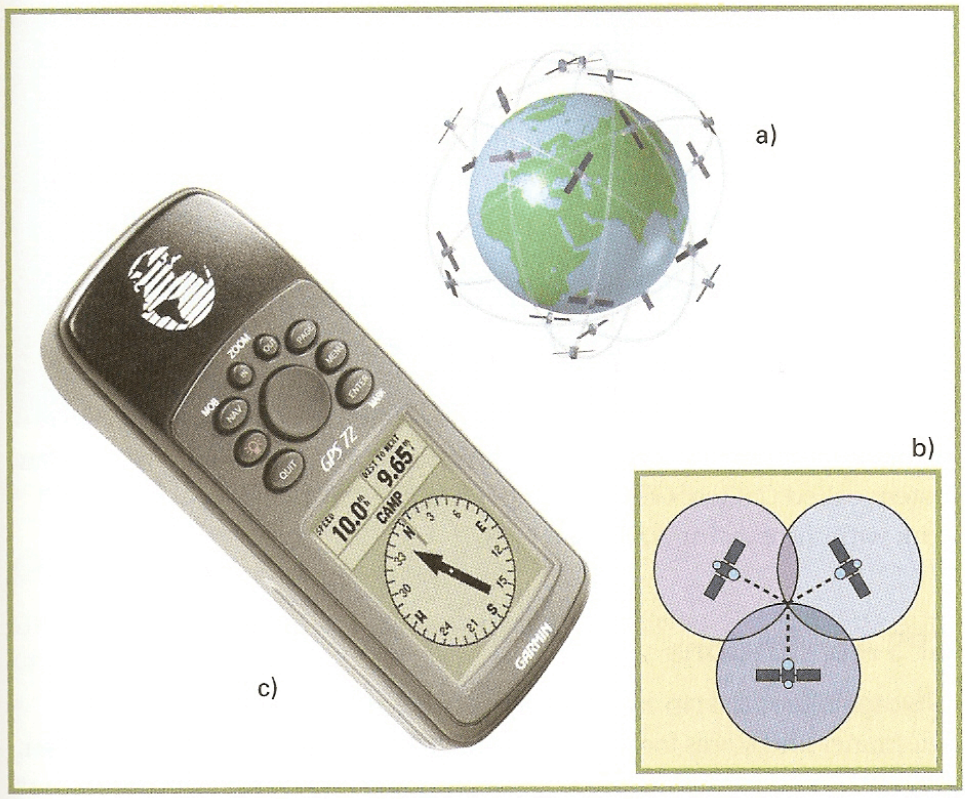
To learn more about GPS, check www.pearsoned.ca/makingconnections2.

OnStar was invented by General Motors but is starting to appear in some other vehicles, such as Acura and Volkswagen.



◀ **Fig. 3-6** How GPS works

a) Orbiting satellites provide navigation data around the clock. The satellites send radio signals to Earth that a GPS unit uses to calculate its latitude and longitude.

Triangulation:

b) Each satellite's signal contains the exact time it was sent.

c) A GPS unit uses this time to measure and calculate the distance of the satellite. Signals from at least three satellites are needed by a GPS unit to determine its location.

OnStar can do other things as well, such as unlock your car if you leave the keys inside, or track your car if it is stolen.

Fig. 3-7 ▶
This is a typical OnStar control unit. The left button is for making cellular calls through OnStar. The middle button connects the driver with the OnStar centre. The right button is for making an emergency contact with the OnStar centre.

air bags. A person at the OnStar centre then tried to call your car using the cellular phone that is also part of OnStar (Fig. 3-7). When no one in the car answered the call, the OnStar representative contacted the nearest emergency services and you and your family were soon on your way to the hospital.

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The Global Positioning System (GPS)

OnStar is just one example of the many ways in which GPS is changing the way we live. But what is GPS, and how does it work?

The Global Positioning System is a satellite-based, position-finding system operated by the United States government. The first satellite was launched in 1978, with the target number of 24 satellites being reached in 1994. Each satellite has a lifespan of about 10 years, so new satellites must be launched on a continuing basis. The satellites are placed in particular orbits so that any place on Earth is in range of at least four satellites.

It is interesting to note that the Internet was also originally created for military use.

Originally, the GPS was created for use by the American military. It was made available for civilian use in the mid-1980s. For many years, GPS receivers cost thousands of dollars, and only very rich individuals and companies could afford them. In recent years, as with most electronic devices, prices have dropped dramatically. Simple GPS devices now cost not much more than $100. Even the least costly GPS receiver will give you your location to within about seven metres, and often less than this. More sophisticated devices have an accuracy of less than one centimetre! The European Union is in the process of creating a similar satellite navigation system called Galileo. Galileo is being designed in such a way that it will work with the existing American GPS.

GPS Applications

GPS capabilities exist in a wide variety of devices. The simplest GPS unit determines and stores locations as latitude/longitude positions. In addition, they are able to store waypoints. A **waypoint** is simply a stored location that is of interest to the user. The GPS is also able to tell you the distance and direction of a waypoint from your current position.

A more complex group of devices combines GPS capability with interactive map databases. These devices show your location in relation to various landmarks. In an auto navigation system this would start with the location of streets and highways, but might include extra useful features such as the location of gas stations and hotels. A marine navigation unit combines information about water depths with port locations and facilities, lighthouses, and other marine navigation aids. An aviation system (Fig. 3-8) works in a similar fashion but would have information about airports, major highways, electrical transmission towers, etc., that would be helpful to a pilot.

In addition to units of these types that can be bought "off the shelf," GPS capabilities have also been built into many specialized units. The OnStar system is one example of this kind of GPS application. Another is used on intercity trucks. In this case, a GPS unit sends the truck's location back to the company's head office. This allows the company's management to monitor the progress of shipments. Devices that combine GPS capabilities with the ability to transmit vehicle locations to a remote receiver are called **telematic** devices.

▲ **Fig. 3-8** This is an air navigation GPS unit. It relates the plane's location, as determined by GPS, to important information needed by the pilot.

GPS Uses

GPS technology is used in a remarkable range of fields. Here are just some of them:

- Agriculture—Tractors, steered by GPS rather than people, can plough perfectly straight rows in half the time.
- Archaeology—GPS has helped archaeologists do their work much more efficiently. For example, it is used to record quickly and accurately the location of artifacts. The data collected can be used to draw quick and accurate maps of archaeological digs.

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You can read about a variety of GPS applications at www.pearsoned.ca/makingconnections2.

- Forestry—GPS is used to plan forest cuts to ensure that the maximum amount of timber can be cut with the minimum amount of environmental damage.
- Geology—GPS is used to make precise maps of geologic features.
- Natural hazards—GPS is used in research to predict the occurrence of volcanic eruptions and earthquakes.
- Recreation—GPS technology is used, with a personal data assistant (PDA), on golf courses to indicate the distance to the hole.
- Surveying—GPS was critical in the construction of the new Hong Kong airport. The airport was built on landfill in the sea, and quick and accurate surveying was necessary to monitor the amount of **subsidence** of the fill.
- Weather forecasting—GPS units sent aloft with weather balloons give the precise location and altitude at which weather observations (temperature, air pressure, etc.) are made.

Blackberry is one brand of PDA.

subsidence
sinking due to compression

NAME: _____

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1. a) What does GPS stand for?

b) What is GPS?

2. a) Who operates the Global Positioning System?

b) When was the first satellite launched? What was the target number of satellites to be launched and in what year did this finally happen?

c) Why must new satellites be launched on a continuous basis?

3. Who was the GPS originally developed for?

4. How accurate are GPS receivers?

5. Explain how GPS technology works.

6. Describe, in your own words, how a GPS can be used on intercity trucks (think of a UPS truck).

7. Explain how GPS is used in:

a. Forestry

b. Geology

c. Natural hazards

d. Weather forecasting

8. Think of other ways GPS is used in our everyday life. Describe **<u>two</u>** areas where GPS is used, or where you think it would be useful.

9. What two major advantages does GPS have? Hint: Consider the advantage that a GPS-based system has over the traditional way of finding locations.