

RESIDENTIAL
CONSTRUCTION
ACADEMY

BASIC PRINCIPLES FOR CONSTRUCTION

FIFTH EDITION



MARK HUTH

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ACADEMY

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MARK HUTH



Australia • Brazil • Mexico • Singapore • United Kingdom • United States

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PREFACE

RESIDENTIAL CONSTRUCTION ACADEMY: BASIC PRINCIPLES FOR CONSTRUCTION, FIFTH EDITION

ABOUT THE RESIDENTIAL CONSTRUCTION ACADEMY SERIES

One of the most pressing problems confronting the building industry today is the shortage of skilled labor. The construction industry must recruit an estimated 185,000 new craft workers each year to meet future needs. This shortage is expected to continue well into the next decade because of projected job growth and a decline in the number of available workers. At the same time, the training of available labor is becoming an increasing concern throughout the country. This lack of training opportunities has resulted in 200,000 unfilled construction sector jobs in 2018. This challenge is affecting all the construction trades and is threatening the ability of builders to construct quality homes.

These challenges led to the creation of the innovative Residential Construction Academy Series. The Residential Construction Academy Series is the perfect way to introduce people of all ages to the building trades while guiding them in the development of essential workplace skills, including carpentry; electrical wiring; heating, ventilation, and air conditioning (HVAC); plumbing; masonry; and facilities maintenance (also referred to as building construction technology). The products and services offered through the Residential Construction Academy are the result of cooperative planning and rigorous joint efforts between industry and education. The program was originally conceived by the National Association of Home Builders (NAHB)—the premier association of more than 140,000 members in partnership with the Home Builders Institute (HBI), a leading career training provider in the residential construction industry.

For the first time, construction professionals and educators created national skills standards for the construction trades. In the summer of 2001, NAHB and HBI began the process of developing residential craft standards in six trades: carpentry, electrical wiring, HVAC, plumbing, masonry, and facilities maintenance. Groups of employers from across the country met with an independent research and measurement organization to begin the development of new craft training standards. Care was taken to ensure representation of builders and remodelers, residential and light commercial, custom single family, and high production or volume builders. The guidelines from the National Skills Standards Board were followed in developing the new standards. In addition, the process met or exceeded American Psychological Association standards for occupational credentialing.

Next, through a partnership between HBI and Cengage Learning, learning materials—textbooks and instructor's curriculum and teaching tools—were created to teach these standards effectively. A foundational tenet of this series is that students learn by doing. Integrated into this colorful, highly illustrated text are Procedure sections designed to help students apply information through hands-on, active application. A constant focus of the Residential Construction Academy is teaching the skills needed to be successful in the construction industry and constantly applying the learning to real-world applications.

In 2009, the Home Builders Institute enhanced the Residential Construction Academy Series by adding industry Program Credentialing and Certification for both students and instructors. National Instructor Certification ensures consistency in instructor teaching/training methodologies and knowledge competency when teaching to the industry's national skills standards. Student Certification is offered for each trade area of the Residential Construction Academy Series in the form of rigorous testing. Instructor and Student Certification serve the basis for Program Credentialing offered by HBI. For more information on HBI Program Credentialing and Instructor and Student Certification, please go to www.hbi.org.



ABOUT THIS BOOK

Whether an individual chooses a career as a skilled craftsperson or is striving to become a general contractor, *Basic Principles for Construction*, fifth edition, provides the necessary background for understanding the construction industry and the basic skills for learning a specific trade.

Basic Principles for Construction, fifth edition, is an outstanding resource for new and advancing construction students or for those considering entering a construction program. This text provides a solid foundation to learn the major trade areas—carpentry, electrical wiring, HVAC, plumbing, and facilities maintenance. It introduces students to the industry—explaining how it is organized and how to successfully gain employment—and also covers the need-to-know information for the daily activities associated with working in the industry, including safety, basic math, tools, and blueprint reading.

ORGANIZATION

This textbook is organized in a logical sequence that is easy to learn and teach and is divided into five major sections:

- **Section 1: The Construction Industry** is designed to provide students with background on the industry. It introduces students to the organization and leadership structure, as well as the importance of ethics, teamwork, and effective communications with others to successfully complete a job. In addition, a new chapter, on green building, introduces readers to green building principles and job site practices while they plan and execute their work.
- **Section 2: Safety** covers all-important elements of safely working on a job site, including working with electricity, hazardous materials, scaffolding, ladders, and compressed air. It also covers Occupational Safety and Health Administration (OSHA) regulations, practical housekeeping, and personal protective equipment to ensure safe work habits.
- **Section 3: Construction Math** reviews the basic math skills and how to practically apply these skills on the job. Examples and practice problems are integrated into the chapters to increase student aptitude in working out various construction problems. The section concludes with a chapter on combined operations, which illustrates the necessity of having the ability to utilize several math skills in completing a single job.
- **Section 4: Tools and Fasteners** introduces students to the selection, use, and care of the various hand and power tools required to complete a job, as well as different types of adhesives and fasteners. The section also includes a chapter on the basics of rigging as it applies to residential construction.
- **Section 5: Print Reading** emphasizes the elements and features of basic residential blueprints and how to accurately read them. Activities at the end of each chapter encourage students to practice their blueprint reading skills.

NEW TO THIS EDITION

The fifth edition of *Basic Principles for Construction* reflects the latest practices in the industry, including:

- New chapter on adhesives and sealants.
- Updated learning objectives, additional key terms, and caution content.
- New coverage of nail guns and nail-gun safety.

FEATURES

This innovative series was designed with input from educators and industry and informed by the curriculum and training objectives established by the Standards Committee. The following features aid learning:

A SUCCESS STORY opens each section, providing insights, advice, and motivation from professionals working in a variety of construction trades and offering an insider's view of construction as a career.

SUCCESS STORY

FABIAN LIERA
TITLE
HBI Plumbing Instructor

EDUCATION
GED: Home Builders Institute's pre-apprentice in plumbing at Fred G. Acosta Job Corps Center; associate degree in business administration from Brookline College, Tucson, Arizona.

CAREER HISTORY
Fabian was a 18-year-old on the verge of dropping out of high school when he enrolled in the Fred G. Acosta Job Corps Center (JCC). After graduating from the JCC, he worked as a plumber. In 1996, he graduated from college and went to work in the plumbing wholesale industry. He worked his way up into management. In 2003, he started a new plumbing supply store called Ironwood Winelson. He sold the business in 2007 and worked in the solar industry until 2011. That is the year he started his present position as a plumbing teacher at the Fred G. Acosta JCC. He is proud to say he is the Plumbing Instructor for Home Builders Institute.

ON THE JOB
Fabian enjoys talking with his students and going over the day's plan. He teaches his students to make short-term goals and learn something new every day. With the students, he opens the shop and tool room, inspects the power tools they will be using that day, and ensures that everyone has a plan and schedule to finish their projects.

BEST ASPECTS OF THE JOB
Fabian has been able to relate to his students. He knows the struggles they are facing, but most importantly he knows the potential they have to become successful in their careers. He says, "I love it when my former students send me a picture of their new truck or house they just purchased."

CHALLENGES OF THE JOB
Challenges change each day, and with more knowledge comes more responsibility. He remembers when he started his career at the Fred G. Acosta JCC, saying, "My challenge was to get there on time and attend all my classes. It changed when I got my first job in my new career; then it was to stay safe and work harder than the next guy." He figured that if there was to be layoffs, he would be the last to be going to the layoffs. As a teacher, his challenges are to motivate his students.

LEARNING FEATURES such as the **Objectives** and **Glossary of Terms** set the stage for the coming body of knowledge and help the learner identify key concepts and information. These learning features serve as a road map throughout each chapter and offer a practical resource for reference and review.

CHAPTER FOUR
JOBSITE SAFETY

OBJECTIVES
After completing this chapter, the student should be able to:

- Explain what an accident is and what causes accidents.
- Define Occupational Safety and Health Administration (OSHA) and explain its impact on construction workers.
- Identify the appropriate personal protective equipment (PPE) for common work situations, and explain how to use it.
- Explain the Hazard Communication Standard, and find information on a Safety Data Sheet (SDS).
- Explain how fires are ignited, sustained, and extinguished.
- Recognize the dangers of working in trenches, and explain how to work safely in them.
- Explain electric shock, and list safety considerations in working around electricity.

GLOSSARY OF JOBSITE SAFETY TERMS

ampere the unit of measure for electric current. Also abbreviated as amp.

class A fire a fire that involves ordinary materials, such as paper, cardboard, and wood. Class A fires can be extinguished with water.

class B fire a fire that involves flammable liquids. Class B fires are extinguished with either dry chemical or CO₂ (carbon dioxide).

class C fire an electrical fire. Class C fires are extinguished with CO₂ (carbon dioxide).

conductor a material that allows electricity to flow.

fire triangle consists of heat, fuel, and oxygen (the three sides of the triangle); the three elements must be present for a fire to burn.

ground (electrical) a conducting body that serves as the common return path for an electric circuit. A ground typically has zero potential. The earth may also be used as a ground.

ground fault circuit interrupter (GFCI) a protective device that senses an imbalance in the amount of current flow between the conductors.

horseplay practical jokes and playful activity that are considered inappropriate on a construction site.

labels user instructions found on most construction products. The product label contains valuable information.

OSHA refers both to the state federal Occupational Safety and Health Administration and to state administration. OSHA also stands for the Occupational Safety and Health Act, which is administered by the Occupational Safety and Health Administration. OSHA generally refers to the laws that are intended to keep workers safe.

personal protective equipment (PPE) any safety equipment you wear to protect yourself from safety hazards.

Right to Know rule the OSHA rule that says that every worker has a right to know about any substances on the job site that might be harmful to humans.

Safety Data Sheet (SDS) gives complete information about the product and what to do in the event of exposure. An SDS is required to be available for any substance that might be harmful.

voltage the electrical pressure that causes current to flow, measured in volts (sometimes abbreviated as V). Voltage is sometimes called electromotive force (EMF) because it is the force that causes electrons to move. Voltage also represents the difference of potential, or potential difference, in a circuit.

work practices the things a worker does and how he or she works—these practices have a lot to do with safety.

working conditions the things in the work environment that affect your work.

47

REVIEW QUESTIONS are designed to reinforce the information in the chapter as well as give students the opportunity to think about what has been learned and what they have accomplished.

CHAPTER 14 HAND TOOLS—SELECTION, USE, AND CARE 157

REVIEW QUESTIONS

Answer the following questions. Match the uses in Column II with the tools in Column I.

<p>Column I</p> <ol style="list-style-type: none"> 16-ounce, curved-claw hammer Cat's-paw Plumb bob Chalk line 2-foot level Builder's level Rip saw Electrician's pliers 10-inch adjustable wrench Nut driver Crosscut saw Coping saw 24-ounce, straight-claw hammer Rafter square 18-inch pipe wrench Utility knife List three safety rules for using laser levels. <ol style="list-style-type: none"> a. b. c. Describe the difference between a crosscut saw and a rip saw. Explain why safety glasses are necessary when driving nails with a hammer. What measurements are indicated in Figure 14-52? <ol style="list-style-type: none"> a. b. c. d. e. 	<p>Column II</p> <ol style="list-style-type: none"> Sawing with the grain of wood Sawing sharp curves in wood Scoring gypsum wallboard Checking square corners Tightening and loosening small nuts and bolts Checking and measuring elevations over long distances Used by framing carpenters for driving large nails For cutting wire and gripping parts Used by finish carpenters for driving nails Marking a straight line for many feet Checking to make sure that a line is perfectly vertical Turning a screw-on fitting on a pipe Pulling nails Checking a window header to make sure that it is level Sawing across a board Tightening large bolts
---	---

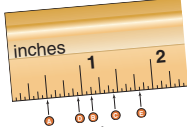


FIGURE 14-52 Problem 25.

ACTIVITIES complete each chapter where applicable and are intended to provide students with a practical “hands-on” experience as it relates to the reading within the text. Everything from identification of tools to Internet research, critical thinking, and building—these activities bring the key points of the chapter to life!

80 SECTION 2 SAFETY

ACTIVITIES

BUILDING A SCAFFOLD

Beginning workers in construction are often called upon to help build scaffolding. You should not attempt to build scaffolds on your own unless you have been thoroughly trained by a competent person. In this activity, you will work in a small group to build a safe scaffold. Do not climb on the scaffold you build until it has been inspected by your instructor.

EQUIPMENT AND MATERIALS

- All parts necessary to build fabricated metal scaffold two stages high
- 2-foot level
- Shovel
- 2 × 10 or 2 × 8 lumber as needed to prepare a level base
- Scaffold-grade wood planks or prefabricated scaffold planks

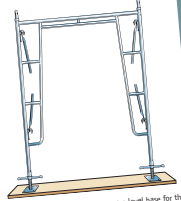


FIGURE 5-7 Use lumber to prepare a level base for the scaffold bases.

PROCEDURE

- Working in the area designated by your instructor, lay out all scaffold parts, and inspect them to ensure that they are in good condition.
- If you are working on bare ground, you may need to prepare a level base. Shovel away high spots or build up low spots with 2 × 8 or 2 × 10 cribbing. Use a straight piece of lumber and a level to ensure that all four corners are level and solid (Fig. 5-7). If the cribbing does not make solid contact with the ground or if one corner is high or low, fix it before you go on.
- Place adjustable base plates on two end frames, position them on the prepared base, and join the two end frames with two diagonal cross braces. It might be necessary to move or adjust the base you prepared so that the base adjust the beam you prepared on top of the prepared surfaces fit squarely on top of the prepared surfaces. This step is especially important. If you start building your scaffold on a solid, level base, the rest is much easier. If your base is not level, the problem will be magnified as the scaffold goes up.
- Check the end frames to see that the posts are plumb (use a level to ensure that they are perpendicular to the earth's surface—see Chapter 14) and the horizontal pieces are level. Have your instructor check your work before you proceed.
- Plank the first stage of scaffolding. The planks should have cleats to prevent them from slipping off the end frame (Fig. 5-8).
- Insert coupling pins in all four top corners, and set two more end frames on top of the bottom stage.
- Install diagonal bracing on the second stage.
- Place planking approximately 8 feet from the ground. The planking from the first stage can be moved up, or you may choose to leave that planking in place and place new planking on the second stage.

TURNKEY CURRICULUM AND TEACHING MATERIAL PACKAGE

We understand that a text is only one part of a complete, turnkey educational system. We also understand that instructors want to spend their time on teaching, not preparing to teach. The *Residential Construction Academy* series is committed to providing thorough curriculum and preparatory materials to aid instructors and alleviate some of those heavy preparation commitments. An integrated teaching solution is ensured with this text, including the MindTap, Instructor's Resource CD and Companion website, a printed Instructor's Resource Guide, and Student Workbook.

MINDTAP

MindTap is a personalized teaching experience with relevant assignments that guide students to analyze, apply, and improve thinking, allowing you to measure skills and outcomes with ease.

- *Personalize Teaching*: Becomes YOURS with a Learning Path that is built with key student objectives. Control what students see and when they see it. Match your syllabus exactly by hiding, rearranging, or adding your own content.
- *Guide Students*: Goes beyond the traditional “lift and shift” model by creating a unique learning path of relevant readings, multimedia, and activities that move students up the learning taxonomy from basic knowledge and comprehension to analysis and application.
- *Measure Skill and Outcomes*: Analytics and reports provide a snapshot of class progress, time on task, engagement, and completion rates.

INSTRUCTOR RESOURCE CD

The Instructor Resource CD is a complete guide to classroom management. Designed as an integrated package, the CD offers the instructor many valuable tools, including an electronic version of the print Instructor’s Resource Guide, PowerPoint presentations, Computerized Testbank in ExamView, and an Image Gallery.

INSTRUCTOR’S RESOURCE GUIDE

This Instructor’s Resource Guide, available in print, provides a step-by-step breakdown of the key points found in each chapter, along with “Teaching Tips” and correlating PowerPoint presentation slides, creating a completely streamlined and integrated approach to teaching. Also included are answers to the Review Questions that appear at the end of each chapter, as well as answers to the exercises in the workbook.

INSTRUCTOR COMPANION WEBSITE

This is an educational resource that creates a truly electronic classroom. It is a website containing tools and instructional resources that enrich your classroom and make your preparation time shorter. The elements of the Instructor Companion Website link directly to the text and tie together to provide a unified instructional system. With the Instructor Companion Website you can spend your time teaching, not preparing to teach. The website contains the materials found on the Instructor Resource CD, including an electronic copy of the Instructor’s Resource Guide with answers to the book and workbook questions, PowerPoint presentations, ExamView Testbank, and Image Gallery.

WORKBOOK

Designed to accompany *Residential Construction Academy: Basic Principles for Construction*, fifth edition, the workbook is an extension of the core text and provides additional review questions and problems designed to challenge and reinforce the student’s comprehension of the content presented in the core text.

ABOUT THE AUTHOR



Mark Huth authored this textbook for many years, bringing a wealth of industry experience to his writing—first working as a carpenter, contractor, building construction teacher, and then as a publisher of construction textbooks. Mark passed away unexpectedly on September 5, 2018. True to his admirable work ethic, he had already finished this edition’s manuscript ahead of schedule. The Cengage team and the many whose lives were touched by his as a teacher, author, and colleague remember him gratefully.

Mark’s career allowed him to consult with hundreds of construction educators in high schools, colleges, and universities. *Basic Principles for Construction* was shaped by his observations of the difficulties students have in studying construction and by the outstanding programs offered at the best schools in the country. He also authored several other successful construction titles, including *Construction Technology*, *Basic Blueprint Reading for Construction*, *Understanding Construction Drawings*, and *Practical Problems in Mathematics for Carpenters*.

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SECTION ONE

THE CONSTRUCTION INDUSTRY

CH 1: ORGANIZATION OF THE INDUSTRY

CH 2: WORKING IN THE INDUSTRY

CH 3: INTRODUCTION TO GREEN BUILDING



SUCCESS STORY

MICHAEL E. C. SURGUY

TITLE

Owner, Michael E. C. Surguy Carpenter Contractors, Inc., New Providence, NJ

EDUCATION

Michael completed high school and attended vocational school studying carpentry. He later obtained his associate degree in occupational studies from the State University of New York at Delhi.

HISTORY

After working as a carpenter and woodworker for a number of years, Michael established his own business; he is the sole owner of Michael E. C. Surguy Carpenter Contractors, Inc. Michael's company does basic framing to complex remodeling and additions, working on \$3–\$4 million homes. A recipient of the Community Builders Association of New Jersey's Sub-Contractor of the Year Award, Surguy is one of New Jersey's specialized carpentry contractors.

ON THE JOB

In a typical day, Michael says, "I need to be on the job. I don't just set up my guys and leave. I have a tool belt on every day. People pay me to be there

and work. If I'm not there, the work doesn't get done. If you get the job, you need to be there and run the job."

BEST ASPECTS

Michael has a deep commitment to his work: "You really need to enjoy it and be passionate about it. I don't think it's with every type of job. In carpentry, you are using your head and your body. There's no price to pay for the wear and tear on your body. Every piece of wood you need to carry with passion. If you show up for work in the morning, and you're thinking that it's too heavy or it's too cold outside, you won't do it."

CHALLENGES

While Michael shares that the carpentry business has been good to him, he explains that building a business is stressful: "When I started out, I lived at my parents' house. I made nothing for the first three years, but my guys always got paid. I got my tools and paid my insurance. If I hadn't lived at home, there's no way I could have done it." Michael says he built his reputation doing jobs that he thought he could do and being honest with his bids, breaking down each job, figuring out the cost of materials and employees. At first, he took on small jobs, which turned into bigger jobs. He started out as sole proprietor and then became a corporation with employees. "Now it's a different ballgame. You have to have liability insurance. It's a business," he notes.

Michael also comments on the challenges of dealing with changes in the economy: "You can't just frame now. There's not enough work. Four years ago, Surguy Construction was doing seven to eight custom houses each year. Now we're only



doing three or four a year.” In response to the economic downturn, Michael has diversified and is now doing exterior detail and cedar siding: “We reframe them, do all the exterior stuff, all the soffit work, and bevel siding.”

IMPORTANCE OF EDUCATION

Michael persevered in school, committed to learning: “When I finished Delhi, I did a lot of studying on my own with trigonometry. I studied a lot at night on my own and took night classes. I bought carpentry books and studied out of those.” When he was starting his business, he prepared himself to be a one-man operation: “I knew that when I started out, I wouldn’t have a crew. I can probably pull a five-guy job with just two guys. I kept a smaller crew but produced just as much work.”

FUTURE OPPORTUNITIES

Michael is greatly concerned with the economy and its effects on the home-building business. He is hoping to make it through these tough times: “In the last four years, I started making money. Last year was a bad year, but this year has started off well. No one knows what is going to happen.”

WORDS OF ADVICE

Michael recalls the advice of his favorite instructor at Delhi: “You can either learn the right way, or you can learn the wrong way. But if you learn the wrong way, you will always work the wrong way.” And to this he adds advice from his own experience: “You have to do work to get work. If you don’t do work, people won’t know you.”



CHAPTER ONE

ORGANIZATION OF THE INDUSTRY

OBJECTIVES

After completing this chapter, the student should be able to:

- Describe five or more potential careers in construction.
- Explain the roles of architects, engineers, city building officials, and contractors.
- Describe the major forms of business ownership and the differences between them.
- Explain what a building code is.
- List three things that a union or trade association does for its members.

GLOSSARY OF ORGANIZATION OF THE INDUSTRY TERMS

apprentice a person who is being trained to work in the building trades. Apprentices attend classes and work under the supervision of a skilled craftsman.

contractor the person who owns the construction business. Contractors enter into contracts with customers to do specified construction work. Contractors hire workers or other subcontractors to complete the contracted work.

corporation a form of business ownership in which people who are not involved in operating the business own shares of the company. The company is operated by a board of directors.

craft see **skilled trades**.

craft union members of a particular craft who are organized to work for the betterment of all members of the group. Union members pay dues as a requirement of their membership.

developer the person or company that buys undeveloped land and works with architects and contractors to develop it into more valuable property.

journeyman a skilled craft worker who has completed an apprenticeship or otherwise proved his or her ability in the trade. The term journeyman is gender neutral and is used to refer to both male and female workers.

laborer an unskilled or semiskilled worker on a construction site.

model code a suggested building code, intended to be adopted as-is or with revisions to become an official code of a particular government.

partnership a form of business in which more than one person shares the ownership and operating duties of a company.

profession an occupation that requires more than four years of college and a license to practice.

semiskilled labor workers with very limited training or skills in the construction trades.

skilled trades the building trades—carpenters, electricians, plumbers, painters, and so on. These occupations require training and skill. The skilled trades are often referred to as the crafts.

sole proprietorship a business whose owner and operator are the same person.

subcontractor a contractor who is performing work for another contractor.

technicians technicians provide a link between the skilled trades and the professions by using mathematics, computer skills, specialized equipment, and knowledge of construction.

unskilled labor workers with no specific training in the construction trades. This term also applies to work that does not require training.

The residential construction industry is a big sector of the U.S. economy. When the economy of the nation is weak, there is often a decline in new home construction. This is measured by the number of housing starts. As the economy improves, housing starts increase. Recently, there has been a strong increase in housing starts, and the U.S. Department of Labor estimates that the growth in construction jobs will be greater than that for the total workforce. There are opportunities for people to work at all levels in the construction industry, from those who handle the tools and materials on the jobsite to the senior engineers and architects who spend most of their time in offices. Few people spend their entire lives in a single occupation, and even fewer spend their lives working for only one employer. You should be aware of all the opportunities in the construction industry so that you can make career decisions in the future, even if you are sure of what you want to do at this time.

CONSTRUCTION PERSONNEL

The occupations in the construction industry can be divided into four categories:

- unskilled or semiskilled labor
- skilled trades or crafts
- technicians
- design and management

UNSKILLED OR SEMISKILLED LABOR

Construction is labor-intensive. That means it requires a lot of labor to produce the same dollar value of end products by comparison with other industries, where labor may be a smaller part of the picture. A construction worker with limited skills is called a **laborer**. Laborers are sometimes assigned the tasks of moving materials, running errands, and working under the close supervision of a skilled worker. Their work is strenuous, and so construction laborers must be in excellent physical condition. Laborers may be **unskilled**, meaning they have no skills related to the trade they are helping; or they may be **semiskilled**, with some skills, but not enough to be considered a skilled craftsman.

Construction laborers are construction workers who have not reached a high level of skill in a particular trade and are not registered in an apprenticeship program. These laborers often specialize in working with a particular trade, such as mason's tenders or carpenter's helpers (**Fig. 1-1**). Although the mason's tender may not have the skill of a bricklayer, the mason's tender knows how to mix mortar for particular conditions, can erect scaffolding, and



FIGURE 1-1 This construction laborer is a mason's tender.

is familiar with the bricklayer's tools. Many laborers go on to acquire additional skills and become skilled workers. Laborers who specialize in a particular trade are often paid slightly more than completely unskilled laborers.

SKILLED TRADES

A **craft** or **skilled trade** is an occupation that involves working with tools and materials and building structures. The building trades are the crafts that deal most directly with building construction (**Fig. 1-2**).

The skills required for employment in the building trades can often be learned in an **apprentice** program. Apprenticeships are usually offered by trade unions, trade associations, technical colleges, and large employers. Apprentices attend class a few hours a week to learn the necessary theory. The rest of the week they work on a jobsite under the supervision of a **journeyman** (a skilled worker who has completed the apprenticeship and has experience

- Carpenter
 - Framing carpenter
 - Finish carpenter
 - Cabinetmaker
- Plumber
 - New construction
 - Maintenance and repair
- Roofer
- Electrician
 - Construction electrician
 - Maintenance electrician
- Mason
 - Bricklayer (also lays concrete blocks)
 - Cement finisher
- HVAC technician
- Plasterer
 - Finish plaster
 - Stucco plaster
- Tile setter
- Equipment operator
- Drywall installer
 - Installer
 - Taper
- Painter

FIGURE 1-2 Building trades.

on the job). The term “journeyman” has been used for decades and probably will continue to be used for many more decades, but it is worth noting that many highly skilled building trades workers are women. Apprentices receive a much lower salary than do journeymen, often about 50 percent of what a journeyman receives. The apprentice wage usually increases as stages of the apprenticeship are successfully completed. By the time the apprenticeship is completed, the apprentice can be earning as much as 95 percent of what a journeyman earns. Many apprentices receive college credit for their training. Some journeymen receive their training through school or community college and on-the-job training. In one way or another, some classroom training and some on-the-job supervised experience are usually necessary to reach journeyman status. Not all apprentice programs are the same, but a typical apprenticeship lasts four or five years and requires between 100 and 200 hours per year of classroom training, along with 1,200–1,500 hours per year of supervised work experience.

The building trades are among the highest paying of all skilled occupations. However, work in the building trades can involve working in cold conditions in winter or blistering sun in the summer. Also, job opportunities will be best in an area where a lot of construction is being done. This should

not be much of a threat to a person interested in a career in the trades. The construction industry is growing at a high rate nationwide. Generally, plenty of work is available to provide a comfortable living for a good worker.

TECHNICIANS

Technicians provide a link between the skilled trades and the professions. Technicians often work in offices, but their work also takes them to construction sites. Technicians use mathematics, computer skills, specialized equipment, and knowledge of construction to perform various jobs. **Figure 1-3** lists several technical occupations.

Most technicians have some type of college education, often combined with on-the-job experience, to prepare them for their technical jobs. Community colleges often have programs aimed at preparing people to work at the technician level in construction. Some community college programs are intended especially for preparing workers for the building trades, while others have a construction management focus. Construction management courses, such as those listed in **Figure 1-4**, give the graduate a good overview of the business of construction. The starting salary for a construction technician is about the same as for a skilled trade, but the technician can be more certain of regular work and will have better opportunities for advancement.

Technical Career	Some Common Jobs
Surveyor	Measures land, draws maps, lays out building lines, and lays out roadways
Estimator	Calculates time and materials necessary for project
Drafter	Draws plans and construction details in conjunction with architects and engineers
Expeditor	Ensures that labor and materials are scheduled properly
Superintendent	Supervises all activities at one or more jobsites
Inspector	Inspects project for compliance with local building codes at various stages of completion
Planner	Plans for best land and community development

FIGURE 1-3 Technicians.

First Semester		Credits
FYE101	First Year Experience	1
BCT103	Construction Hand and Power Tools	1
BCT104	Construction Safety and Equipment	1
BCT109	Framing Principles	4
BCT110	Site Preparation and Layout	2
BCT117	Construction Materials and Application I	3
CSC124	Information, Technology, and Society	3
MTH124	Technical Algebra and Trigonometry I	3
or		
MTH180	College Algebra and Trigonometry I	3
TOTAL CREDITS		18
Second Semester		Credits
BCT118	Construction Materials and Applications II	3
BCT107	Print Reading and Architectural Drafting	3
BCT130	Interior Finish	3
BCT135	Weather Resistant Barriers and Finishes	2
BCT140	Roof Structures	3
ENL111	English Composition I	3
FIT	Fitness and Lifetime Sports Elective	1
TOTAL CREDITS		18
Third Semester		Credits
BCT234	Masonry Principles	5
BCT238	Concrete Construction	3
BCT260	Introduction to Electrical and Mechanical Systems	3
ENL201	Technical and Professional Communication	3
PHS103	Physics Survey	3
or		
PHS114	Physics with Technological Applications	4
TOTAL CREDITS		17
Fourth Semester		Credits
BCT255	Construction Estimating	3
BCT256	Residential Construction Planning, Scheduling and Management	3
BCT259	Trim and Millwork	5
BCT268	Construction Technology Applications	3
BCT305	Codes in Construction	1
HUM	Humanities Elective	3
or		
SSE	Social Science Elective	3
or		
ART	Art Elective	3
or		
FOR	Foreign Language Elective	3
or		
AAE	Applied Arts Elective	3
or		
IFE	International Field Experience Elective	3
TOTAL CREDITS		18

FIGURE 1-4 Typical construction management program at a community college.

DESIGN AND MANAGEMENT

Architecture, engineering, and contracting are design and management professions. A **profession** is an occupation that requires four or more years of college and a license to practice. Many contractors have fewer than four years of college, but they often operate at a high level of business, influencing millions of dollars, and so they are included with the professions here. Many construction professionals spend most of their time in offices and are not frequently seen on the jobsite.

Architects usually have a strong background in art, so they are well prepared to design attractive, functional buildings. A typical architect's education includes a four-year degree in fine art, followed by a master's degree in architecture. Most of their construction education comes during the final years of work on the architecture degree.

Engineers generally have more background in mathematics and science, so they are prepared to analyze conditions and calculate structural characteristics. There are many specialties within engineering, but civil engineers are the ones most commonly found in construction. Some civil engineers are mostly involved in road layout and building work. Other civil engineers work mostly with structures. They are sometimes referred to as structural engineers.

A **contractor** is the person who owns the construction business, who does most of the building. In some cases, the company itself is considered the contractor, because it is the company that enters into a contract for the work. In larger construction firms, the principal (the owner) may be more concerned with running the business than with supervising construction. Some contractors are referred to as general contractors and others as the **subcontractor** (Fig. 1-5). The general contractor is the principal construction company hired by the owner to construct the building. A general contractor might have only a skeleton crew, relying on subcontractors for most of the actual construction. The general contractor's superintendent coordinates the work of all the subcontractors.

It is quite common for a successful journeyman to start his or her own business as a contractor, specializing in the field in which he or she is a journeyman. These are subcontractors who sign on to do a specific part of the construction, such as framing or plumbing. As the contractor's company grows and the company works on several projects at one time, the skilled workers with the best ability to lead others may become foremen. A foreman is a working supervisor of a small crew of workers in a specific trade. All contractors have to be concerned with business

management. For this reason, many successful contractors attend college and get a degree in construction management. Most states require contractors to have a license to do contracting in their state. Requirements vary from state to state, but a contractor's license usually requires several years of experience in the trade and a test on both trade information and the contracting business.

AN OVERALL VIEW OF DESIGN AND CONSTRUCTION

To understand the relationships between some of the design and construction occupations, we shall look at a typical housing development. The first people to be involved are the community planners and the real estate **developer**. The real estate developer has identified a 300-acre tract on which he would like to build nearly 1,000 homes, which he will later sell at a profit. The developer must work with the city planners to ensure that the purpose for which he has planned is acceptable to the city. The city planner is responsible for ensuring that all buildings in the city fit the city's development plan and zoning ordinances. On such a big project, the developer might even bring in a planner of his own to help decide where parks and community buildings should be located and how much parking space they will need.

As the plans for development begin to take shape, it becomes necessary to plan streets and to start designing houses to be built throughout the development. A civil engineer is hired to plan and design the streets. The civil engineer will first work with the developer and planners to lay out the locations of the streets, their widths, and drainage provisions to get rid of storm water. (Did you ever consider how much water falls on a one-mile-long by 32-foot-wide street when an inch of rain falls? More than 105,000 gallons! Where does that water go?) The civil engineer also considers soil conditions and expected traffic to design the foundation for the roadway.

An architectural firm, or perhaps a single architect, will design the houses. Typically, several stock plans are used throughout a development, but many homeowners wish to pay extra to have a custom home designed and built. In a custom home, everything is designed for that particular house. Usually, the homeowner, who will eventually live in the house, works with the architect to specify the sizes, shapes, and locations of rooms; interior and exterior trim; type of roof; built-in cabinets and appliances; use of outdoor spaces; and other special features. Architects specialize in use of space,