PART 6: For Additional Help.....

For more help with this activity, look up the following terms. You'll find some of them in this book. (Check the index.) You'll find others in dictionaries, encyclopedias, and other resource materials.

bill of materials
brainstorm
cost-effective
orthographic projection
problem-solving method or approach
prototype

PART 7: How Well Did You Meet the Challenge?.....

When you've completed your invention, evaluate it. Have you achieved what you intended? Work with your teacher and classmates to evaluate all the inventions. Consider the following qualities for each and then discuss responses to the questions.

- usefulness
- safety
- innovativeness (newness, originality)
- cost-effectiveness

1. What features do you particularly like in some of the other inventions? Why?
2. Which inventions are best or most practical for aiding handicapped persons?
3. Which inventions could help persons with more than one handicap?
4. How could your own invention be improved?
5. How did you use each of the basic resources of technology in the development of your invention? (people, information, materials, tools and machines, energy, capital, time)
6. If you were to design and build another device to aid the handicapped, what would you do differently?

PART 8: Extending Your Experience.....

This activity helps you realize some of the many ways in which technology can be used to make people's lives easier. Also, through experience, you have gained understanding in how basic resources of technology are used to solve technical problems.

Think about the following questions and discuss them in class. You'll find more about using resources to solve technical problems in Chapter 10, "The Design Process/Problem Solving Process," and Chapter 11, "Designing Graphic Solutions."

1. What handicaps were not addressed by your class? How can technology be used to help overcome these handicaps?
2. Are there handicaps that are too complex for today's technology to be effective in correcting? What future technological breakthroughs would be useful in overcoming complex handicaps? (Use your imagination. In technology, things that are only ideas today may become realities tomorrow.)

CHAPTER 10

The Design Process: A Problem-Solving System

Introduction

The Dictionary of Occupational Titles, published by the United States Department of Labor, lists more than 20,000 jobs. "Problem solver" is not one of them. Yet, if you spoke with people employed in many of those jobs, you would probably learn that much of what they are responsible for is designing solutions or solving problems.

There are, however, many occupations that have the words *design* or *designer* in their titles. Fig. 10–1. Are a designer and a problem solver one and the same? As you continue reading, substitute one term for the other—does either term fit? In this way, you can make up your own mind.

After reading this chapter, you should be able to

Briefly explain each step in the problem-solving process.

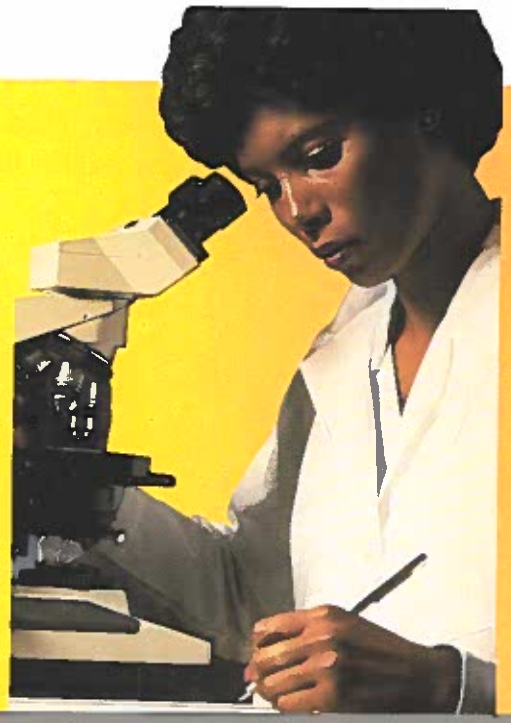
Give examples of market research and consumer research.

Describe the use of models and prototypes in the problem-solving process.

Evaluate the use of feedback in product improvement.

Words you will need

market research
consumer research
design criteria
brainstorming
mock-up
prototype
field-test



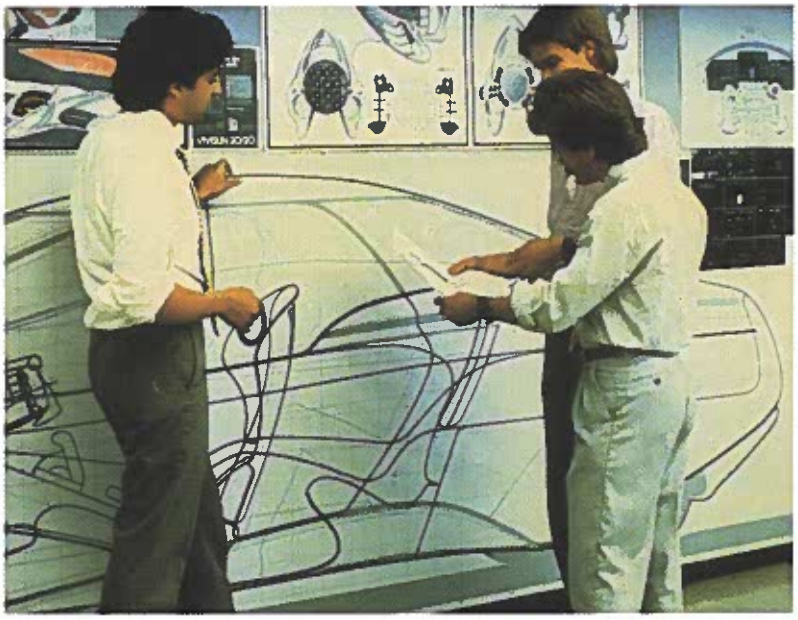


Fig. 10-1. Although *problem solver* is not a job title, many jobs place major emphasis on solving problems. Often, the solution to a problem involves designing a product.

A Basic Approach to Solving Problems

How do we go about designing a solution to a problem? Is there a process or system that we can use? Yes, there is. Although there are many different kinds of problems, most of them can be solved using a standard approach.

Will following this approach always guarantee the "best solution"? Hardly. Solutions to problems, like the world in general, are rarely perfect. In fact, it is not always possible to get a group of people to agree on exactly what the problem is.

In any event, the most that can be expected is for you to do your best. The material that follows will help you do just that. The basic problem-solving approach is shown in Figure 10–2 A and B.

Should you always follow the steps in this order? Yes, but some steps are of greater importance than others, and some can be combined with others. Also, you may need to repeat a few of these steps more than once, especially the last two. Let's take a closer look.

Recognize the Problem

You might not have realized it, but you solve many problems on a daily basis. Did you have difficulty finding your shoes this morning? How will you decide where to sit for lunch? You see? All of these are problems that we have to solve every day.

Once you have identified a problem, ask yourself if it is stated clearly and accurately. Is it too general or overly restrictive? Can everyone involved understand it?

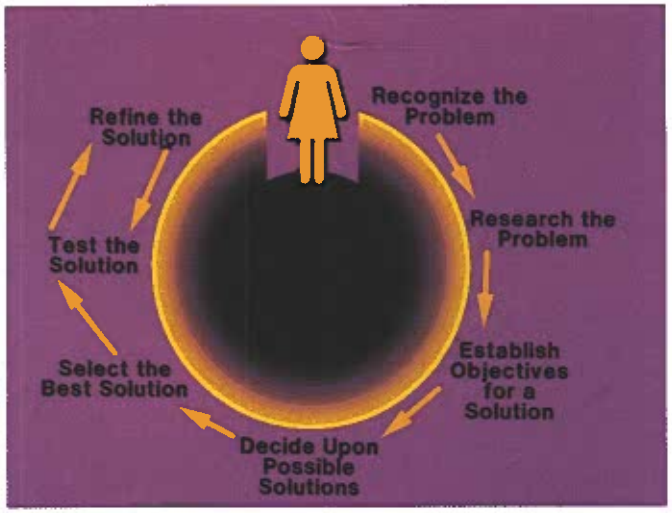


Fig. 10-2A. The problem-solving process provides a logical outline to follow, whether you're designing a product or solving another type of problem.

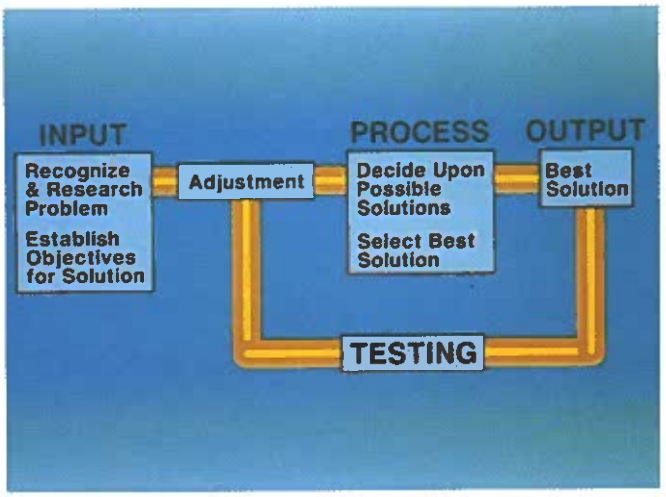


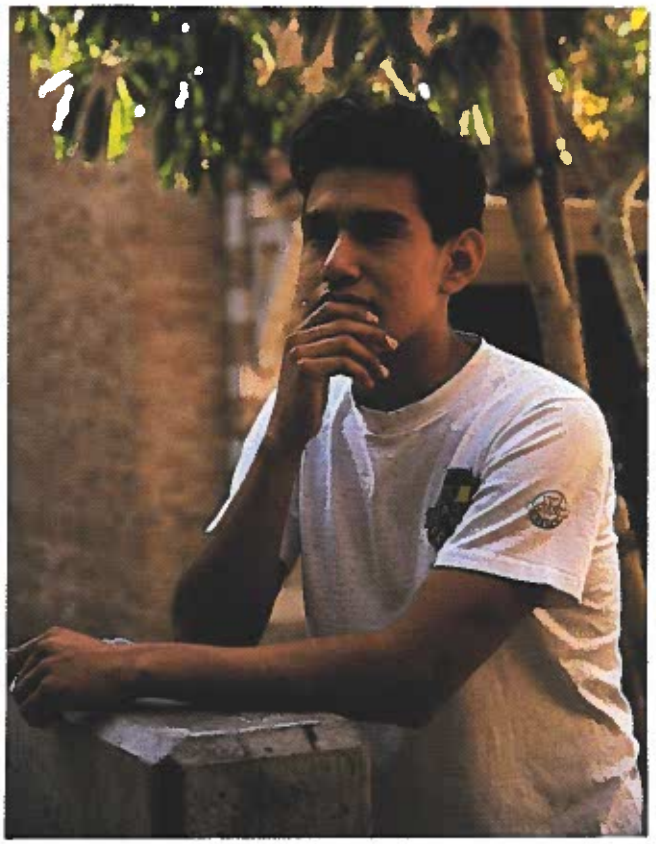
Fig. 10-2B. Like all other processes, the problem-solving process can be thought of in terms of inputs, processes, and outputs. The "testing" loop allows the solution to be refined.

If a problem is poorly stated, much of the effort you spend trying to solve it may be wasted. Consider for a moment this problem statement: "Design an inexpensive toy." Could you design an acceptable toy from that description? What else would you want to know? In fact, many necessary details are missing here. You will nearly always need to know some specifics about the nature of the problem. Remember, it is more difficult to solve a problem that you do not understand. Fig. 10–3.

TECHNOLOGY TRIVIA

Solving a problem can take a while. It took more than 20,000 engineers a billion hours of design time to develop the Space Shuttle.

Fig. 10-3. Just figuring out exactly what the problem is can take some serious thought. Taking time at the start to define the problem can save time later on.



Research the Problem

Gathering information is often the task given least attention in a design problem. People want to "get on with it," and not spend time in preparation. There are good reasons, however, for spending time researching your problem and gathering information. Mistakes made at the beginning of a product's design may flaw the final product. In addition, it is easier to correct errors during the "paper" stage than during manufacturing or installation.

How do you research a problem? Here are some general rules. First, try to focus on what will be most helpful. It makes little sense to gather all kinds of information on a topic, since not all of it will apply to the task at hand. Second, limit your research. Don't bother to research something with which you are already familiar. Finally, keep in mind that the material you gather should be practical. Avoid complex data that no one can understand.

Your approach to research will vary according to your topic.One approach is to talk to people who can help you. This includes anyone who might act as a resource: people in the same situation as you, experts, or people who sell or distribute your type of product. The list depends a great deal on the design problem itself.

You can also do library research. The library contains a wealth of information on almost every topic. You will find information in books, newspapers, magazines, trade periodicals, and clip file folders. Fig. 10–4. Many libraries also offer computerized database searches. Be sure to check with the reference librarian—this might prove to be your most rewarding inquiry.

Don't forget to check out your competition. This type of input is called **market research**. Are similar items already in use? You don't want to duplicate something that already exists. On the other hand, you might chance upon something that will guide or inspire you. Market research is a good way to discover what is popular in the marketplace. You can then decide whether to join the trend or provide something different.

Survey users of products similar to your proposed product. This is often called **consumer research**. What do people want? What do they like the least about the materials now being marketed?

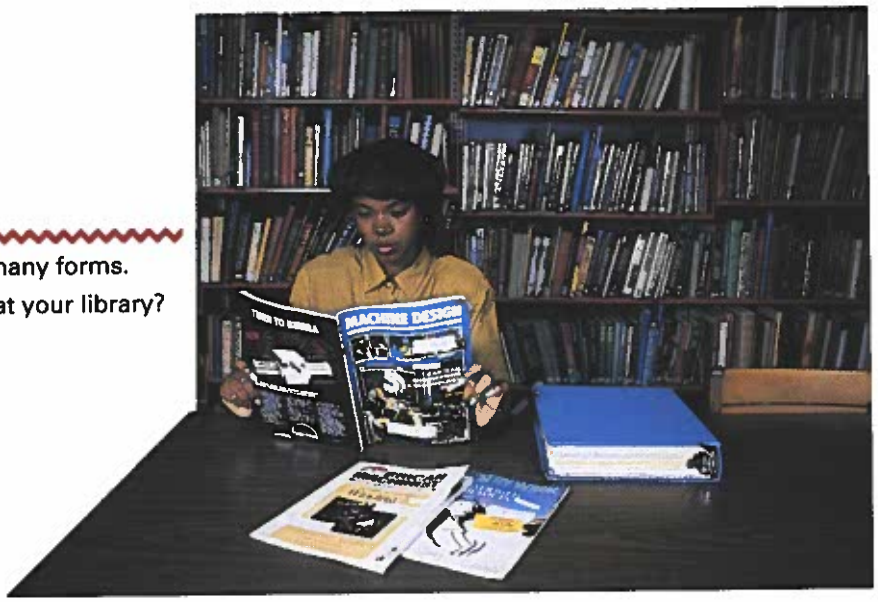


Fig. 10-4. Libraries offer information in many forms. What types of information can you find at your library? What services are offered?

Suppose you are a designer of athletic shoes. Survey your friends and family to learn what they like or don't like about the brands now on the market. Using your survey results, decide how you would improve the design of athletic shoes.

Establish Objectives for Solution(s)

Now it is time to decide on the goals that the solution must fulfill. These goals are often called **design criteria**. You can ask yourself questions to help establish your goals. Of course, your questions will depend on your specific problem. Some of the questions you might ask are:

- Is color a factor?
- Who will be using it?
- What materials should be used (or avoided)?
- Are there any environmental concerns?
- How will this item be used?
- What is the suggested price range?
- Why is this product needed?
- What are the legal considerations?

How many questions or goals do you need? You need as many as necessary to provide a framework to design your product. You don't want to stifle your creativity or overwhelm yourself with too many requirements, but you don't want to omit significant guidelines, either.

Decide on Possible Solutions

All ideas or solutions do not come from a single source. If they did, everyone would rush to the same place whenever they had a problem. How do you generate possible solutions to a problem? There are several ways to find possible solutions. Read through the following suggestions, and see what appeals to you:

- Brainstorming—One or more people just pour out ideas. In the **brainstorming** approach, you gather all of the ideas you can, without trying to make them perfect. Fig. 10–5.
- Listing—Compile a list of all the characteristics of the problem at hand. Later, you can use your list to suggest ideas that might work.
- Discussion—Talk the situation over with someone who is not directly involved. Ask questions. Then try reversing roles with the person. It never hurts to hear someone out.
- Sleep on it—figuratively, that is. Taking a rest and coming back to the problem allows you to look at the situation with a fresh eye.

Fig. 10-5. Brainstorming allows people to share all of their ideas about a problem. Since the goal of brainstorming is to gather all sorts of ideas, no one needs to feel that an idea is silly or not worth mentioning.

Evaluate Suggested Solutions

There are many ways to evaluate solutions. The "best" way depends on the solution you're evaluating. In general, however, you should compare each solution with your original goals. Fig. 10–6.

The characteristics you should consider are remarkably similar to those you considered when you set your goals. The characteristics you might need to look at include:

- Appropriateness of size, weight, color, etc.
- Ease of use
- Probable cost
- Reliability, durability
- Potential hazards
- Appeal to users
- Effect on environment
- Manufacturing concerns

Fig. 10-6. Evaluating the suggested solutions allows you to make comparisons. Some assessments can be measured objectively by using instruments. Others rely more on judgment.

Select the "Best" Solution

This is not as easy as it sounds. Sometimes there doesn't seem to be a "best." You might even have to reject all the possible solutions and start all over again.

To decide on the best solution, you may need to make **mock-ups**. Fig. 10–7. Mock-ups are models (typically full-sized) that look like the real thing but do not necessarily work or contain the actual materials or mechanisms.

Test the Solution

It is now time to make the item and discover how well the process worked. The first working model of a device is called a **prototype**.

Fig. 10-7. These students have made a mockup of a mailbox they have designed. What can this mockup tell them about the product?

Next you must **field-test** your product, or use it under realistic circumstances. If the design problem is an automobile, for example, you will need to determine how well it works and whether it is safe to use. Fig. 10–8.

IMPACT

Did you know your community could have an impact on the nation's marketplace? Companies often test-market new products in selected cities. If the product does well in those cities, it will be mass produced and sold nationwide. Have you ever been asked to sample a new food or beverage in a store and give your opinions about it?

Fig. 10-8. Making a working prototype helps you improve the product or device before manufacturing begins in earnest.

Refine the Solution

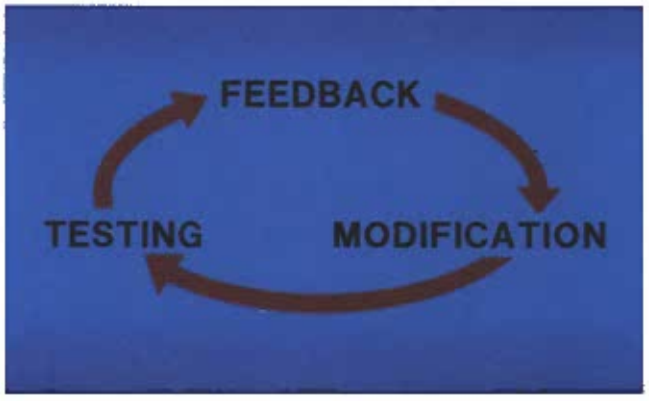
It is rare for a proposed solution to remain as is at the prototype stage. As more people test and use it, they may suggest improvements. You should try to encourage such feedback. This process of testing and modification can continue for many cycles. Fig. 10–9.

▶▶▶ FOR DISCUSSION ◀◀◀

1. Why should people bother to follow a model, or process, to solve problems?
2. Do all jobs involve some type of problem solving? Explain your answer.

■ **A large river flows through your model community. Using the problem-solving process, decide on the best way to get people across the river on a daily basis.**

Fig. 10-9. To develop a solution to its greatest potential, it is not unusual to go through several cycles of testing and modification.



Chapter Highlights

- People have been solving problems for thousands of years.
- The problem-solving process gives us a helpful method for designing a solution.
- A clear statement of the problem is a good start toward its solution.
- Establishing goals provides a means for proposing and evaluating solutions.
- People often modify or revise their solutions as a result of feedback.

Test Your Knowledge

1. Explain why there may not be one perfect solution to a problem.
2. What are the basic steps of the problem-solving process?
3. Name three design criteria you might consider if you were designing a new book bag for students.
4. Why is it important for a problem to be stated clearly?
5. Name three general rules to follow when you research a problem.
6. What is market research?
7. Why should you establish goals for suggested solutions?
8. What are four ways to come up with ideas of possible solutions to a problem?
9. Why do designers make mock-ups?
10. What are prototypes used for?

Correlations

SCIENCE

1. Suppose your friend sprained an arm and couldn't move it. Design a device to allow your friend to fasten buttons and open and close zippers without help.

MATH

1. Try some consumer research. Ask your friends and family to rate the following cereals on a 1 to 5 scale (5 points means "like it a lot"; 1 means "dislike it a lot"): corn flakes, oatmeal, raisin bran, shredded wheat. Draw a graph showing the survey results.

LANGUAGE ARTS

1. Select one of the following problems. Write a report about the basic problem-solving techniques you would use to find a solution. (A) Your community needs to reduce the amount of waste going into the landfill. (B) Many of the students in your school skip lunch. (C) Senior citizens need transportation to get to the grocery store, doctor's office, etc.

SOCIAL STUDIES

1. The date is 1875, and you and your family live in New York. As part of a settlement program, the government has offered your family 100 acres of free land in the Indiana Territory if you will move there. Use the problem-solving procedure to make the decision whether to accept the offer or remain in New York.

CHAPTER 11

Designing Graphic Solutions

Introduction

How do you express an idea? Using words? Using gestures? People often draw their ideas on paper. Sometimes they even make a model. They do these things because it is often easier to see a concept than to describe it. Sketches and other types of drawings are primary means of communication in many professions and trades. Perhaps this is why it is often said, "A picture is worth a thousand words."

After reading this chapter, you should be able to

Identify three types of pictorial drawings.
Explain the usefulness of orthographic/multiview drawings.
Explain the value of using different line types.
Discuss the purpose of dimensioning.
Describe the use of scale in drawings.
Demonstrate good lettering techniques.
Give examples of the types of things that should be noted in a parts list.
Discuss the use of models in presenting graphic solutions.

Words you will need

pictorial
oblique
isometric
perspective
multiview
dimensioning
scale
bill of materials
computer modeling