Technology & Engineering will help you to understand the following:

- How people use technology to make our world work.
- Why technological systems work the way they do.
- In what ways technology affects both people and our planet.

This book covers the seven areas of technological activity:

- Communication and information.
- Transportation.
- Construction.
- Manufacturing.
- Medicine.
- Agriculture and biotechnology.
- Energy and power.

In this book, you will learn that technology is a reaction to problems and opportunities—a human adaptive system. You will learn that technological systems are made up of many parts requiring tools. Also, you will learn about the problem-solving and design process, especially the testing, evaluating, and communicating of design solutions.

Sections explore, in depth, the production of products and structures, communication and information, agricultural and biorelated technologies, transportation, and the use of energy. The management of technological systems is covered because every system must have direction. The examination of societal and personal views of technology rounds out the book.

Technology & Engineering is illustrated with photographs, drawings, diagrams, and original artwork to help explain the concepts in the text. Most of these illustrations are in color. This material has been carefully selected to make technology easy to understand. Each chapter begins with objectives so you know what is covered. Key words are in bold italics to help make you aware of them. Review questions and activities will improve your understanding. The activities between sections provide you with valuable hands-on experience.

Impacts, both positive and negative, accompany the use of technology. The only way people in the modern world can choose and apply technology responsibly is to understand how technology develops and how the various technological systems interact. A Student Activity Manual has activities and exercises giving you important experience, while fully enriching the concepts developed in the text.

A sound understanding of technology is vital for making wise choices. As you study, you will see the effects of your choices. These choices control how technology is used. Each person can make a difference to be sure that technology is used responsibly. With a solid understanding of technology, you can understand and take an active part in our human-built world.
About the Author

Dr. R. Thomas Wright is one of the leading figures in technology-education curriculum development in the United States. He is the author or coauthor of many Goodheart-Willcox technology textbooks. Dr. Wright is the author of Manufacturing and Automation Technology, Processes of Manufacturing, and Technology. He is the coauthor of Exploring Design, Technology, & Engineering with Dr. Ryan A. Brown.

Dr. Wright has served the profession through many professional offices. These offices include President of the International Technology and Engineering Educators Association (ITEEA) and President of the Council on Technology Teacher Education (CTTE). His work has been recognized through the ITEEA Academy of Fellows award and Award of Distinction, the CTTE Technology Teacher Educator of the Year, the Epsilon Pi Tau Laureate Citation and Distinguished Service Citation, the Sagamore of the Wabash Award from the Governor of Indiana, the Bellringer Award from the Indiana Superintendent of Public Instruction, the Ball State University Faculty of the Year Award and George and Frances Ball Distinguished Professorship, and the EEA-Ship Citation.

Dr. Wright’s educational background includes a bachelor’s degree from Stout State University, a master of science degree from Ball State University, and a doctoral degree from the University of Maryland. His teaching experience consists of 3 years as a junior high instructor in California and 37 years as a university instructor at Ball State University. In addition, he has also been a visiting professor at Colorado State University; Oregon State University; and Edith Cowan University in Perth, Australia.

Technology Student Association (TSA)

Modular Activities

The Technology Student Association (TSA) is a nonprofit, national student organization devoted to teaching technology education to young people. TSA’s mission is to inspire the organization’s student members to prepare for careers in a technology-driven economy and culture. The demand for technological expertise is escalating in American industry. Therefore, TSA’s teachers strive to promote technological literacy, leadership, and problem solving to their student membership.
TSA Modular Activities are based on the TSA competitive events current at the time of writing. Please refer to the Official TSA Competitive Events Guide for actual regulations for current TSA competitive events. This guide is periodically updated. TSA publishes two Official TSA Competitive Events Guides. One guide is for middle school events. The other guide is for high school events. To obtain additional information about starting a TSA chapter at your school, to order the Official TSA Competitive Events Guide, or to learn more about TSA and technology education, contact TSA:

TSA
1914 Association Drive
Reston, VA 20191-1540
www.tsaweb.org

The Career Clusters

The Career Clusters are 16 groups of different types of occupational and career specialties, which are further divided into pathways. Looking ahead at these pathways will help determine the course of study for your chosen career. The Career Cluster icons are being used with permission of the:

What comes to mind when you think of an extraterrestrial? You may imagine the small, green beings you see on the covers of science fiction novels. Today, scientists are beginning to envision a different picture of life in space. Through the process of terraforming, they hope to someday sustain human life on another moon or planet.

**Terraforming**
is the alteration of a planet or moon's surface to make it suitable for human life. In other words, it is an attempt to make it like Earth. Because the planets and moons we've looked at so far are so different, terraforming would be a big challenge. It could take centuries, or even longer, to successfully complete a terraforming project and begin human habitation on a place other than Earth.

The process of terraforming is currently hypothetical. Many questions need to be answered before we can even consider such a project. Will a country, several countries, or a private organization be responsible for the terraforming process? How much would it cost and who would provide funding? And most importantly, what planet or moon would be the best candidate for terraforming? Determining which is most Earth-like would ensure an easier and more successful conversion.

Atmospheric composition, distance from the Sun, and the presence of water are a few important factors to consider when evaluating a planet or moon's potential for terraforming. With a rotation rate and axial tilt similar to Earth, Mars has emerged as the leading contender. Water is frozen at Mars' polar caps while carbon, oxygen, and nitrogen are all present in its atmosphere. However, the atmosphere is very thin, oxygen levels low, and temperatures significantly cooler than on Earth. Scientists have suggested several methods to heat the planet, including placing large, sun-reflecting mirrors on its surface or building factories that would produce greenhouse gases. Greenhouse gases have proven to raise the temperature on Earth.

Terraforming an entire planet would be extremely costly and time-consuming. As a result, scientists are now exploring the option of paraterraforming. Paraterraforming would transform only a portion of the surface within an enclosed structure. The structure could then be expanded over time as financial capabilities and knowledge increase.

Should the Earth ever suffer a major disaster or crippling overpopulation, terraforming would offer humans an opportunity to escape and thrive elsewhere in the solar system. Many questions still need to be answered, but terraforming may one day be the key to establishing human life on other moons and planets.
Figure 24-7. Vehicles such as these aircraft are designed differently for cargo and people.

Chapter 27: Energy

Types of Energy

In this chapter, we look at energy from a variety of sources. We discuss the types of energy: the connections among energy, work, and power; and the forms of energy; how energy is measured; and other relationships. We examine the various sources of energy and whether energy technology is helpful or harmful.

Figure 24-5. Vehicles such as these aircraft are designed differently for cargo and people.

New Terms appear in bold italics where they are defined.

Chapter 28: Using Technology to Transport

Energy Is Used for . . .

Figure 22-12. Radio waves are changed to carry the message through AM or FM. Notice how the amplitude of the original sound wave and the carrier wave have been combined. The combined signal is transmitted in the radio waves. Notice the frequency of the carrier wave remains constant. The frequency modulated waveform is clear in this graph.

Figure 25-11. Radar waves are changed to carry the message through AM or FM. Notice how the amplitude of the original sound wave and the carrier wave have been combined. The combined signal is transmitted in the radio waves. Notice the frequency of the carrier wave remains constant. The frequency modulated waveform is clear in this graph.

Academic Connections: Communication

Advertising

Many commercial telecommunication broadcasts are supported through advertising. An important part of this advertising is a slogan. A slogan is a short phrase designed to keep the product or company in the consumer’s mind. They are easily remembered, and they sell products. Slogans are designed to differentiate the product or service. The Hallmark slogan above suggests that the company is concerned with providing quality service. A good slogan must meet several criteria. First, it must have the ability to be memorable. For example, many of us remember the slogan “We try harder” (Avis rental cars). Second, a good slogan should cause customers to purchase the item and feel good about it. For example, Holiday Inn offers the slogan “Comfy beds, great food.” Third, the slogan should be different from other slogans in use. For example, if a slogan is not new, it will be subject to ridicule and criticism. This chapter provides some guidelines to help you understand the importance of a slogan.

Chapter 24: Using Technology in Communication

Academic Connections: Science

STEM Connections provide information on a topic relevant to the chapter material that connects the content to communication and history.

Chapter 24: Using Technology in Communication

Academic Connections: Science

STEM Connections provide information on a topic relevant to the chapter material that connects the content to math or science.
Maintaining Technological Products

We want products to work properly when we need them. This often requires periodic maintenance and necessary repairs. Finally, each product or structure should be disposed of properly after it has served its purpose. Whenever possible, the product and structure should receive periodic maintenance and necessary repairs. Filters and dishes are washed to maintain their usefulness and extend their lives. Filters in furnaces and air-conditioning units are changed so the units function properly.

Using products makes our lives better. We must use and dispose of products wisely, and we should choose wisely those products we do use.

Test Your Knowledge

1. What are the three major factors to consider when analyzing whether or not to purchase a product?
2. List the five steps followed in installing a product.
3. Changing the oil in an engine is part of a(n) ______ maintenance program.
4. Name the three major items discussed in a maintenance manual.
5. Service manuals contain parts lists. True or false?
6. Service manuals contain parts lists. True or false?

Summary

Using products makes our lives better. We must use and dispose of products wisely, and we must choose wisely those products we do use.

Test Your Knowledge questions help students review the topics and the material covered in the chapter.

Summary

Using products makes our lives better. We must use and dispose of products wisely, and we should choose wisely those products we do use.

Test Your Knowledge questions help students review the topics and the material covered in the chapter.

STEM Applications

1. Select one day in your life. List all the items you used and whether or not you can be recycled.
2. Select a complex product you use often. List the following:
   A. The preventive maintenance it requires.
   B. The repairs it needs now or might need in the future.
   C. The preventive maintenance it requires.

Think Green

Think Green features briefly explain environmental concepts related to technology.

Safety

Safety notes identify activities that can result in personal injury, if proper procedures or safety measures are not followed.

Chapter 18

Using and Servicing Products and Structures

Copyright © 2012 by McGraw-Hill Education. All rights reserved.

Careers

Career Corner features identify and explain different careers related to the chapter material.
Activity 3A
Design Problem

Background
All technology involves a machine or device to perform material, energy, or information transactions. These machines are used to change the form of one or more of these resources into a new, more usable form.

Situation
You have been selected as the public relations director for a local animal shelter. You are concerned about issues that are not adequately addressed. This group wants to inform the public about these important issues.

Challenge
Choose one or two animal issues to address. Be sure to select an issue that is not adequately addressed. Develop a template for an advertisement. If your school has computer access, you may develop a more complex computerized software program to help you produce the flyers.

Activity 3B
Fabrication Problem

Background
We live in a material world. All around us are products that have been developed using material-processing technology. Each part of these products has been produced using a different material-processing technology. Each product requires a number of materials and equipment. Each material-processing technology increases its efficiency and reduces its emissions. The engine can provide power to the wheels through a transmission. The transmission can change the form of one or more of these resources into a new, more usable form.

Materials
- 1/2 inch- and 1/4-inch-diameter wood dowels
- 1/2-inch and 5/8-inch-diameter wood dowels
- 1/2-inch and 3/8-inch-diameter dowels
- 1/2-inch and 1/2-inch-diameter wood dowels
- A small construction project, such as a doghouse or shed.
- A ballpoint pen or mechanical pencil.

Technology Explained

A hybrid vehicle: a vehicle combining two or more sources of power. With one set of gears at low speeds, people are looking for more efficient automobiles. One alternative in the standard car is the hybrid vehicle. What is a hybrid vehicle? A hybrid vehicle is any vehicle combining two or more sources of power. Most hybrid vehicles are classified as a hybrid electric vehicle. A hybrid electric vehicle combines an internal combustion engine and electric generators and motors. Many submarines are also hybrids. They combine nuclear power with electric generators and motors. Some city buses are hybrids. They use diesel engines for parts of the route and overland electric power for other parts.

TSA Modular Activities features are additional activities intended to develop skills used in TSA's competitive events.
## Brief Contents

### Section 1
**Technology** 20
- **Chapter 1** Technology: A Dynamic, Human-Created System 22
- **Chapter 2** Technology as a System 38
- **Chapter 3** Types of Technological Systems 54

### Section 2
**Technological-System Components** 68
- **Chapter 4** Inputs to Technological Systems 70
- **Chapter 5** Technological Processes 92
- **Chapter 6** Outputs and Feedback and Control 116

### Section 3
**Tools of Technology** 136
- **Chapter 7** Production Tools and Their Safe Use 138
- **Chapter 8** Measurement Systems and Tools and Their Role in Technology 168

### Section 4
**Problem Solving and Design in Technology** 188
- **Chapter 9** The Problem-Solving and Design Process 190
- **Chapter 10** Developing Design Solutions 204
- **Chapter 11** Evaluating Design Solutions 220
- **Chapter 12** Communicating Design Solutions 238

### Section 5
**Applying Technology: Producing Products and Structures** 258
- **Chapter 13** Using Technology to Produce Artifacts 260
- **Chapter 14** The Types of Material Resources and How They Are Obtained 270
- **Chapter 15** Processing Resources 288
- **Chapter 16** Manufacturing Products 308
- **Chapter 17** Constructing Structures 336
- **Chapter 18** Using and Servicing Products and Structures 364

### Section 6
**Applying Technology: Communicating Information and Ideas** 380
- **Chapter 19** Using Technology to Communicate 382
- **Chapter 20** Printed Graphic Communication 396
- **Chapter 21** Photographic Communication 422
- **Chapter 22** Telecommunication 442
- **Chapter 23** Computer and Internet Communication 468

### Section 7
**Applying Technology: Transporting People and Cargo** 492
- **Chapter 24** Using Technology to Transport 494
- **Chapter 25** Transportation Vehicles 506
- **Chapter 26** Operating Transportation Systems 540

### Section 8
**Applying Technology: Using Energy** 560
- **Chapter 27** Energy: The Foundation of Technology 562
- **Chapter 28** Energy-Conversion Systems 576

### Section 9
**Applying Technology: Meeting Needs through Biorelated Technologies** 606
- **Chapter 29** Agricultural and Related Biotechnologies 608
- **Chapter 30** Food-Processing Technologies 634
- **Chapter 31** Medical and Health Technologies 658

### Section 10
**Managing a Technological Enterprise** 684
- **Chapter 32** Organizing a Technological Enterprise 686
- **Chapter 33** Operating Technological Enterprises 700
- **Chapter 34** Using and Assessing Technology 724

### Section 11
**Technological Systems in Modern Society** 740
- **Chapter 35** Technology: A Societal View 742
- **Chapter 36** Technology: A Personal View 758
Contents

Section 1
Technology 20
Tomorrow’s Technology Today
Cloning 21

Chapter 1
Technology: A Dynamic, Human-Created System 22
Technology Defined 23
Technology as a Dynamic Process 26
Positive and Negative Aspects of Technology 26
Career Corner
Industrial Engineering Technicians 27
Technology and Types of Knowledge 28
The Evolution of Technology 29
Academic Connections: History
The Presidential Election of 1960 30
Technology Explained
Smart Houses 32
Think Green
Overview 35

Chapter 2
Technology as a System 38
Goals 40
Career Corner
Purchasing Agents 40
Inputs 41
STEM Connections: Science
Newton’s Third Law of Motion 43
Processes 45
Technology Explained
Solar Collectors 46
Outputs 49
Think Green
Sustainability 49
Feedback and Control 50

Chapter 3
Types of Technological Systems 54
Level of Development 55
Economic Structure 57

Career Corner
Controllers 57
Number of People Involved 59
Type of Technology Developed and Used 60
STEM Connections: Science
Genetic Engineering 62

Section 1 Activities 66

Section 2
Technological-System Components 68
Tomorrow’s Technology Today
Home Fuel Cells 69

Chapter 4
Inputs to Technological Systems 70
People 71
Career Corner
Construction Laborers 73
Tools and Machines 74
STEM Connections: Mathematics
The Law of Equilibrium 77
Think Green
Organic Cotton 81
Materials 82
Information 85
Energy 86
Finances 87
Time 88

Chapter 5
Technological Processes 92
Problem-Solving and Design Processes 94
Production Processes 97
Career Corner
Production Managers 99
Academic Connections: History
The Tennessee Valley Authority (TVA) 104
Technology Explained
Hybrid Vehicles 107
Management Processes 112
Chapter 17
Constructing Structures 336
Buildings 337
Career Corner
Carpenters 342
Academic Connections: Communication
Word Origins 348
Heavy Engineering Structures 353
Think Green
Green Architecture 356
TSA Modular Activity
Structural Engineering 362

Chapter 18
Using and Servicing Products and Structures 364
Selecting Technological Products 365
Installing Technological Products 366
Maintaining Technological Products 367
Career Corner
Building Inspectors 367
Repairing Technological Products 368
Altering Technological Products 370
STEM Connections: Science
Materials Science 371
Disposing of Technological Products 372
Think Green
Green Packaging 374

Section 5 Activities 376

Section 6
Applying Technology: Communicating
Information and Ideas 380
Tomorrow’s Technology Today
Smart Materials 381

Chapter 19
Using Technology to Communicate 382
Career Corner
Advertising 383
Communicated Items 384

Chapter 20
Printed Graphic Communication 396
Printing Methods 397
Career Corner
News Reporters 398
The Steps for Producing Printed Graphic Messages 401
STEM Connections: Mathematics
Measuring Type 402
Technology Explained
Fax Machines 408
Computer-Based Publishing 414
Think Green
Inks 414
TSA Modular Activity
Promotional Graphics 419
TSA Modular Activity
Desktop Publishing 420

Chapter 21
Photographic Communication 422
Light and Photography 423
Career Corner
Commercial and Industrial Photographers 425
Fundamentals of Photographic Communication 426
Academic Connections: History
The Beginning of Photojournalism 429
Technology Explained
Digital Theaters 432
Chapter 27
Energy: The Foundation of Technology  562
Types of Energy  563
Energy, Work, and Power  563
Career Corner
Power Plant Operators  565
Forms of Energy  566
Academic Connections: History
The Origin of Horsepower  567
Sources of Energy  569
Think Green
Renewable and Inexhaustible Energy  569
Effects of Energy Technology  572

Chapter 28
Energy-Conversion Systems  576
Inexhaustible-Energy Converters  578
Renewable-Energy Converters  586
Career Corner
Power-Line Installers  587
Thermal-Energy Converters  588
STEM Connections: Science
Laws of Gases  592
Electrical-Energy Converters  593
Applying Energy to Do Work  596

Section 8 Activities  604

Chapter 29
Agricultural and Related Biotechnologies  608
Types of Agriculture  610
Career Corner
Agricultural Workers  612
Academic Connections: History
The Homestead Act and the Morrill Act  618
Think Green
Sustainable Agriculture  624
Agriculture and Biotechnology  628
TSA Modular Activity
Agriculture and Biotechnology Design  632

Chapter 30
Food-Processing Technologies  634
Primary Food Processing  636
Career Corner
Food-Processing Workers  643
STEM Connections: Science
Irradiation  646
Secondary Food Processing  649
Think Green
Local Organic Food  652

Chapter 31
Medical and Health Technologies  658
Technology and Wellness  659
Career Corner
Biomedical Engineers  661
Technology and Illness  665
STEM Connections: Science
Aerodynamics  670
Technology Explained
Dialysis Machines  673
Features

Tomorrow’s Technology Today

Cloning 21
Home Fuel Cells 69
Cryonics 137
Nanotechnology 189
Terraforming 259
Smart Materials 381
Invisibility Cloaks 493
Fuel Cells in Automobiles 561
Genetically Modified (GM) Foods 607
Warm-Up Jackets 685
Artificial Ecological Systems 741

Career Corners

Industrial Engineering Technicians 27
Purchasing Agents 40
Controllers 57
Construction Laborers 73
Production Managers 99
Dental Hygienists 120
Machinists 141
Surveyors 173
Engineers 193
Drafters 206
Market Researchers 223
Engineering Technicians 242
 Plumbers 262
Forest and Conservation Workers 274
Milwrights 290
 Automobile Assembly Workers 312
Carpenters 342
Building Inspectors 367
Advertising 383
News Reporters 398
Commercial and Industrial Photographers 425
Radio and Television Broadcasting 445

Computer Programmers 472
Automotive Mechanics 498
Railroad Conductors 512
Bus Drivers 546
Power Plant Operators 565
Power-Line Installers 587
Agricultural Workers 612
Food-Processing Workers 643
Biomedical Engineers 661
Top Executives 691
Technical Illustrators 704
Landscape Architects 729
Public Relations 746
Technology-Education Teachers 766

Academic Connections

History

The Presidential Election of 1960 30
The Tennessee Valley Authority (TVA) 104
The Origin of Radar 195
The Beginning of Photojournalism 429
The Internet 476
The Origin of Horsepower 567
The Homestead Act and the Morrill Act 618

Communication

Computer Bugs 146
Principles of Design 245
Word Origins 348
The Power of Radio 386
Advertising 450

STEM Connections

Mathematics

The Law of Equilibrium 77
Measuring Area 176
Solid Geometry 210
Calculating Board Footage 294
Measuring Type 402
Calculating Buoyant Force 516
Relating Speed, Time, and Distance 550
Calculating Bids 707

Science
Newton's Third Law of Motion 43
Genetic Engineering 62
Chlorofluorocarbons (CFCs) 122
The Principles of Expansion and Contraction 266
Synthetic Fuels 278
Materials Science 371
Newton's First Law of Motion 501
Laws of Gases 592
Irradiation 646
Aerodynamics 670

Technology Explained
Smart Houses 32
Solar Collectors 46
Hybrid Vehicles 107
Integrated Circuits (ICs) 126
Computer Numerical Control 143
GPS 227
Computer-Aided Design (CAD) Systems 248
Nuclear Energy 303
Robots 316
Digital Video Discs (DVDs) 389
Fax Machines 408
Digital Theaters 432
Fiber Optics 454
Virtual Reality 481
Magnetic Levitation (Maglev) Trains 520
Dialysis Machines 673
Wind Tunnels 712
Earth-Sheltered Buildings 731
Plasma Displays 749

Think Green
Overview 35
Sustainability 49
Organic Cotton 81
Recycling 153
Carbon Footprint 216
Green Materials 282
Volatile Organic Chemicals 305
Reduction 328
Green Architecture 356
Green Packaging 374
Forest Stewardship Council 391
Inks 414
Wet Chemistry 435
Efficient Power Use 460
Electronic Media Waste 483
Hybrid Vehicles 532
Alternative Fuels 552
Renewable and Inexhaustible Energy 569
Sustainable Agriculture 624
Local Organic Food 652
Green Household Cleaners 675
Sustainability Plan 718
Shopping Bags 755
Compact Fluorescent Lamps (CFLs) 768

TSA Modular Activities
Computer-Aided Design (CAD), Engineering with Animation 236
Computer-Aided Design (CAD), Architecture with Animation 254
Structural Engineering 362
Promotional Graphics 419
Desktop Publishing 420
Imaging Technology 440
Film 464
Cyberspace Pursuit 488
System Control Technology 556
Agriculture and Biotechnology Design 632
Medical Technology 680