From: LIFE PLANS by
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14

Systems Thinking

"I could really do better if I knew how to . . ."

"Making up my mind is hard when . . ."

"So many things seem to happen at once that I . . ."

Sound familiar? How often do you act without being quite sure what you're doing? Are you ever sorry for something you did or did not do? Do you ever go along with another person's idea because you don't have a better one? When was the last time someone else made up your mind for you? Did you feel trapped or sorry afterward? If you answer "yes" to such questions, join the club. Everyone does those things sometimes!

Perhaps you acted under pressure. Maybe you felt that doing *some*thing was better than doing *no*thing. You didn't take the time to figure out what was going on and why. What happened in the end? You probably didn't get the results you hoped for. In fact, maybe you have learned to expect the unexpected! You can improve your chances of having things work out the way you want them to. You can gain more control of your own life. You can learn to manage.

SEEING THE BIG PICTURE: A SYSTEMS VIEW

One way to gain control of your life is to see the big picture. Have you ever been in a plane or on top of a mountain or high building? You get a different perspective on things. You see much more than you can up close. You can gain a similar perspective on your own life. You can get a "big picture" or general perspective on everything that has an effect on you and the choices you make.

Systems thinking is one way to look at complex problems without becoming confused. You can learn to see things from this new perspective. You can learn to see them as *units* instead of as separate parts. You can learn to see forests instead of just trees! And you can apply this kind of thinking in your everyday life.

Linear Thinking

Remember how you first learned to think? It was in terms of cause and effect. For example, two-year-old Jessie's mother says, "If you don't finish your vegetables, you get no dessert." That's an early lesson in cause and effect. Four-year-old Mark learns that if he throws his toy on the floor it will break. If it breaks, it won't work. If it doesn't work properly, he won't be able to play with it. His friends won't be able to play with it either, and maybe they won't want to play with him. One cause has one effect. One effect becomes the cause of another effect. Cause and effect links events in space and time. Events are understood in an "If . . . then" framework. But not everything fits into this kind of thinking.

As Jessie gets older, she learns that if she does not eat properly, she may not have the energy or endurance she needs to qualify for a swimming meet. A swimmer who is in better shape and who outperforms her makes the best time. That swimmer gets to try out for the Olympics. If Jessie wants a chance at the Olympics, it will be more complicated than just watching what she eats. She also needs knowledge of the sport and the rules of competition to achieve her goal.

When Mark breaks a toy, he may be bored for a while. Later in life, if he totals a bike or a car, he may not be able to go to his job or out on a date. A whole lot of things may happen. As we mature, our lives get complex.

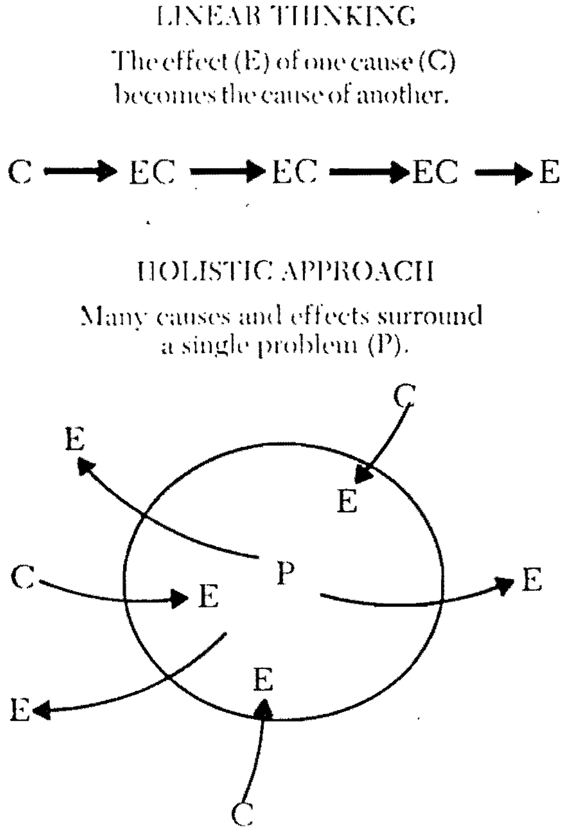
Systems Thinking

Cause-and-effect thinking is fairly simple. It is *linear*, like a chain reaction. You see things one at a time. One event is obviously related to another. Linear thinking still works a lot of times, but sometimes it is too limited. Complex events have more than one cause. The same cause has more than one effect. You need to think about complex problems differently.

Systems thinking is a way to think about complex events. It is a holistic approach. *Holistic* means taking wholes or units into account. You don't just think about a part of the problem. You try to see it in relation to other things. Systems thinking provides a fresh approach to everyday happenings. Figure 14-1 diagrams the differences between linear thinking and the holistic approach.

For example, let's say you want a new vest to wear, or you want to have a picnic to celebrate your birthday. Making a garment or planning a picnic starts with a mental picture of a goal. You can't think about just one part

Figure 14-1



of the vest. The front and back are part of a whole unit. The fabric is related to the design. So are the buttons and thread. The vest is related to your body shape. The skills needed to make the garment are important parts of such a project, too. So is the time available between getting the idea and having the vest ready to wear. Just wishing won't make it happen! You have to get organized. You have to manage your time, energy, skills, and materials to get the result you want. When the vest is completed, you judge your satisfaction by how it looks and how it fits. You are already engaged in a form of systems thinking.

As for the picnic, you also need to get things together so they coordinate as a whole. What if you take off for the beach and halfway there you find somebody left the hot dogs at home? If you arrive and find you don't have a blanket and the ice is melted? You may still have fun — but was it the way you imagined it would be? If you had thought every part of your plan through in advance, things might have turned out differently.

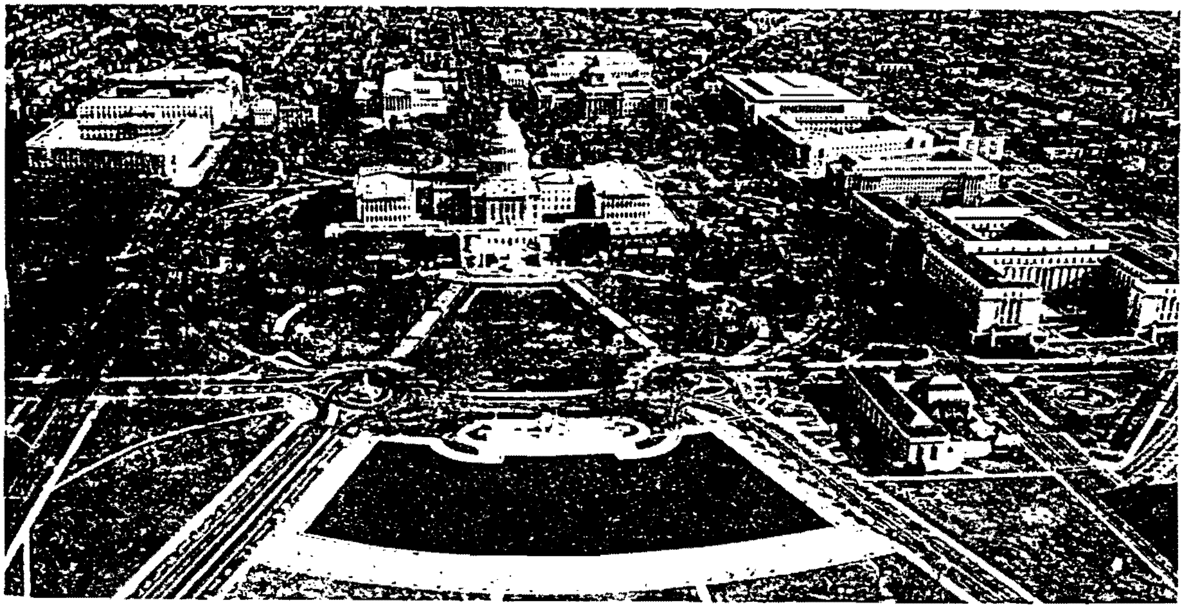
Systems thinking is one way to think of several things at once. When you make a garment, you are not just "stitchin'," and when you plan a meal, you are not just "stirrin'." In both cases, you are also "thinkin'" — aren't you?

Describing a System Objects and events that are related in their purpose and depend on each other to function make up a system. All the parts of a system are *inter*related, *inter*connected, and *inter*dependent. Because of this, a change in any part of the system will affect other parts of the system. Just one change can affect several things at once. Systems thinking challenges you to look for connections — even when they don't seem obvious.

The Goal of a System A system is identified by its overall purpose, or goal. Some systems have more than one goal. In general, a system has one major goal — to maintain itself, to keep itself going. This goal is called *system maintenance*. All parts of the system must work together to achieve this goal.

Visualizing a System You can't actually see or touch a system. It is too big. But you can see or touch parts of it. You can hold a picture of the entire system in your mind,

14-1 An abstract concept like "government" is sometimes better understood through a concrete symbol. This view of the U.S. Capitol, flanked by the Senate office buildings, the Supreme Court building, and the Congressional office buildings, reflects at a glance our system of government with its interrelated parts.
Library of Congress



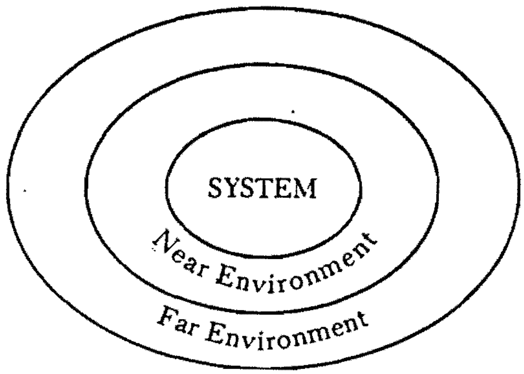
just as you can "see" the vest before you start it and can "see" the picnic as you start to plan it.

To visualize a system, you must first think about all or at least most of the parts it needs to achieve its purpose. Once you do this, you can draw a boundary, or mental line, around the whole thing.

System Boundaries Every system is a part of a larger system. It is also separated from it by a boundary. The boundary defines what is *inside* the system and what is *outside* the system. Everything outside the system's boundary is called its *environment* (see Figure 14-2). A system may have more than one environment. For example, your skin is the boundary between your body system and the environment outside it. But you breathe in oxygen and exhale carbon dioxide. You take in food and excrete waste. You are interactive with the environment, but your boundary stays the same.

Types of System There are many types of system. Each is enclosed within its boundary. A *physical system* is part of nature. It is the nonliving parts made up of chemical elements like carbon, hydrogen, oxygen, and nitrogen. It includes atoms and molecules. It includes the physical forces that hold them together, like gravity and velocity.

Figure 14-2 In this illustration, the system is shown in relation to a *near environment* that influences it most directly. Indirect influences come from the *far environment*. You can think of the system as yourself, or your family, or your neighborhood. In each case, the view shifts. When *you* are the system, your family is part of your near environment. When your family becomes the system, how does this picture change? What is its near environment?

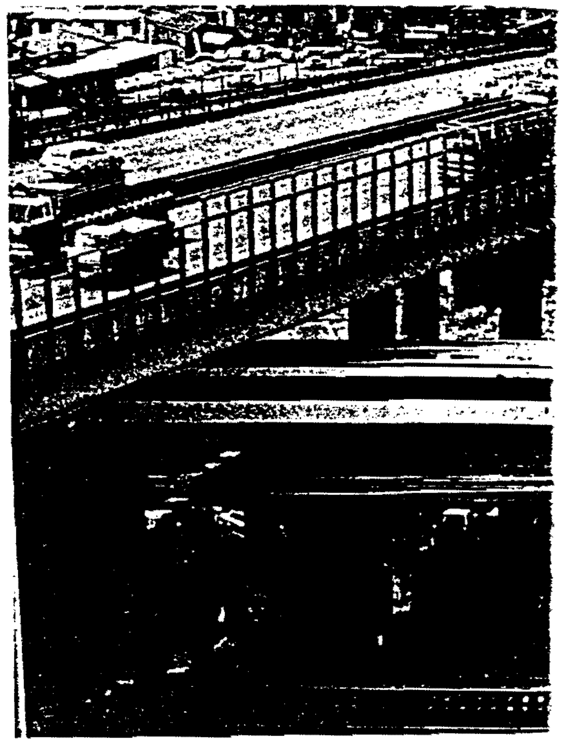


Natural systems also include lakes, mountains, rivers, oceans, prairies, tundras, forests, grasslands, and such forces as wind, rain, and snow. Natural systems become the lifespace, or habitat, of living species. A species is a living system of interrelated plants or animals. The natural system and the living system can be studied as a unit. In this case, they become an *ecosystem*.

A *social system* is made up of interacting human beings. Instead of seeing vast numbers of isolated human beings, we group them in social systems. Clans, tribes, and families are social systems. Because a family and its habitat provide a lifespace for a human group, it has been regarded as an ecosystem in Chapter 4. By looking at a family as an ecosystem, we see what families of different kinds in different times and places have in common. They all meet the life-support needs of their members.

Human beings create various systems for various reasons. *Economic systems* regulate the production and distribution of goods and services. *Political systems* control the distribution and exercise of power. *Mechanical systems* are products of human invention. They are the results of our technology.

A *transportation system* is devised to move people and goods. For example, cars, buses, traffic lights, highways, subways, airplanes, bridges, railroads, and traffic laws are all related. They are parts of the transportation system. If any part of the transportation



14-2 In this bird's-eye view of a transportation system, you can see how different elements—railroads, tracks, trucks, passenger cars, and highways—work together toward a common goal of moving people and goods.
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system breaks down, something will happen in other parts of the system.

What happens if a bridge is closed? What happens when an accident blocks traffic? What happens if a traffic light fails to function properly? Isn't each part of the system important to the whole? What if everything goes wrong at once? The system would be in big trouble, wouldn't it? It would not be serving its purpose.

Do you look at speakers, tuners, and amplifiers as separate items? Don't you call them a *stereo system?* They work together to bring you the musical pleasure you want.

Consider your experience as a student. Students, teachers, administrators, schools, school boards, textbooks, janitors, classrooms, laboratories, and school buses are all part of the *education system*. Why? Because they are all related to the purpose of education.

The same person, thing, or event can be part of more than one system. You are part of the social system, the economic system, and the education system. A school bus is part of the transportation system *and* the education system.

Systems Interface The place where the boundary of one system meets the boundary of another system is called the *systems interface*. For example, your family system interfaces with the natural system, the economic system, and the education system. Where systems interface, *transactions* take place. Two basic system transactions are the exchange of energy and the exchange of information. The system needs energy to do its work. It needs information to do its work properly. A system can exchange energy or information with more than one system.

Systems Process Energy and Information

A system's efficiency depends on how well it processes energy and information. Whatever enters the system from outside and whatever activates it from inside are called *inputs*. An input to the system, therefore, can come from both inside and outside its boundary. For example, the message "Lunch is ready" is an input. So is the physiological message "I'm hungry." The first input comes from outside, the other from inside, your living system. Inputs are a stimulus. The system must respond. The system responds by acting on the stimulus. These actions are processes.

The input must be processed. Because inputs are just "passing through" the system, processes are also called *throughputs*. A throughput is any process that changes or acts on the input. When input has been processed, it leaves the system as *output* (see Figure 14-3). For example, food is an input to your body system. It is processed into nutrients your body can use and wastes your body cannot use. Digestion is a throughput. Energy to do work is an output. So is body waste.

Outputs are inputs that have been changed, used, or just moved through the system as a result of various processes. For example, information may enter the system. If not processed and used, information leaves the system as it entered. The input may be wholly or only partly changed. If your mother inputs the message "Lunch is ready," and your body inputs the message "I'm hungry," you eat your lunch. If your mother inputs the same message, but your body message is "I'm not hungry," there is a different outcome.

Figure 14-3 Anything that enters a system may be changed by processes or activities that occur in the system. The input goes into the system. The input is put through the system (i.e., processed). The changed input leaves the system as output.

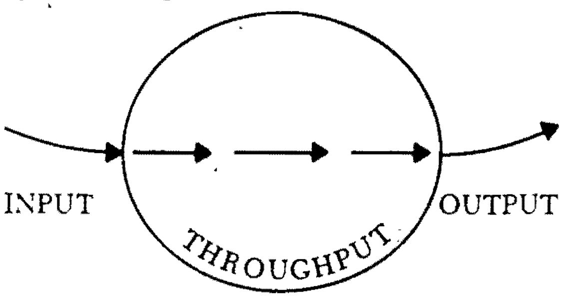
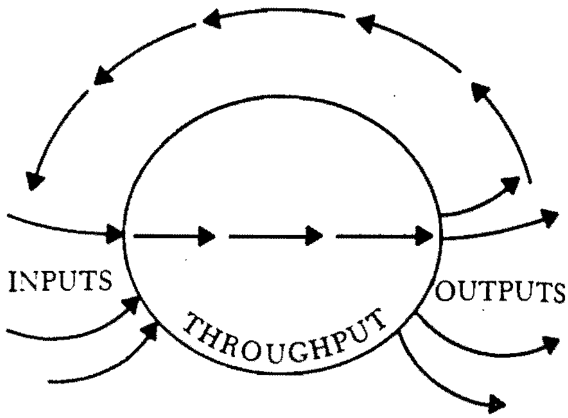


Figure 14-4 When output returns as input to the system that produced it, it creates feedback, or a feedback loop.



You don't eat your lunch. But there is another possibility. Your culture may teach that it is improper to refuse food when it is offered. In that case, the message "I'm not hungry" may be overridden. You eat even when you are not hungry.

The Role of Feedback

Feedback is a special kind of input. It is output that returns or "feeds back" to the system that originated it. It returns to where it started, making a *feedback loop* (see Figure 14-4). Feedback makes it possible for systems to change their operation. Feedback loops let the system know how well it is achieving its goal. *Positive feedback* is a "yes" message. It serves as a green light. It tells the system that it is "okay" to continue as it has been or that its goal has been reached. You can get feedback in the form of a smile from your mom when you eat your lunch. It can also come from your internal feeling of satisfaction after eating.

Negative feedback is a "no" message. It informs the system to change what it is doing in order to function properly. If you tell your mother "I'm not hungry" on hearing that "Lunch is ready," her frown provides you with negative feedback!

Mechanical systems operate on the principle of feedback. Take the case of a room humidifier. It is a mechanical system designed to regulate the amount of moisture in the air. That is its only purpose. If the water in the system evaporates, the motor stops. A red light goes on. This is a signal to "input" water. When this is done, the red light goes off and the system resumes its work.

Your body is something like this. In your body system, thirst is a signal that it is time for you—the system's operator—to take in or input water. Once you meet this need, by drinking (throughputting) water, you are no longer thirsty.

Modern living requires that you be aware of the role of feedback in many areas of your life. Another mechanical system with which you are familiar is the refrigerator. It is a self-regulating system—once its controls are set. There is a "set point" that controls temperature. A thermostat provides feedback. When the refrigerator's temperature drops below the set point, it gets too cold. If the temperature goes above the set point, the refrigerator gets too warm. The thermostat registers this information. It sets the machine in motion to bring the temperature to the desired level. So long as the thermostat and the rest of the machinery are in working order, the refrigeration system performs its function.

Feedback Loops

The pathway that feedback takes to return to the system that produced it is called a *feedback loop*. Some feedback loops are simple. They are short and direct. For instance, someone you want to please thanks you for a favor. That is a simple, direct feedback loop. If that person tells your teacher and your teacher tells your neighbor and your neighbor tells your parents *and* your parents tell you how pleased they are to hear good things about you—*that's* a longer, indirect feedback loop!

Biofeedback: A Special Case

Your body is more complicated than any machine. It has a number of feedback loops that must all work *together* to keep you in physical and mental health. Among these are feedback from your respiratory, circulatory, skeletal, digestive, and nervous systems. Your body system can keep itself operating properly by means of *biofeedback*. Biofeedback is provided by the organism itself. Some biofeedback is automatic. Thirst is an example. Some biofeedback is controlled by the individual. For example, some people can change their heart or pulse rate by meditating. Some can block pain messages through an exercise of will.

Your Body System

Your skin is the boundary between your body system and its many environments. Your skin and other sense organs interface with your environment. They input information for your brain to process. This information comes in many forms, such as sensations. For example, your skin registers pressure. It registers changes in temperature. Your brain interprets this input. It translates it into concepts such as "It is cold," or "It is getting hot." Your skin may "output" perspiration or "gooseflesh." These reactions may solve the problem. Or you may act on this information in other ways. You can change your environment. You may open or close a window. You

14-3 The human body is a system of interrelated, interconnected, and interdependent parts. Proper food, air, rest, and sleep are inputs. Exercise is a throughput that keeps the system fit and provides positive feedback—a good appetite, a reserve of energy and endurance, and a sense of well-being.

may drink some warm soup. You may put on or take off clothes. You can turn the thermostat in the room up or down. You can move closer to a stove, fireplace, or radiator. You can do any or all of these things. To date, no mechanical system has been designed that can act as quickly or respond in so many ways as a human being can.

Maintaining a System

To maintain itself, a system must keep its inputs and outputs balanced. This balanced state is called *equilibrium*. Equilibrium is constantly being maintained by feedback loops. Equilibrium does not mean that things stay the same. They change. But the system as a whole stays the same. This is called *dynamic equilibrium*. You can visualize dynamic equilibrium by thinking of a piece of mobile sculpture.

Each part of the sculpture is connected to the others. If one part moves, so do the others. The same parts end up in a lot of different positions. It may not always look the same. But the sculpture as a whole *is* the same. It is a unit in interaction. The parts are in dynamic equilibrium. So, too, with a human being. You are a living system whose subsystems must remain in dynamic equilibrium. This is a state of wellness—or positive physical, mental, and social health.

Needs and Wants: Programmed Inputs In Unit I, we discussed the hierarchy of human needs as described by Maslow. Human needs are inputs programmed into us as members of the human species. Wants are inputs programmed by the culture. We must learn to separate needs from wants. For example, when Max wakes up and says, "I am hungry," he is responding to a programmed biological need for food. When his brother asks him what he wants for breakfast, and he says, "Cornflakes and milk," this "want" is programmed by the culture. Max has *learned* to want cornflakes and milk for breakfast.

If Max lived in France, he might answer his brother's question by saying, "Brioche et chocolat." He is stating his preference for a roll and cocoa. If Max were a Hispanic American, he might request "Frijoles refritos y cafe." This would tell his brother that he wants refried beans and coffee. The need is the same in each case. How it is met is influenced by the culture each person lives in. Cultural preferences are also an input.

The basic human program exists from birth. It is in your chromosomes and genes. It is part of the genetic code discussed in Chapter 2. In each of us it is reprogrammed by the culture in which we live. Both the need and the want are system inputs that must be processed together.

Stress: System Overload Systems need inputs to maintain themselves. But systems may become overloaded. They may try to do too much. A system becomes overloaded when it has too many inputs or when inputs come too quickly to be processed efficiently. If the load is too heavy, parts of the system start to break down. If the system cannot recover, other parts are soon affected. The entire system starts to break down. It cannot function properly. The result of such system overload is *stress* on the system. Extreme stress ends in disequilibrium and the breakdown of the whole system.

Restoring Equilibrium To restore itself, a living system must adjust its behavior to keep inputs and outputs in balance. It does this through complex feedback loops. Some-

Applying Systems Thinking in Everyday Life

How can you use systems thinking in everyday life? Below are two examples of how you can examine some things you take for granted from a systems perspective. Let's say in one case that your goal is to make butter. In the other, your goal is to be healthy.

	Butter	Health
INPUTS	Cream Energy Churn Know-how Time Standards of taste	Heredity Environment Your body systems Good food Sunlight Fresh air Pure water Health knowledge
THROUGHPUTS (including PROCESSES)	Churning Not adding salt Adding salt	Wise eating Dieting Exercising Sleeping and resting
OUTPUT(S)	Sweet butter Salt butter Buttermilk	Health Fitness Good looks Good feelings
FEEDBACK + Positive − Negative	+ Fresh, tasty butter − Butter that is too salty, not salty enough, or has too much buttermilk in it	+ Improved health − Fatigue and physical problems (maybe from "overdoing it")

times, it is necessary to intervene in this process. For example, doctors do this when they diagnose disease. They may restore equilibrium by replacing parts of a damaged system as, for example, when they do a heart bypass operation. The bypass operation is a way to restore a feedback loop in the circulatory system. It helps the overloaded system to recover.

Natural systems may also be stressed because of overload. This happens when humans dump toxic wastes in natural systems. Later they may have to intervene in order to restore the natural system to health. They introduce waste treatment plants or other measures to maintain our ecosystem.

Systems Thinking for Everyday Life

Systems thinking can help you analyze a problem in everyday life so you can see all its related parts. Once you learn to use systems terms, you can use them to describe many different systems. Most important, you can program yourself in ways that help you maintain your own system—your "self system"—at peak performance. This ability allows you to manage the events that affect your daily life. In effect, it allows you to design your own life in the way you choose to program yourself.

Information processing offers you a way to sort through many inputs. It can help you defuse the time bomb of system overload created by constant frustration and stress. You can process information to help you make choices that meet your needs and satisfy your wants reasonably well.

A calculator can process numbers. A computer can process data and words. You can do these things, too. Computers do many humdrum tasks. They do many complex ones, also. But human beings are more complicated than the most advanced computer. The information processing that is related to your well-being takes place in your brain. T most creative decisions and choices are up you. That is because you are not a machi You are a human being.

END OF CHAPTER

Check It Out

1. What are the differences between cause-and-effect thinking and systems thinking?
2. Describe different kinds of systems.
3. How do systems interact with each other?
4. How does feedback affect a system?
5. What are the differences between needs and wants?

Decision Path One
Manage a Store (Retail Outlet)

Step 1. Look over the chart of retail outlets on pages 438-439. Compare the types of services. Select three different types of stores that you might like to manage.

Decision Path Two
Manage a Summer Recreation Program

Step 1. Contact the recreation department in your community. Find out the types of recreational activities offered.

Decision Path Three
Design and Market a New Product or Service

This activity has two parallel plans—*designing* and *marketing*. Any new or altered product or service has a design/production phase and a marketing/distribution/sales phase. This Path can be done by one or two people or by a team. Each plan is separate, yet side by side. The design/production phase usually begins first. The marketing/distribution/sales phase usually starts shortly thereafter.

Step 1. Select the product or service in the following way. Identify products or services that are in demand according to newspaper articles, "interview on the street" surveys, and opinion polls along with your own knowledge, experience, and skills. For example, you might decide to produce and sell holiday craft items such as tree ornaments, felt-covered cans to hold pencils and pens, or sets of paper or fabric gift bags with drawstrings.

Decision Path Four
Plan a Wedding

Step 1. Plan interviews with at least six people about their weddings. Prepare a list of questions for your interviewees and an interview log to record responses. Ask about the hour, day, and month of the wedding; attire; number in the wedding party; preliminary events such as engagement parties, showers, rehearsal dinners, etc.