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SCIENCE & TECHNOLOGY PERSPECTIVES

systems in action

***Student Book
Sample Pages***

Unit A: Systems in Action
Draft Material for Review Only.

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SYSTEMS IN ACTION

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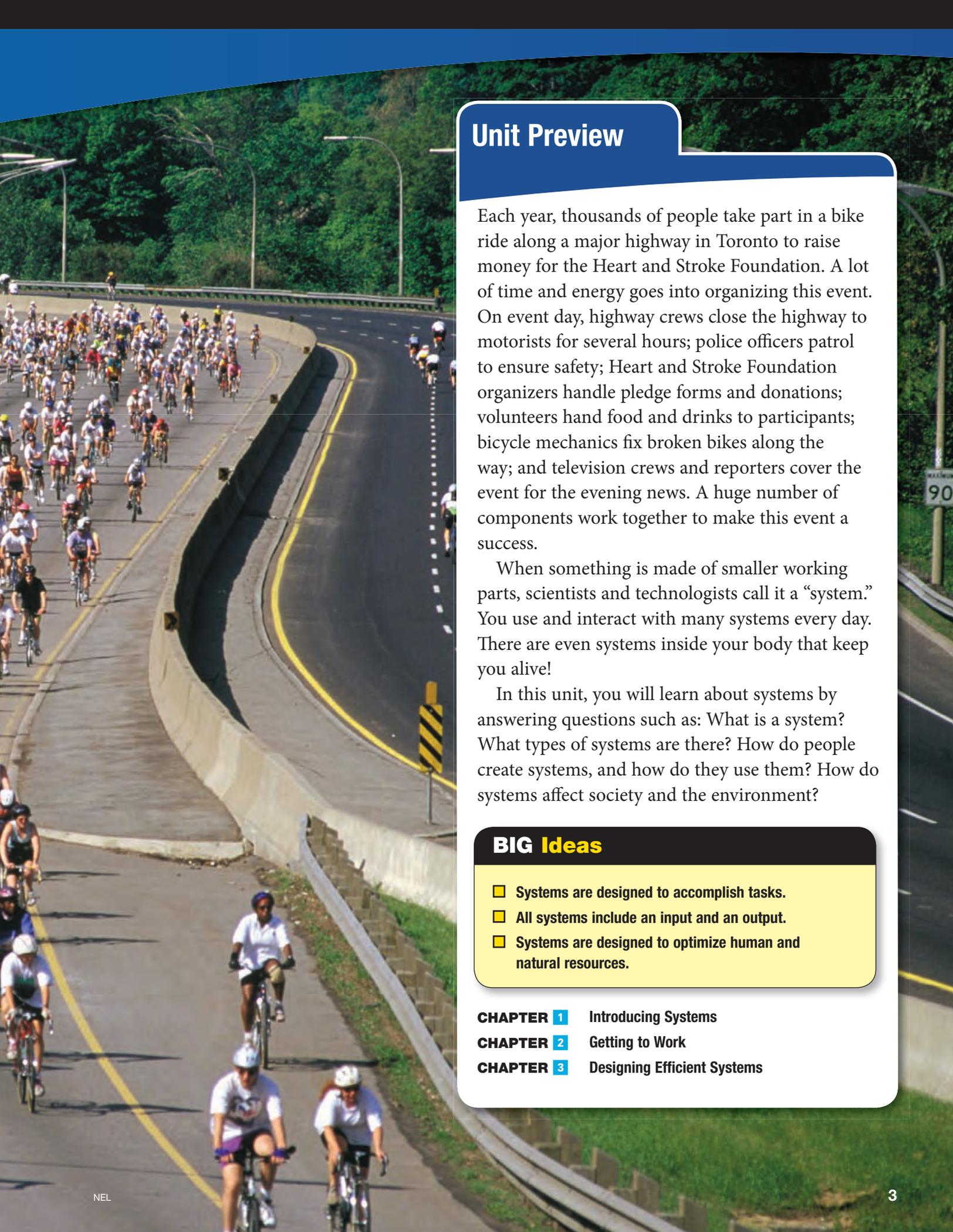
Credits 90

UNIT

SYSTEMS IN ACTION

A





Unit Preview

Each year, thousands of people take part in a bike ride along a major highway in Toronto to raise money for the Heart and Stroke Foundation. A lot of time and energy goes into organizing this event. On event day, highway crews close the highway to motorists for several hours; police officers patrol to ensure safety; Heart and Stroke Foundation organizers handle pledge forms and donations; volunteers hand food and drinks to participants; bicycle mechanics fix broken bikes along the way; and television crews and reporters cover the event for the evening news. A huge number of components work together to make this event a success.

When something is made of smaller working parts, scientists and technologists call it a “system.” You use and interact with many systems every day. There are even systems inside your body that keep you alive!

In this unit, you will learn about systems by answering questions such as: What is a system? What types of systems are there? How do people create systems, and how do they use them? How do systems affect society and the environment?

BIG Ideas

- Systems are designed to accomplish tasks.
- All systems include an input and an output.
- Systems are designed to optimize human and natural resources.

CHAPTER 1 Introducing Systems

CHAPTER 2 Getting to Work

CHAPTER 3 Designing Efficient Systems

Downhill Daredevils

Ryan and his sister, Zara, had been waiting for this BMX race for months. They marvelled at the speed, jumps, falls, and general punishment the bikes and riders seemed to take without severe damage. Although two bikes had bent wheels, most of the bikes were holding up well. Zara and Ryan knew that their bikes would have crumpled in minutes given this treatment.

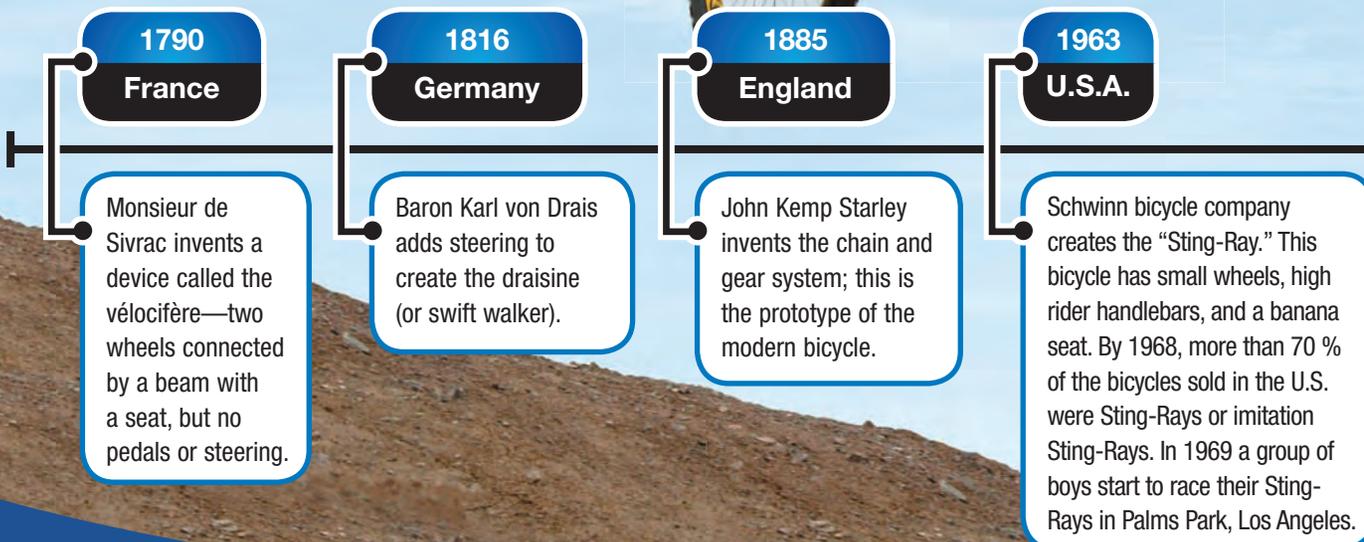


LINKING TO LITERACY

Reading a Timeline

A timeline is a visual representation of a sequence of events. Begin by reading the title. Then, look at the dates at the beginning and the end. What period of time is covered? Read each date and event in order, thinking about which needs were met by each change.

BMX Racing History



Between races, Ryan and Zara checked out some of the bikes and spoke to the riders. They were amazed by the complicated parts that made up each bike. Each part was designed to perform a specific function, whether cushioning the impact on landings, keeping the chain from coming off, or slowing down and stopping the bike. Everything seemed different about these bikes—the suspension, gears, frame, brakes, and especially the price. These bikes were expensive! There was also the additional cost of the safety gear the riders had to wear.

Ryan and Zara began discussing how bikes have changed over the years. They recalled how the bikes that they rode when they were younger differed from their current bikes. They remembered their Mom telling them that when she was young her bike did not have gear-shifters or hand brakes. She had something called a banana seat on her bike! Bicycle technology had come a long way since then.

Ryan and Zara became fascinated with BMX biking and decided to find out more about this exciting sport. They were also impressed by the BMX race itself. They learned that BMX racing is a highly organized sport with regional, national, and international rules and regulations.



Judging by the “Start” and “Finish” lines and the well-groomed trails, Ryan and Zara could tell that many people had done a lot of work to prepare for this event.

Although they liked the idea of BMX racing, Ryan and Zara wondered if it was a good idea to cut down so many trees to make the racetracks. They also noticed the soil compaction and erosion on the course. They decided to speak to their parents and friends about BMX racing and do more research before taking up the sport.

1970

U.S.A.

The Bicycle United Motocross Society is founded in Long Beach, California. It organizes races, hands out trophies, creates membership cards and a scoring system, and organizes rankings. This leads to the creation of other racing groups, such as the National Bicycle League (NBL) and the American Bicycle Association (ABA).

1973

U.S.A.

The Yamaha Motobike is released for sale. It is considered the first BMX (bicycle motocross) prototype. The Motobike has front- and rear-wheel suspension, knobby tires, and stronger wheel rims. All of these improvements make the bike sturdier for off-road racing.

Present

Worldwide

Many groups worldwide organize BMX races and competitions. Through the work of some of these groups, BMX racing became an Olympic sport in the 2008 Beijing Olympics.

Components of a Bicycle Race

BMX racing is a highly organized sport involving people, bicycles, safety equipment, racetracks, rules, and regulations. In this activity, you will distinguish between the components of BMX bicycles and the components of an organized race.

1. Get a large piece of paper. Write “BMX” in a circle in the centre of the page.
2. Fold the paper in half vertically. At the top of the left-hand side, write the title “Bicycle.” At the top of the right-hand side, write the title “Race” (Figure 1). This is the beginning of a mind map.
3. In groups of three or four, brainstorm all the parts you can think of that make up a BMX bicycle. Record each part in a separate bubble.
4. On the right-hand side of your mind map the page, extend to include what goes into organizing a bike race.
5. When your teacher asks you, leave your paper at your desk and do a gallery walk to see what others have written. Bring your notebook and a pen with you to jot down new ideas.
6. After you return to your desk, add to your diagram any new ideas you obtained from your classmates. Write these ideas in another colour.
7. Recall what you have learned about systems in previous grades and think back to how a system was described in the Unit Preview. As a class, complete a KWL chart (Figure 2). You will leave the “What we LEARNED about systems” column blank for now.

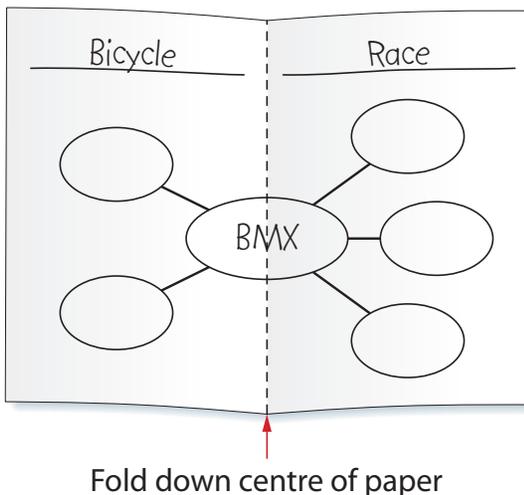


Figure 1

What we KNOW <i>about systems</i>	What we WANT to <i>learn about systems</i>	What we LEARNED <i>about systems</i>

Figure 2

8. Answer the following in your own words.
 - (a) Pick a bicycle part from one of your mind map bubbles and describe the types of forces that act on that part of the bicycle.
 - (b) Look at the photos in the Downhill Daredevils story. Describe the protective equipment that the cyclists are wearing. Use the idea of forces to explain how the equipment protects the cyclist.

Helping Hands

BMX bikes are designed to meet the needs of their riders. Everyday systems are also designed to meet the specific needs of their users. As you progress through the unit, you will discover how important it is to consider the needs of others when designing systems. You will develop the skill of “systems thinking” by examining the interrelationships among the components of a system, and between systems, societies, and environments.

Enable Industries Inc., is holding a contest called “Helping Hands.” The contest involves designing a system to meet a specific need. You will design and build one of the following devices.

- 1. A Better Gripper** Opening jars can be a daily challenge for people with joint pain, reduced hand strength, or simply small hands. You will design and build a system that helps a person safely hold a container and remove its lid.



- 2. An Extension Grabber** Some places are hard to reach for individuals with reduced mobility. You will design and build a system that enables people to reach into the far corner of a closet or under a bed from a sitting position to pick up objects.
- 3. A Cup Lifter** Some people are not able to raise a cup to drink from it. You will design and build a system to raise a cup of water so that someone can drink from it without having to bend over or lift the cup.

Unit Task By the end of the Systems in Action unit, you will be able to demonstrate your learning by completing this Unit Task. As you work through the unit, continue to think about how you might meet one of the above challenges. Read the detailed description of the Unit Task on page 80, and look for the Unit Task icon at the end of selected sections for hints related to the task.

Assessment

You will be assessed on how well you

- plan and design your device
- build, test, and improve your prototype
- explain your device in a User's Guide, and communicate your project to the judging committee

1

Introducing Systems

KEY QUESTION: What are systems?

Looking Ahead

- Systems are composed of parts that work together to perform a function.
- Systems may be physical (for example, telephones, electronic games, or organ systems) or social (for example, health care, transportation, education, police force, or an ant colony).
- Systems have inputs, outputs, and side effects.
- The skills of analysis can be used to study the inputs, outputs, and side effects of everyday systems.
- The way we use systems affects society and the environment.

VOCABULARY

system	output
physical system	side effect
social system	systems thinking
force	consumerism
input	

More Than Meets the Eye

Pictures always tell a bigger story than seems to be the case at first glance. Like the BMX race that Zara and Ryan observed, the objects and scenes shown here are not unique or isolated; they contain smaller parts that work together and are connected to other things in their environment.



Excavators are large machines that do a lot of work.



Courts perform an important function in society.



Cameras are used to take pictures.



Blue boxes are used to help reduce the amount of garbage in landfills.

LINKING TO LITERACY

Inferring from Pictures

When we read, we use clues from the text and figures to determine or "infer" information that is not directly stated. Sometimes the information we get from figures helps us more clearly understand what we are reading.

- 1 Analyze each picture by asking yourself, "What is the main purpose of the object or scene illustrated in the picture? What smaller components does the object or scene contain that helps it fulfill its purpose? What connections may there be between the object or scene and other objects (including people) in its environment?" Record your thoughts in point form. Discuss your ideas with a partner.



Ambulances are used to quickly and safely transport people who are sick or injured.

1.1

Types of Systems

A handheld can opener is a device that makes life easier (Figure 1). The task of a can opener is quite simple—it must safely remove the lid of a can. A can opener is an example of a system. A **system** is a group of parts that function together to perform a specific task—in this case the safe removal of a can’s lid.

system: a group of parts that work together to perform a desired task

LINKING TO LITERACY

Scanning

Scanning is a way of previewing the section to get a general idea of what it is about. Look at the title. Scan for highlighted words and definitions in the margin. Look for any figures and captions. Ask yourself, “What is this section about?”



Figure 1 The parts of a can opener work together to hold the can and remove the lid.

Physical Systems

physical system: a group of physical parts that need to work together to perform a function

Physical systems refer to systems that rely on a group of physical parts to perform a function. Physical systems may be natural or human-made. Natural physical systems include the solar system and an animal’s digestive system. Human-made physical systems include mechanical systems, optical systems, electrical systems, and combinations of these. The names of these systems come from the type of energy they use. Table 1 describes some human-made systems.

Table 1 Some Human-Made Physical Systems

Type of system	Example	Type of energy used	
mechanical	jackhammer (pneumatic drill)	energy stored in pressurized air	
optical	camera	light energy	
electrical	electric circuit	electrical energy	

Human-made physical systems are called tools, appliances, devices, instruments, gadgets, or utensils. These systems help us accomplish tasks faster than we normally would or even help us accomplish tasks that we normally would not be able to do. Many of the devices we use everyday are combinations of the systems described in Table 1. For example, a car is a combination of systems containing an engine, which is largely a mechanical system; brakes, which are usually hydraulic systems; and a radio, starter, lights, and computer chips that are mainly electrical systems.

Social Systems

A group of organisms working together to perform a task is a **social system**. Social systems may be natural or human-made. Examples of natural social systems are ant colonies, bee colonies, and a wolf or coyote pack (Figure 2). Human-made social systems include health care, education, and waste management systems, symphony orchestras (Figure 3), and rock bands. Social systems establish ways that people or other organisms interact and relate to one another. 🌐

social system: a group of people, or other organisms, joining together to perform tasks and establish relationships

To learn more about the honeybee social system,

[Go to Nelson Science](#)



Figure 2 Coyotes have a well-defined social order within each pack.



Figure 3 Every performer in an orchestra has a specific part to play. However, they function together to perform a symphony.

Aboriginal Clan Systems

Human social systems have existed for thousands of years. The clan systems of traditional First Nations' peoples are social systems. For example, the Ojibwe (Figure 4) believe that the clan system was determined by the Creator and each clan was named in honour of an animal *doodem*, or totem. According to legend, six beings came out of the sea—the Bullhead (fish), Crane, Bear, Little Moose, Marten, and Thunderbird. These beings were used as the basis for the original clans. There are now at least 20 different clans among the Ojibwe bands.



Figure 4 Woodland Raven by Mark Seabrook. In Ojibwe First Nation, the Raven is a bringer of news. Animals represent many things, including clans, in First Nations.

Table 2 lists some of the common Ojibwe clans. Clan systems are used as a form of government and as a way of determining the tasks that people in the clan perform.

Table 2 Some Ojibwe Clans and Their Traditional Roles

Clan	Ojibwe name	Role/occupation
Crane and Loon	<i>Ajejaug</i> (Crane)	<ul style="list-style-type: none"> • share chieftainship • conduct communication with outsiders • assist with communication within the band
Fish	<i>Giigo</i>	<ul style="list-style-type: none"> • teachers and scholars • help settle arguments between the leaders of the Crane and Loon clan
Bear	<i>Makwa</i>	<ul style="list-style-type: none"> • police and guardians • have knowledge of the environment and learn of natural medicines available in the environment
Hoof	<i>Waawaashkeshi</i> (Deer), <i>Adik</i> (Caribou)	<ul style="list-style-type: none"> • gentle caregivers • look after housing and recreation
Marten	<i>Waabizheshi</i>	<ul style="list-style-type: none"> • hunters, gatherers, and warriors
Bird	<i>Maang</i>	<ul style="list-style-type: none"> • spiritual leaders

Communities are traditionally governed by a band council made up of leaders from the various clans. The clan system also governs relations between tribes and helps provide guidance about marriages. In the Ojibwe Nation, clans are passed down the generations through the male family line. The Mohawk clans follow the mother's bloodline. Clan Mothers choose chiefs, raise leaders, record names, and advise partnerships. The clan continues to be an important element of First Nations identity.

To learn more about
Canada's First Nations,

Go to Nelson Science



CHECK YOUR LEARNING

- Give two examples of each of the following systems:
 - mechanical system
 - optical system
 - hydraulic system
 - electrical system
- What do physical systems and social systems have in common? How are they different?
- Give two examples of each of the following:
 - physical systems designed by people
 - naturally occurring physical systems
 - social systems that you are a part of
 - naturally occurring social systems
- Why are Aboriginal clan systems considered human social systems?

System Components

Physical systems and social systems vary in size and complexity. Some systems, such as can openers and school clubs, are relatively small and simple. Other systems, such as space shuttles and federal governments, are very large and complex.

Breaking Down Systems into Subsystems

In most cases, a system has smaller systems within it. These are called subsystems. Subsystems help the system perform the task for which it is designed. For example, a handheld can opener has two subsystems in it, the holding and cutting subsystem, and the turning subsystem (Figure 1).

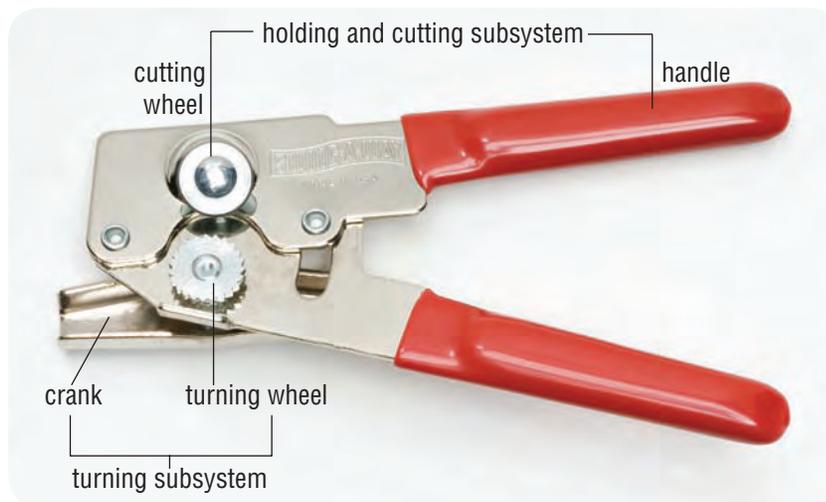


Figure 1 A can opener is made of different subsystems.

Unlike the can opener, the global positioning system (GPS) is a large, complex system that provides precise location information anywhere on Earth (Figure 2).

GPS has three major subsystems: the space subsystem, the control subsystem, and the user subsystem. The space subsystem is made up of 24 orbiting satellites that transmit signals to Earth. The control subsystem is made up of several U.S. Air Force monitoring stations. The user subsystem is a receiver that takes signals from at least three satellites at once and turns them into useful information. Common examples of the user subsystem are the GPS units in many vehicles and the handheld receivers used by backpackers.

Breaking Down Subsystems into Mechanisms

Subsystems contain mechanisms. A mechanism is the part of a subsystem that changes one type of force into another, one type of energy into another, one type of motion into another, or one type of action into another (Figure 3). In physical systems, forces make things move. A **force** is a push or pull on an object that may result in a change in the object's motion or shape.



Figure 2 GPS receivers turn signals from various satellites into useful information for a driver.



Figure 3 Rotary motion of the handle causes rotary motion of the blades.

force: any push or pull



Figure 4 The mechanical action of your teeth contributes to the process of food digestion.

In a mechanical system such as the can opener, the handles and the cutting wheel are the mechanisms that make up the holding and cutting subsystem. Squeezing the handles at one end causes the other end to grip the can, and pushes the cutting wheel into the can. The crank and turning wheel make up the turning subsystem. Force applied to the crank is transferred to the toothed wheels and then to the can, causing it to rotate.

Natural physical systems have subsystems and mechanisms too. The human body contains organ systems such as the digestive system and the circulatory system. The digestive system contains subsystems called organs. Examples of these subsystems are the mouth, stomach, and intestines. In the mouth, teeth act as a mechanism for cutting and grinding food into smaller pieces (Figure 4).

Building Up Systems into Industries

Over the years, people have worked together to create complex combinations of systems called industries. Industries produce goods and services that people need or desire. Industries are combinations of physical and social systems that work together to produce a particular class of goods and services. For example, the communications industry includes all of the physical and social systems that produce books, newspapers, magazines, radio and television broadcasts, billboard advertisements, Internet websites, telephones, and telecommunications, such as the GPS. Table 1 describes some common industries and their related physical and social systems.

To learn more about careers in these industries,

Go to Nelson Science



LINKING TO LITERACY

Reading a Table

Tables organize and summarize information. They make it easier for the reader to compare different things. Read the title of Table 1. Next, read the column headings to see how the information is organized. Scan the first column to find an industry of interest to you. Then, read across to discover related physical and social systems.

Table 1 Sample Industries and Some Related Systems

Industry	Some related physical systems (devices)	Some related social systems
communications	computer, scanner, electrical circuits, video recorder, television, radio satellites, transmission antennas	advertising services, authors, animators, set design
construction	power saw, air compressor, backhoe, crane	architectural design, land surveying, real estate sales office
green	chainsaw, irrigation systems, greenhouse, lawnmower	landscape design, composting services, forest management
service	hair stylist's chair, stethoscope, food mixer	health spas, walk-in clinics, eco-tourism
transportation	car hoist, diagnostic equipment, highway, gas pump, trucks, airplanes	small engine repair, auto body repair, aeronautical engineering, gas station

System Inputs and Outputs

All systems (and subsystems) have inputs and outputs. **Inputs** are all of the things that go into a system to make it work. Inputs may include forces, energy, and resources (raw materials). The input of a can opener includes the force your hand puts on the handles. **Outputs** are all of the tasks or services that the system performs. The output of a can opener is the turning and cutting of the can's lid.

A bicycle is a system whose main purpose is to transport a person from place to place. The main input into this system is the downward force the rider applies to the bicycle's pedals. The desired output is the forward motion of the bicycle. A garden is a system whose main outputs include flowers, fruits, and vegetables (Figure 5). Successful gardens require a variety of inputs, including water, sunlight, fertilizer, seeds, and pruning, to produce the desired outputs.

input: the force, energy, or resources that you put into a system

output: the task or service that a system is designed to perform

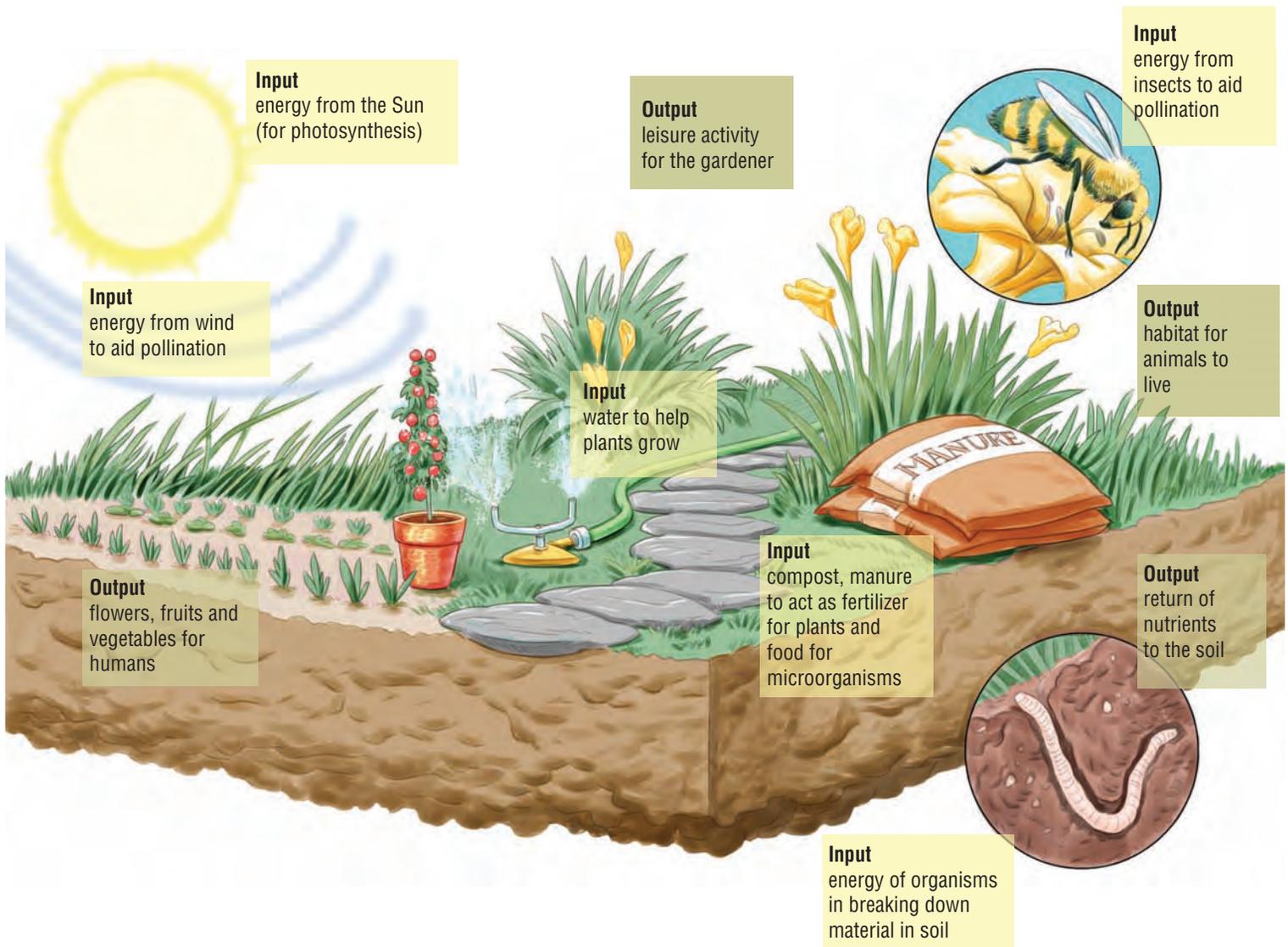


Figure 5 Complex systems, such as gardens, involve many inputs and outputs.



Figure 6 Saving lives is a desired output of a health care system.

side effects: the unintended or undesired outputs of a system

Another example of a system is Ontario’s health care system. Its overall purpose is to help keep Ontarians healthy and to care for them when they become ill (Figure 6). Subsystems of the health care system include hospitals, doctors’ offices, walk-in clinics, medical laboratories, and nursing and ambulance services. Some inputs of the health care system include doctors, money, nurses, lab technicians, X-ray machines, maintenance workers, wheelchairs, computers, and electricity. Outputs include emergency operations, medicines, grief counselling, and medical information to patients.

Side Effects and Systems Thinking

While all systems have desired outputs, they often have undesired outputs called **side effects** as well. For example, the desired output of a car is motion. Some of the side effects of using cars are air pollution, traffic congestion, noise pollution, and the loss of natural habitat due to roads and parking spaces (Figure 7).



Figure 7 Cars allow for easier movement, but an undesired output of car use is air pollution.

systems thinking: taking into consideration the inputs, outputs, and side effects of systems

Since people have a choice of the kinds of systems we use and the way we use them, we also have a responsibility to make wise choices. **Systems thinking** involves thinking about how the parts of a system work together, and also about trying to understand how systems affect people, other organisms, and the environment. Developing systems thinking can help people make better choices in the way they use systems. Systems thinking and better choices may not entirely eliminate side effects, but can help reduce their negative impacts on society and the environment.

✓ CHECK YOUR LEARNING

- Why are “input” and “output” good words to use when discussing systems?
- (a) Name two inputs, two outputs, and two side effects of the health care system.
(b) Compare and contrast one of the outputs with one of the side effects.
- Which inputs to a garden occur naturally? Which inputs are provided by humans? Are there any side effects to a garden? Explain.
- In your own words, define “systems thinking.”
- Describe the relationship between side effects and systems thinking.

Tech CONNECT

Aliens, Elephants, and Grinning Gorillas—The World of Animatronics

Puppets have come a long way since wood marionettes were controlled by strings on a small stage. Science and technology are responsible for some of the most amazing characters in movies. Small, green Jedi masters, time-travelling robots, and Santa's reindeer have come to life on the screen through the technology of animatronics. Animatronics is the art of creating something that looks alive by using electronics, mechanical systems, and remote control (Figure 1).



Figure 1 This amazing elephant was used in an outdoor theatre in London, England. The elephant was created using animatronics.

In the early years of special effects, “stop-motion” animation was often used. Movie segments were shot frame by frame, with the puppet being moved slightly between each frame. Twenty-four pictures were taken for each second of film. Other techniques involved the use of rods and wires to move parts of the puppet. Today, complicated mechanisms and motor systems allow smoother, more natural movements. Animatronics also allows a remarkable variety of movement to take place. Animatronic puppets can now pick up and shake an actor. Some puppets, such as the gorilla in Figure 2, are so detailed that you can see a single eyebrow being raised.



Figure 2 Making a subtle facial expression requires a complicated system of mechanics and electronics.

Often, the onscreen character is several different puppets or one that has many parts that can be changed. Even a single puppet may require several people to control it. The puppet may also have a complicated control system to manage the movements that make the creature look real.

Today, many films use both animatronics and 3-D computer graphics. While creatures may be easier to create on a computer screen, animatronics allows actors to interact with physical creatures.

If you are interested in the world of animatronics, find out if your school is involved in any robotics competitions that are available to schools. Visit the Nelson Science website to learn more about building a robotic hand.

To learn more about animatronics,

[Go to Nelson Science](#)



Examining Physical Systems

Every system has a purpose or function for which it was designed. To perform its function, the system requires some kind of input to achieve the desired output. A device may have subsystems or mechanisms that perform smaller parts of the overall function. In this activity, you will examine common products to determine their purpose and some of their inputs, outputs, and side effects.

SKILLS MENU

- | | |
|--|---|
| <input type="checkbox"/> Questioning | <input type="checkbox"/> Performing |
| <input type="checkbox"/> Hypothesizing | <input checked="" type="checkbox"/> Observing |
| <input type="checkbox"/> Predicting | <input checked="" type="checkbox"/> Analyzing |
| <input type="checkbox"/> Planning | <input type="checkbox"/> Evaluating |
| <input type="checkbox"/> Controlling Variables | <input checked="" type="checkbox"/> Communicating |

Purpose

To identify the purpose, input, output, and side effects of common physical systems.

Equipment and Materials

- scissors
- nutcracker
- flashlight
- wind-up toy
- hammer and board with nail
- salad tongs
- adjustable wrench
- portable hair dryer
- musical instrument
- microscope
- other materials provided by your teacher



scissors



nutcracker



flashlight



wind-up toy



hammer and board with nail



salad tongs



adjustable wrench



portable hair dryer



musical instrument



microscope

Procedure

1. In your notebook, construct a table similar to Table 1 (on the next page). Do not copy the information about the bicycle. It serves only as an example to help you.
2. Record the name of a system and its overall purpose in your table.
3. Examine the system to determine which components are responsible for performing specific tasks. Record your observations in your table.
4. Record the mechanism or subsystem responsible for performing part of the purpose, the input required, the desired output, and side effects.
5. Repeat steps 2 to 4 for each of the systems given to you.

LINKING TO LITERACY

Reading Procedural Text

Procedural text is used when the reader needs to follow instructions to reach a goal. Think about other kinds of procedural text you might have used—a recipe or instructions for putting something together. Procedural text always has a purpose, sometimes requires equipment and materials, and asks the reader to follow a series of steps.

Table 1 Examining Systems: Purpose, Input, Output, and Side Effects

System: Overall purpose	Components: Mechanisms or subsystems involved (if applicable)	Desired task	Input	Output	Side effects
Bicycle: • transportation	pedals, gears, and chain system	• to turn the back wheel	• downward force on the pedals	• pushing force of the back wheel against the ground • forward motion of the bike	• friction between the gears and chain slow down the bike
	gear shifter	• to move the chain between gears	• pushing or pulling of the gear lever (or turning of the hand grip)	• pushing or pulling of the chain from one gear to the next	• vibration during gear change
	brakes	• to slow or stop the wheel	• grasping force on the brake handle	• gripping of the wheel rim by the brake pads	• screeching noise, wearing down of the brake pads

Analyze and Reflect

(a) *Inter-* means between or among, and *connect* means to link. How does the word “interconnected” apply to systems and subsystems?

Apply and Extend

(b) How might an understanding of components, purpose, input, output, and side effects help a repair person determine how to fix a product (Figure 1)?



Never attempt to fix or test an electrical product without the help of a knowledgeable adult. Electrical shocks or fires could result.

(c) Choose two systems and explain how one component affects the way the other components function.

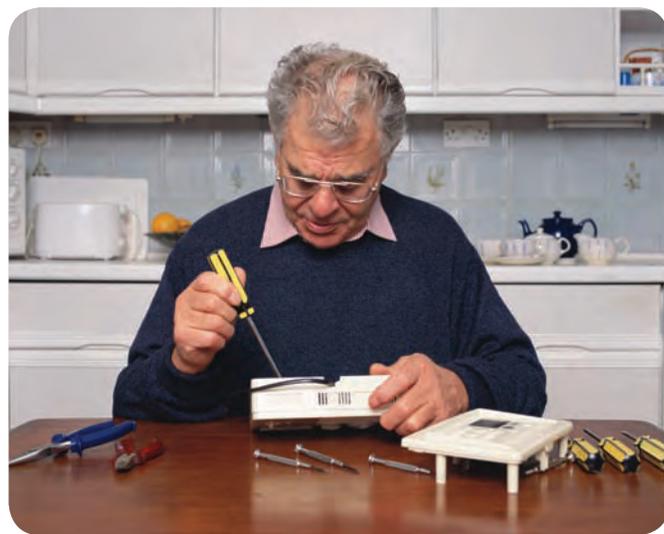


Figure 1 How might knowing about inputs, outputs, and side effects help you fix a device?

(d) Choose two other systems and describe what might happen to a component to make the system unsafe to use.

Systems Evolve

All systems change or evolve over time. What drives these changes? Changes to living conditions, changing social conditions, and new technologies all contribute to the ways systems evolve. The following systems have changed a lot in the last few decades.

Waste Management Systems

People produce mountains of waste. Canadians produce about 31 million tonnes of waste each year. In the past, we just piled it up



Figure 1 Waste management is a major social concern.

or buried it. Today, about 67 % of our garbage is buried in landfill sites (Figure 1). As populations grow, and concern for the environment increases, we recognize the need for better waste management systems. In many countries, including Canada, landfill is only one part of waste management. Other parts include recycling programs, hazardous waste drop-off depots, composting, incineration, and public education to reduce the amount of garbage generated.



TRY THIS: A School Litter Management System

SKILLS MENU: observing, communicating

We are often asked to “think globally and act locally.” Taking action to improve your local environment is one way to begin; and carefully examining the problem is a good place to start.

Equipment and Materials: map of school and school grounds divided into sections, lined paper or notebook

1. Walk around your assigned section of the school. On the school map, record each location where you find litter.



Do not pick up any litter unless given instructions by your teacher on how to do so.

2. Record the amount and type of litter found at each location.
3. Use your data to help build a class report.
 - A. What type of litter was most common? Was this litter generated from the school or the community? State your evidence.
 - B. Develop plans for an in-school litter management system. The system should include a communication plan (for example, a poster campaign) and an action plan (for example, a way to eliminate the litter problem).
 - C. How did the class work together as a social system?

Telephone Systems

Telephone systems have been around since the late 1800s, but have undergone many changes over the past 50 years. Early telephones (Figure 2(a)) relied on a number of physical mechanisms. These phones had a spring-loaded “hook” that moved up when the handset was lifted off the base to answer a call and moved down when the handset was replaced. Early phones also had a circular disk called a “rotary dial.”

Electronic touch-tone phones, in which callers pressed buttons instead of turning dials, became widespread in the 1960s. Up until the 1980s, most telephones were connected by wires. Calls had to be made from inside buildings or outdoor phone booths. Today's telephones (Figure 2(b)) are smaller, mobile, and have different uses. They are completely electronic, with few, if any, moving parts. They can transmit sound, printed messages, photographs, and moving images all over the world. 

To learn more about the history of telephones,

Go to Nelson Science 



(a)



(b)

Figure 2 As systems evolve, do we become more dependent on them?

Education Systems

Imagine going to Grade 9 in a school where you did not need to attend regular classes all the time. What would it be like to be able to learn at your own pace and to write tests when you were ready? How would you like to have the freedom, within guidelines, to make your own timetable? Believe it or not, schools like this exist! Mary Ward Catholic Secondary School in Toronto is one of just two self-directed learning schools in Ontario (Figure 3).

Changing a school system is not easy. Some social factors ease the process, while others make it more difficult. When creating the self-directed learning system at Mary Ward, educators, students, and the community dealt with factors that helped the change (such as the belief that students are more successful when they take responsibility for their own learning) and factors that made the change difficult (such as the belief that students should finish all courses by the end of the traditional school year).



Figure 3 Mary Ward Catholic Secondary School is a school for self-directed learning in Toronto.

CHECK YOUR LEARNING

1. What are some parts (both physical and social) of a waste management system?
2. Early waste management involved dumping garbage in one spot and then burning it, burying it, or leaving it there. Describe some of the social factors that caused this system to evolve.
3. (a) What social factors need to be addressed when a conventional school plans to change into a school for self-directed learning?
(b) How would you react if your school planned to change into a school for self-directed learning? How would your parents react?

SKILLS MENU

- Defining the Issue
- Researching
- Identifying Alternatives
- Analyzing the Issue
- Defending a Decision
- Communicating
- Evaluating

consumerism: linking personal happiness with the purchase of goods and services

Consumerism

Consumerism is the practice and belief that happiness and satisfaction come from purchasing goods and services. As consumers, we often change systems long before it is necessary to do so. Relatively new devices are discarded while still usable (Figures 1 and 2). Why do we replace items that still function? What are the advantages and disadvantages of doing this? What, if anything, should we do about widespread consumerism? Do we also replace social systems that may still be functioning satisfactorily?



Figure 1 Usable computers often end up in waste management sites.



Figure 2 New mobile phones appear on the market every few months.

The Issue

We have been called a “throw-away” society. In our desire to have the latest devices, we throw away products and systems that still function. This behaviour comes with costs—to us, to society, and to the environment.

You are being asked to participate in a discussion as part of your community’s Future Leaders Association. Future Leaders is a community group whose goal is to influence businesses, environmental organizations, and social justice groups. Members come together to discuss issues of importance to society and make recommendations to regional councillors for making the community a better place to live.

Goal

To discuss the following statement and offer solutions as needed:

The benefits of being a throw-away society outweigh the costs to society and the environment.

Gather Information

First determine whether we truly are a “throw-away” society. Survey classmates about whether they have replaced any functioning systems lately, and their reasons for doing so. Check websites for facts about costs and benefits of consumerism. What are some of the specific environmental and social costs of our behaviour? Table 1 offers various points of view about consumerism.

Go to Nelson Science



LINKING TO LITERACY

Comparing and Contrasting

Table 1 compares a number of different points of view on the same topic. It helps to show the reader the similarities and differences between different roles. Compare the points of view of the environmentalist and the local politician.

Table 1 Consumerism: Points of View

Role	Point of view
business person	When customers buy my products, I can keep my workers employed. If people stopped buying things, I would have to lay people off and perhaps even close my business.
environmentalist	When we throw away things that are still useful, we create unnecessary waste. Much of that waste is plastic and will take hundreds of years to decompose. Some of the waste is toxic and can pollute soil and water. By learning to live with less, we can help future generations as well as the environment.
social worker	I'm not certain how consumerism helps those most in need. Work may be created, but most products are not made locally. The jobs go elsewhere. Our local people need to have jobs that pay well.
local politician	When people are working and spending, their taxes help pay for important things like roads, health care, parks, and water and waste management. However, if people consumed less, the costs of waste management would be reduced.
student	When certain things like calculators and computers are first produced, they are slow, large, and clunky. Then they come out with faster, smaller, and more interesting machines. I don't want to be the only one using old, outdated equipment!

Identify Solutions

Is there evidence that the Goal statement is true? Is there evidence that the statement is false? Consider some alternatives to the way we live that would help us and subsequent generations enjoy a more secure future.

Make a Decision

Decide where you stand on this issue, determine your key points, and be prepared to offer at least two alternative behaviours that would be effective and acceptable to Grade 8 students.

Communicate

Prepare to participate in the Future Leaders Association discussion by focusing on key points you want to make. You want to present your evidence in an interesting and effective manner. You may want to use software, a photo essay, a collage, or some other method to make a powerful statement.

Introducing Systems

BIG Ideas

- ✓ Systems are designed to accomplish tasks.
- ✓ All systems include an input and an output.
- Systems are designed to optimize human and natural resources.

Looking Back

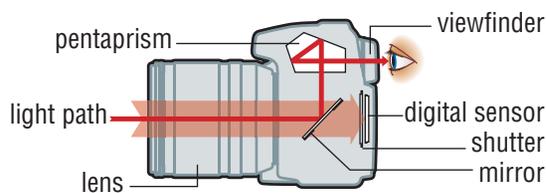
Systems are composed of parts that work together to perform a function.

- Systems are often composed of smaller subsystems and mechanisms that perform part of the overall function.
- Components of systems have specific tasks that they must perform for the system to work well.



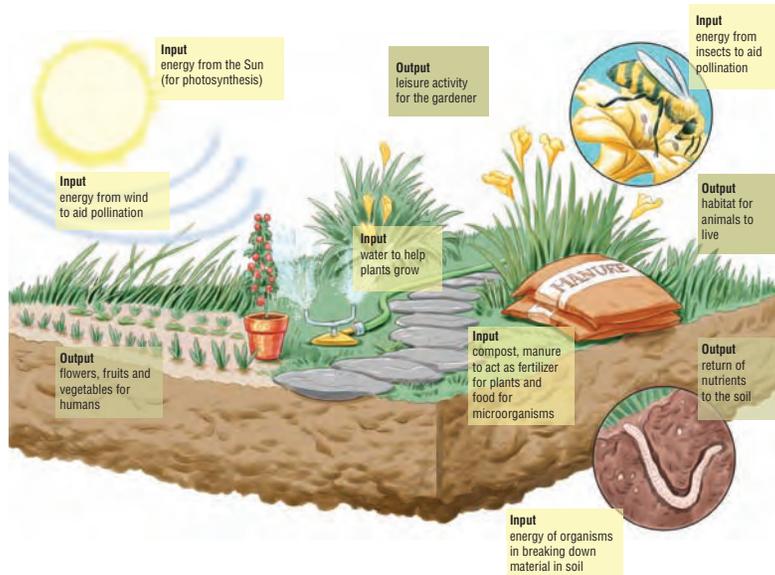
Systems may be physical (for example, telephones, electronic games, or organ systems) or social (for example, health care, transportation, education, police force, or an ant colony).

- Physical systems are often named according to the type of energy they use (for example, mechanical systems/mechanical energy, optical systems/light energy).
- Social systems are named for the type of service they provide (legal system, education system, transportation system, for example).



Systems have inputs, outputs, and side effects.

- Systems require inputs (force, energy, resources) and produce outputs (desired force, work, service).
- Many systems produce side effects, or undesired outputs.



VOCABULARY

system, p. 10
physical system, p. 10
social system, p. 11
force, p. 13
input, p. 15
output, p. 15
side effect, p. 16
systems thinking, p. 16
consumerism, p. 22

The skills of analysis can be used to study the inputs, outputs, and side effects of everyday systems.

- Devices may be investigated by identifying their subsystems and mechanisms.
- A system's usefulness may be evaluated by analyzing its effects on society and the environment.

The way we use systems affects society and the environment.

- Some side effects to using systems negatively affect society and the environment.
- People often replace systems, even when they still work.
- There are costs and benefits to consumerism.
- When we change how we make and use systems, we often impact society and the environment.
- Systems thinking is an ability to understand how parts of a system relate to all other parts, as well as how the system as a whole relates to its users, society, and the environment.



What Do You Remember?

- When using a can opener, what input force is involved? What is the output force? 
- Different types of physical systems are named for the type of energy they use. Give an example of each type of system and state the type of energy they use.
 - mechanical system
 - optical system
 - electrical system 
- Identify two components of the following systems:
 - the circulatory system
 - a can opener
- Social factors can influence the evolution of a system. For example, when more women joined the work force, the need for quality child care rose.
 - Name two systems, and for each one list two social factors that have caused those systems to evolve. Discuss your answers with a partner. 
 - From your discussions, add one more system to your list and describe two social factors that caused it to evolve.  

What Do You Understand?

- Use a Venn diagram to compare physical systems with social systems. 
- Explain why a garden is a system. 
- Name five products or devices you used today, and tell which type of physical system they represent. (For example, a bathroom tap is a mechanical system.)  
- Pick any natural or human-designed system of interest to you. List four components and describe what part of the process each contributes to making the system run well. 

- For each of the machines or systems in Figure 1, identify the following:
 - the desired task
 - the input
 - the output
 - any side effects of the system  



Figure 1

- You can make an electromagnet by wrapping a coil of wire around a nail (Figure 2), and then passing electricity through the wire. Identify four components of this system and tell the function of each.  

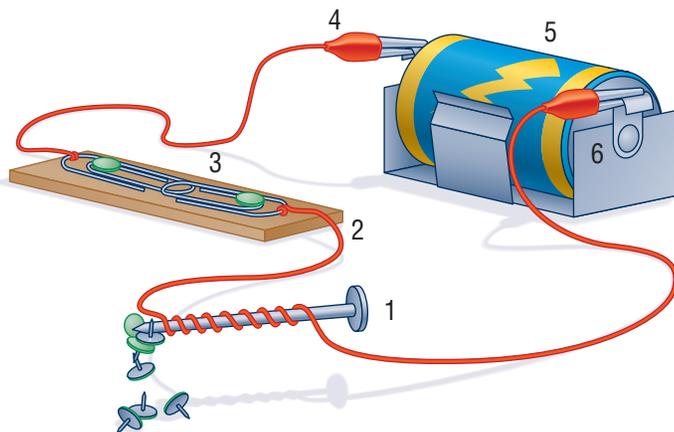


Figure 2



11. Choose two of the social systems listed below. For each system you have selected, list one or two desired tasks, inputs, and outputs, including side effects:
- (a) public transportation system
 - (b) Ojibwe clan system
 - (c) health care system
 - (d) waste management system **K/U A**
12. Why is it often more difficult to analyze social systems than physical systems? **K/U**
- Solve a Problem!**
13. Ensuring student safety is one of the functions of a school system. Car traffic in front of a school at the start and end of the school day can sometimes be a problem.
- (a) Identify the desired outcomes of parents driving their children to school.
 - (b) What are some of the side effects of students being driven to school?
 - (c) Propose a traffic system that would meet the needs of parents and the school.
- T/I A C**
- Create and Evaluate!**
14. Think of a device that you have used in the past 24 hours.
- (a) How was the device useful to you?
 - (b) Identify the subsystems in the machine and the function of each one.
 - (c) Summarize how the subsystems contribute to the overall purpose of the device. **K/U A**
15. Research a system that has undergone significant changes in your lifetime. Use electronic and print resources to create a timeline showing the major changes that have occurred to the system over time and the reasons for each change. Remember to cite your sources of information. **T/I A C**
- Go to Nelson Science**
16. Name two systems that you use a lot. For each system, describe how using it positively or negatively affects the environment. **A**
17. In your opinion, what is the most useless device you have in your house? What is its purpose, and why do you think it makes little sense to have it? **A C**
18. For each social system below, suggest what you think are its two most important components. Justify your answer.
- (a) health care system
 - (b) justice system
 - (c) education system
 - (d) public transportation system **T/I A C**
19. Cars cause pollution. Mountain bikes compress and erode soil, destroying plants and habitats for animals. It is believed by many that our use of certain systems is causing global warming. Choose a system and create a poster to convince people to use it in a way that helps conserve or protect the environment. **T/I A C**
20. Choose any two industry sectors from Table 1 in Section 1.2. Research them to find two other physical systems related to that industry and two other related social systems. **T/I A C**
- Go to Nelson Science**
- Reflect on Your Learning**
21. What knowledge about systems was the most interesting to you? What information about systems was the least interesting to you? Explain your choices. **T/I C**
22. Think back to the Key Question on the first page of this chapter.
- (a) In a brief paragraph, answer the Key Questions. You may use diagrams.
 - (b) Write one or two more questions about the topic of this unit that you would like to explore.