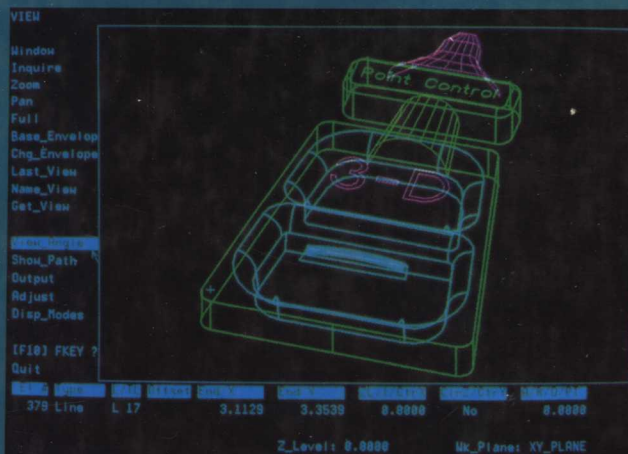
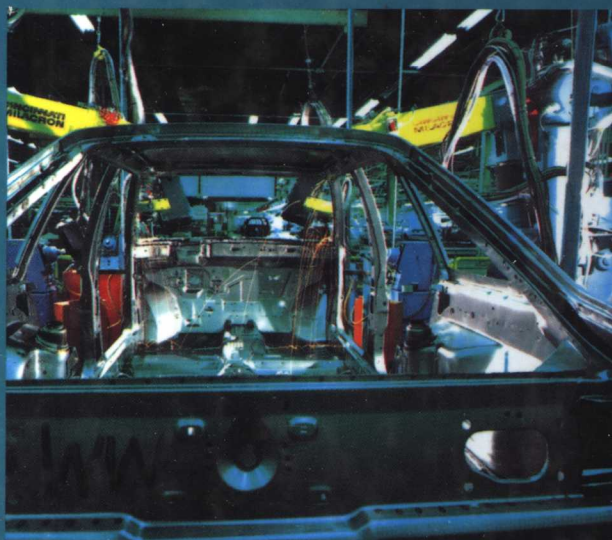


MANUFACTURING TECHNOLOGY

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PREFACE

Manufacturing technology is central to the way we live. Without manufactured goods, our lifestyles would be radically different. Modern manufacturing technology makes possible the buses, cars, and bicycles we use everyday to go to school or to work. Telephones, televisions, radios, computers, even the paper that this book is printed on, would not exist without manufacturing technology. The electricity that lights our homes, as well as most of the materials used to construct our homes, would not be available without the products made by manufacturing. Manufacturing technology affects almost every aspect of our lives and of people's lives around the world.

Manufacturing: A Systems Approach

Manufacturing technology is a system of technology. One way to study technological systems is with the systems approach. This approach involves studying the inputs, processes, and outputs that are part of the system.

The systems approach is used in this book to study manufacturing technology. The main sections of the book focus on the following:

- | | |
|--------------------|---|
| ■ inputs | people, materials, tools and machines, energy, information, safety, finances, and time; |
| ↓ | |
| ■ processes | design engineering, production engineering, organization and management, materials processing, marketing, and accounting; |
| ↓ | |
| ■ outputs | manufactured goods, scrap, waste, and pollution. |

Even though this text uses the systems approach to study manufacturing, you should keep in mind that manufacturing does not always happen in a perfect input-process-output order. Your teacher may ask you to read chapters out of order, and with a good reason. Manufacturing is a complex system and can be studied in many ways. The chapters in this book can be used in almost any order your teacher chooses.

Manufacturing is Making Products

Manufacturing technology is using tools, materials, and processes to make products. For this reason, the study of manufacturing technology should take a hands-on approach. This text will help you learn how to use tools and machines safely and efficiently to manufacture products.

The chapters in this book that discuss the actual "doing" of manufacturing are the chapters in Section Three on processes. Most of your studying will focus on these chapters.

Of course, in order to fully understand manufacturing technology, you must also study the inputs and outputs of manufacturing. Some of these chapters also include hands-on activities in which you will use tools and machines to process materials. But in several other chapters, you will study manufacturing by using minds-on activities.

Technology is changing the way people work in manufacturing. Today and in the future, more manufacturing jobs will call for workers with both mental skills (using mental tools and your mind) and technical skills (using technical tools and your hands).

Manufacturing Technology includes a balance of hands-on and minds-on learning activities.

The Impacts/Feedback of Manufacturing

Your study of manufacturing using the systems approach will not be complete if you do not learn about the impacts and feedback of manufacturing. We struggle with some very serious social and environmental problems today, and many of these problems have resulted in part from manufacturing technology. Unemployment, job dissatisfaction, and dangerous work situations are some of the problems that workers face. Overpriced and low-quality products and poor product safety are issues we all face as consumers. The environmental problems of air, water, and soil pollution, the greenhouse effect, and ozone depletion can all be traced in some way to manufacturing. The importance of understanding the technologies of manufacturing systems and their impacts can not be over-stressed. Many chapters in this book discuss the impacts of manufacturing on people and our natural environment.

Special Features

Manufacturing Technology uses a number of special features, including:

Key Terms. Listed at the beginning of each chapter, these important terms and phrases are highlighted within the text.

Boxed Articles. These are short stories of interesting or unusual information related to the chapter's subject.

Photographs and Illustrations. There are hundreds of color photos, illustrations, and line drawings that will help you understand the important parts of manufacturing.

Summary. The key points of each chapter are summarized.

Discussion Questions. These questions stress critical thinking and problem-solving skills.

Chapter Activities. Hands-on and/or minds-on activities are included in all chapters.

Your Classroom Manufacturing Experience. This section summarizes some of the more important chapters and includes several plans for products that you and your classmates can manufacture.

Glossary. A complete glossary of terms with definitions is included as an appendix to help you study.

Technology Student Association. A special section describes the Technology Student Association and its manufacturing-related activities.

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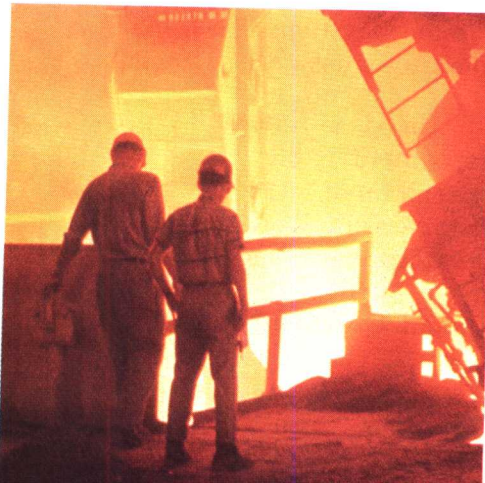
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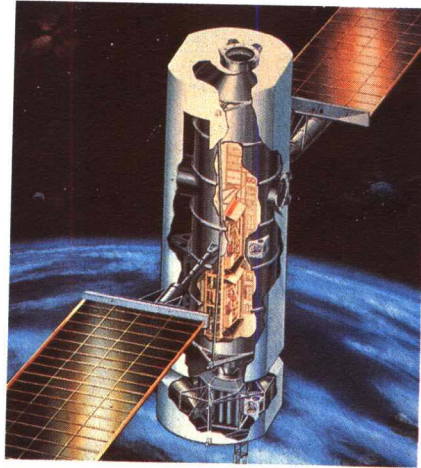
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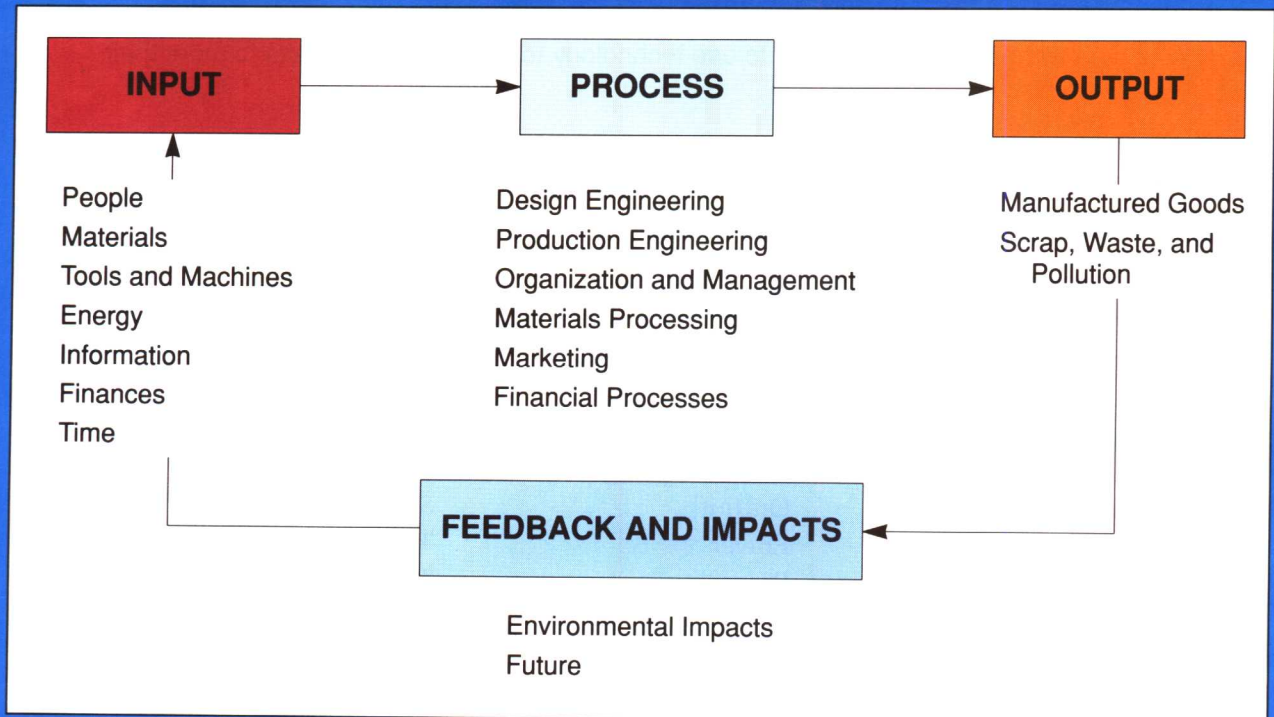
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SECTION ONE

INTRODUCTION

In this section, you will learn about the study of manufacturing. First, you will learn what manufacturing technology means, and how to use the systems approach to study it. Chapter 2 describes the history of manufacturing, from cottage industries to mass production. In chapter 3, you will study different types of manufacturing systems, including custom, intermittent, and continuous manufacturing. Finally, chapter 4 will help you understand how people in different departments work together in a manufacturing company.



- CHAPTER 1 ■ Introduction to Manufacturing
- CHAPTER 2 ■ The History of Manufacturing
- CHAPTER 3 ■ Types of Manufacturing Systems
- CHAPTER 4 ■ Careers in Manufacturing

CHAPTER 1

Introduction to Manufacturing

OBJECTIVES

After completing this chapter, you will know about

- What technology is and how it relates to manufacturing.
- What it means to manufacture something.
- The time when people first began to use technology to manufacture objects to meet their basic needs.
- What a systems approach is.
- Why the systems approach is used throughout this book.
- The four components of the systems model.
- The concept that large systems are usually made of subsystems.

KEY TERMS

Basic needs
Communication
Construction
Energy
Feedback

Input
Manufacturing
Output
Power
Processes

Production
Subsystems
System
Technology
Transportation

What Is Technology?

Technology is all around us. It is part of our everyday lives. Without it our lives would be very different. Manufacturing is based on technology. What, then, is technology? Simply defined, **technology** is the tools, materials, and processes people use to extend their power to make or do something. The food we eat has been produced, packaged, and transported

through technology. Your home was planned and built by people using tools, materials, and processes. Cars and gas are examples of technologies that meet people's needs and wants.

Without people, technology would not exist. Technology depends on human knowledge. People apply their knowledge through tools, materials, and processes, Figure 1-1.



Figure 1-1. Technology, including the computers shown here, depends on human knowledge. Technology includes tools that make certain tasks easier. (Courtesy of LTV Aircraft Products Group, Dallas, TX)

They make daily decisions about technology that shape their lives. These decisions include whether to write or call on the telephone; whether to walk, ride a bike, or drive a car; and whether to buy a product or try to make it. Decisions are based on need, cost, time, fashion, individual values, and many other factors.

Technology always results in change. Think of the changes from technology since your grandparents' youth. Your parents have also seen many advances in technology during their lifetimes. Changes in technology can affect people's life-styles, their health, and how they understand the world around them, Figure 1-2. Technology also changes the natural environment, which can affect our lives. Because humans make the decisions about the use of technology, they can control the changes caused by technology. To make the best choices, we must be informed decision-makers.

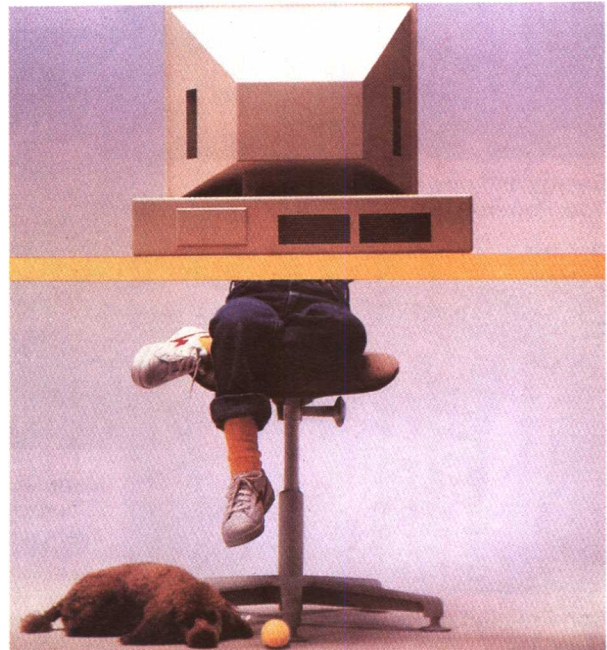


Figure 1-2. Children learn about their world from technology. (Courtesy of Eaton Corporation)

Technology and Manufacturing

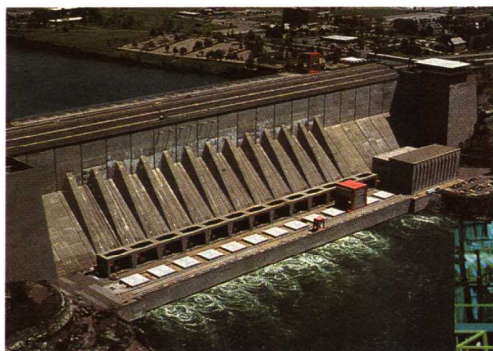
To study technology as it relates to manufacturing, four major areas are used. These include **communication**, **transportation**, **production**, and **energy and power**. Communication technology is the study of sending and receiving information through visual, audio, electronic, or other means. Radios, telephones, televisions, and computers are all communication technologies. Transportation technology moves people and things using vehicles like buses, trucks, cars, bicycles, airplanes, and even the space shuttle.

Production technology is the study of how the goods and services that we use every day are made. Production is further broken into **construction** and **manufacturing**. Construction projects are usually fixed to the ground and built where they will be used. Roads, buildings, pipelines, and bridges are examples of

construction technology. Manufactured products meet human needs and wants and are often transported to stores where they are sold, Figure 1-3.

Energy and power are the base of all the technical systems described above. Without energy and power, most of the communication, transportation, and production systems as we know them would not exist.

All of these areas are related. The space shuttle, Figure 1-4, transports people and equipment. It has complex communication devices and requires the construction of a launch pad. Such devices and construction need a huge number of manufactured products. Even a simple product like a package of chewing gum has been manufactured, transported to the store, and packaged with a label to tell you what it is. Manufacturing technology produces all the necessary parts of communication and transportation projects.



Energy and power (Courtesy of New York Power Authority)



Transportation (Courtesy of Aluminum Association, Inc.)



Construction (Courtesy of Ford Motor Company)



Manufacturing
(Courtesy of Rockwell International Corp.)



Communication (Courtesy of Contel Corporation)

Figure 1-3. These systems are used to study technology.

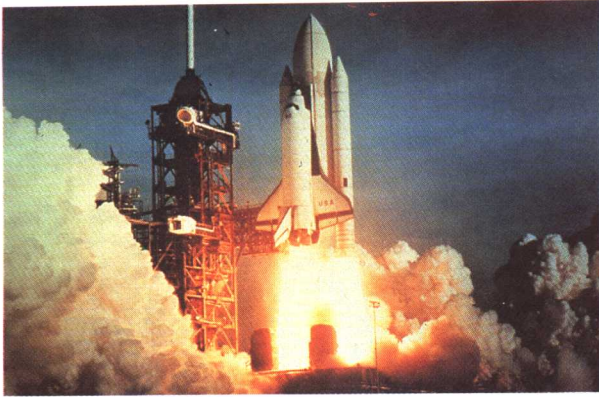


Figure 1-4. Launching of the space shuttle requires all of the technical systems. (Courtesy of NASA)

This text will look at manufacturing as a technological system people use to make goods that meet our needs and wants. In addition, some impacts of manufacturing will be discussed. Our world is becoming more interconnected politically, culturally, and economically. Therefore, the impacts of manufacturing on people locally and worldwide are becoming more important. Just as important is the impact of technology on our natural environment and the overall health of our planet.

Manufacturing Entrepreneurs

Do you have an idea for a product that you feel is unique, but you're not sure how to manufacture and market it, or whether it would even be worth the try? Starting a business can be risky, especially if you have not worked in the business world. However, many good businesses have been launched with little more than an idea and a desire to make it fly. Here is the story of Donna Epp, president of Creative Fabric Design, Ltd.

Already a wife and mother, Donna began by taking business and design courses at a local college. There she met Diane Wulf, whose interest in design and fashion matched her own. Their business started as a small sewing business in the basement, where Creative Fabric Design, Ltd. was born. By investing a little money and working at home, they could balance family and work responsibilities. After a while, they felt sure enough about their business to rent space and move the operation out of the home. Their business has become a full-scale factory employing ten full-time workers and many subcontractors.

Donna and Diane feel they were maverick in their approach because they were not afraid to express and create designs

that had not been tried before. They added many details and their reputation grew as people saw that they stood behind their work. Today they are ready to become one of the largest comprehensive workrooms in the trade, and were recently recognized by the International Society of Interior Designers. These entrepreneurs offer some tips for success:

- Make a list of realistic goals.
- Set the time frame within which you will reach these goals.
- Interview banks and do business with the bank that will meet your needs as your company grows.
- Use any free space at home before you take on overhead expenses.
- Research your business needs, including geographic area, market potential, income, and competitors.
- Reconcile your financial needs. Be honest about your personal financial needs and those of your business.
- Know about business etiquette. Quality of service counts.
- Avoid stereotyping images based on gender, race, and so forth.

Manufacturing and Basic Human Needs

Humans have **basic needs** that must be met for them to survive in their natural environment. Some of these include food, clothing, and shelter. These needs can vary based on climate or region. Basic needs were met by even the earliest people. At that time, the materials used were the most easily found and the tools and processes were simple, Figure 1-5. To manufacture something is to change a naturally occurring material to make it more useful or valuable. Ancient people who used fire to cook their food and scraped animal skins for robes and shelter were using technology to make products. These first manufactured items met basic needs for survival. Manufacturing is making products.

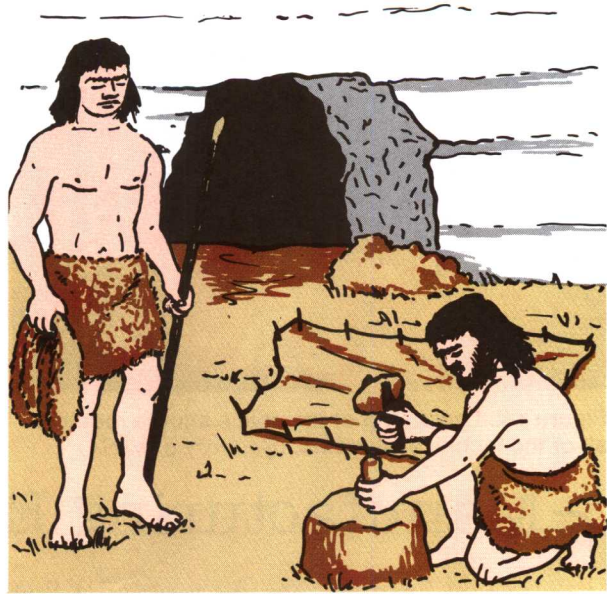


Figure 1-5. Early people used simple technology to meet their basic needs.

The Choice of Champions

In recent years, bicycle designers have tried to build the best bicycle frame by using very light, strong materials like advanced composites and titanium. They have made excellent frames, but not without difficulty. Composites and titanium need special tools and careful handling. They are also hard to bond. The performance of such frames has not necessarily justified their cost.

Manufacturers have traditionally used steel or aluminum to make bicycles. Recently a technique for varying the diameter of steel and aluminum tubing was developed. This now makes it possible to decrease the weight but keep the strength of these materials. One end can be enlarged to fit a bracket while the other end can be made to fit the hardware at that position. Changing tube diameter does not create stress, or a local area weakened by pressure. It was developed using a computer-aided design (CAD) system.

The frame offers a rider good stiffness for control, but enough flexibility to absorb road-generated shocks.

The variable diameter tubing was originally developed to make golf club shafts. It offers many advantages. Steel can be brazed, sawed, pinned, drilled, bolted, and glued in a normal manufacturing area. The cost of steel tubing is far less than composites or titanium.

Because of the advantages of variable diameter aluminum tubing, it was used for the bicycles ridden by the U.S. cycling team in the last Olympics.



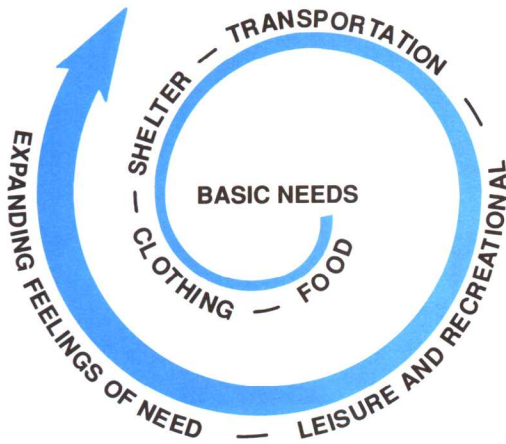


Figure 1-6. Manufacturing creates an ever-increasing feeling of need.

Beyond Basic Needs

Today manufacturing technology provides for much more than basic needs. Once the basics have been met, our feeling of need grows to include items for leisure and luxury, Figure 1-6. Advanced technology has increased the leisure time of many people. Recreational items like skis, tennis rackets, and camping equipment are things we buy to satisfy our



Figure 1-7. Life-styles, including leisure time activities, change with technology. (Courtesy of Sony Corporation of America)

growing feeling of need. Televisions, recreational vehicles, and vacation homes are not necessary to sustain life. These may, however, become needs based on a life-style change resulting from technology, Figure 1-7.

Almost everything you see that is not part of the natural environment has been manufactured. In fact, it is a challenge to find something that has not been manufactured. Plywood, Figure 1-8, is made of wood, a natural material, but has been manufactured into a laminated (glued together) 4' x 8' sheet. The piece of chalk your teacher may use is also a natural material (soft limestone), but it has been made into an easy shape for writing. Indeed, it is hard to find even one item that has not been changed in some way.

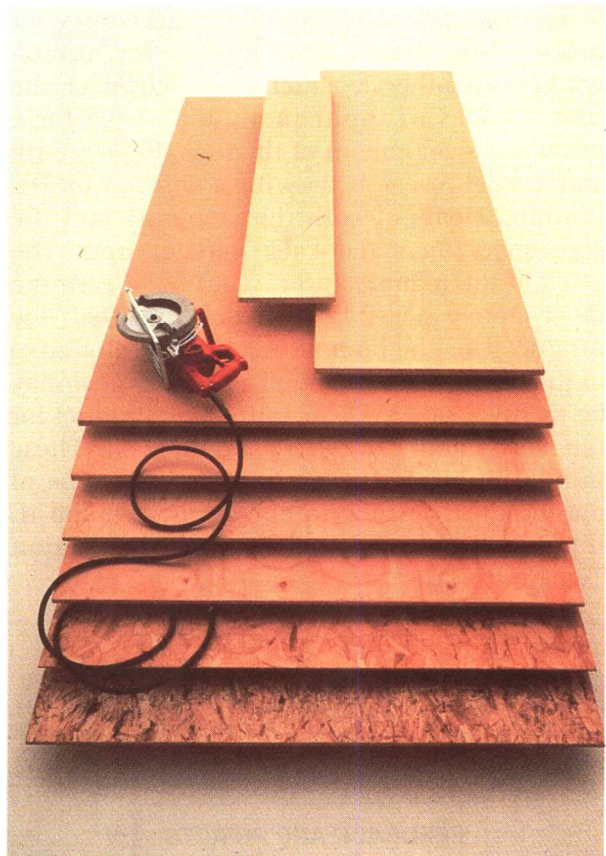


Figure 1-8. Plywood and chipboard materials are made from wood, a natural material, but are manufactured into a more usable form. (Courtesy of Weyerhaeuser Company Inc.)

A Systematic Approach

Our world is complex—a wide web of systems and subsystems that can confuse us. We are part of a school system, we might travel on a public bus or subway system, and we all have our own systems for studying or for organizing our rooms. We need a way to organize our thoughts about the events we see happening around us. We need a systematic way to view our world if we are to understand how it works. Likewise, we will use a **system** to study manufacturing technology. Figure 1-9 shows a model for this system.

Input

The **input** for a manufacturing system is everything needed to start and maintain a manufacturing enterprise. The most obvious example of input is the money needed to get the tools, machines, materials, buildings, and energy for production. Wages and benefits for human workers are other considerations. However, the first sources of input include an idea for a product; development of the idea, Figure 1-10; and market research showing a demand for the product. Goals of both the company and the consumers (buyers) are also parts of input. The goals of the manufacturer might be to earn the most money possible. To reach this goal, the product must be both affordable and attractive to the buyer. The consumer's primary goal may be to buy a safe, reliable, attractive product for the least amount of money, Figure 1-11. These inputs influence the product and the type of manufacturing technology used to make it. Input will be discussed in detail in Section Two of this book.

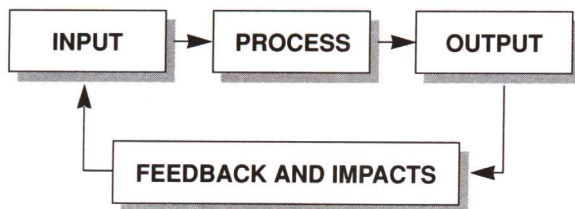


Figure 1-9. This systems model is used to study manufacturing technology.



Figure 1-10. Developing an idea often takes input from people with different experience and expertise. (Courtesy of Allen-Bradley Company, Milwaukee, WI)

Process

The **processes** of manufacturing relate to the jobs and tasks associated with the design, production, and selling of a product. Manufacturing processes can be grouped in the following categories:

- Design engineering
- Production planning
- Ownership and management
- Processing materials
- Marketing
- Accounting

Each person in a manufacturing company does certain jobs that relate to one of these cat-



Figure 1-11. The consumer wants a safe, reliable product at an affordable price. (Photo by Ted Horowitz, courtesy of Schering-Plough Corporation)