

Basic Principles for Construction

Third Edition



MARK HUTH

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RESIDENTIAL CONSTRUCTION ACADEMY

Basic Principles for Construction

Third Edition

MARK W. HUTH



Australia • Brazil • Japan • Korea • Mexico • Singapore • Spain • United Kingdom • United States

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Preface

HOME BUILDERS INSTITUTE RESIDENTIAL CONSTRUCTION ACADEMY: BASIC PRINCIPLES FOR CONSTRUCTION

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 200,000 to 250,000 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 a shortage of 65,000 to 80,000 skilled workers per year. This challenge is affecting all 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, HVAC, plumbing, masonry, and facilities maintenance. 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 200,000 member groups in the residential construction industry—and its workforce development arm, the Home Builders Institute (HBI).

For the first time, construction professionals and educators created national skills standards for the construction trades. In the summer of 2001, NAHB, through the 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 assure 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 the HBI and Delmar/Cengage Learning, learning materials—textbooks, videos, 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* series is teaching the skills needed to be successful in the construction industry and constantly applying the learning to real-world applications.

The newest programming component to the *Residential Construction Academy* series is industry Program Credentialing and Certification for both instructors and students by the Home Builders Institute. 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. Student Certification is tied to a national database that will provide an opportunity for easy access for potential employers to verify skills and competencies. Instructor and Student certifications serve the basis for Program Credentialing offered by the HBI. For more information on HBI Program Credentialing and Instructor and Student certifications, please go to www.hbi.org/certification.

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* provides the necessary background for understanding the construction industry and the basic skills for learning a specific trade.

Basic Principles for Construction 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 the all-important elements of safely working on a job site, including working with electricity, hazardous materials, scaffolding, ladders, and compressed air. It also covers OSHA regulations, practical housekeeping, and personal protective equipment to ensure safe work habits.
- **Section 3: *Construction Math*** reviews 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 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 third edition continues the structure, organization, and all of the content that made the previous editions so successful; but in this edition we added content that some instructors thought was missing. Specifically, we've added a full-color design with new and updated photos and figures. Coverage of building codes and safe materials handling ensures readers will stay current with industry standards and trends. A new chapter, on green building, introduces students to green building principles and job site practices to plan and execute their work. In addition, all new Success Stories start off each section, and end-of-chapter summaries facilitate comprehension.

We encourage instructors and students to comment on what they like about this book and what they would like to see improved. Comments from those who use the text are our most valuable resource for continuing to make *Basic Principles for Construction* the best it can be.

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.

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.



The **GLOSSARY** at the end of the book is written in both English and Spanish.



CAUTION features highlight safety issues and present urgent safety reminders for those working with the various tools in the industry—so that students can avoid potential mishaps.

112 SECTION 3 Construction Math

original problem and given information. To avoid this, result of multiplication and division are usually rounded off to the same number of decimal places as the highest number of places used in the given has 3 decimal places, the answer should be rounded off to 3 places.

To round a decimal fraction, locate the digit in the number that gives the desired number of decimal places. Increase that digit by 1 if the next digit to the right is 5 or more. Do not change the value if the digit to the right is less than 5. Drop all digits that follow.

EXAMPLE 4 To round 0.63861 to 3 decimal places, increase the 8 to 9 (the next digit is 5 or more) and drop the 61. The rounded number is 0.639.

To round 3.0746 to 2 places, do not change the 7 in the second place (the next digit is less than 5), but do drop the 46. The rounded number is 3.07.

PROBLEMS
Multiply the following quantities:

26. 29.3
× 5

27. 27.68
× 2.4

28. 1.414
× 0.25

29. 0.12
× 0.22

30. 29.3
× 0.115

Solve the following problems:

31. The rating stamped on an oil burner nozzle indicates how many gallons of oil are sprayed each hour. If the nozzle is marked 0.65 and it sprays for 8.75 hours, how many gallons are sprayed?

32. If 0.8 square of shingles can be applied in 1 hour, how long will it take to apply 8.25 squares?

American Wire Gauge Size Number	Wire Diameter in Inches
10	0.10190
11	0.08704
12	0.07479
13	0.06409
14	0.05492
15	0.04737
16	0.04020

FIGURE 7-6

33. What is the resistance of a piece of copper wire that has a size of 2.5 mil feet if 1 mil foot has a resistance of 10.4 ohms?

34. A certain size of lumber costs \$1.15 per board foot. What is the cost of 50.5 board feet of that lumber?

35. What is the cost of 1,450 feet of BX cable if it sells for \$0.675 per foot?

36. If a truck uses 0.2 gallon per mile and diesel fuel costs \$3.159 per gallon, what does it cost to drive the truck 13,215 miles?

37. How much larger is the diameter of number 11 wire than the diameter of number 16 wire. Refer to Figure 7-6.

38. Sometimes in the manufacture of wire, the wire is actually slightly larger or smaller than intended. If the wire is measured and found to be 0.0799 inch in diameter, what standard wire size is it intended to be? Refer to Figure 7-6.

39. Pipe is made in many weights, the most common being schedule 40, schedule 80, and schedule 120. Figure 7-7 shows the inside diameters of 1-inch pipe. ("Nominal" means it is sold as 1-inch pipe although its actual size may be different.) What is the difference in the inside diameter of 1-inch schedule 40 pipe and 1-inch schedule 80 pipe?

40. According to Figure 7-7, what is the wall thickness of 1-inch schedule 80 pipe?


EXAMPLES and **PRACTICE PROBLEMS** integrated into the math chapters illustrate for students, step by step, the various methods of working out construction problems. In addition, it encourages them to practice and improve their math skills.

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.

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REVIEW QUESTIONS

- List the main members of a green home building team.
- At what point does the subcontractor who will do the framing get involved in a green home?
- What is the major objective when selecting a site and planning the position of a green home on a site?
- What things can be considered in site planning to reduce the amount of energy used for air conditioning in a home?
- List four things that can be considered to reduce energy consumption in a home.
- What percent of all energy consumed in the United States is used by homes?
- What is meant by best practices?
- How can products used in construction affect the health of the occupants of a home?
- What is meant by sustainable products?
- What is the role of a green verifier in the NAHB Green Program?



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!

CHAPTER 4 Jobsite Safety 79

ACTIVITIES

ACCIDENT REPORT

- Search newspapers to find a report of a recent construction accident. If you do not subscribe to a newspaper or your paper does not describe a construction accident, you will find copies of many newspapers in the library and on the Internet. Make a copy of the article for your report.
- Write a very brief description of your own, giving just the most important facts about the accident, including what caused it.
- Explain what safety rules were broken to cause the accident and how it could have been prevented.
- Give a brief report on the accident to your class.

SAFETY HAZARDS

Visit a construction site, or base this activity on conditions in your school lab. Describe each of the safety hazards you see, explain why it is a hazard, and describe what has been done or should be done to correct the hazard. Find at least five hazards that either exist or have been corrected or avoided. Make a form like the one below to record your findings.

HAZARD	WHY A HAZARD	RECOMMENDATION TO CORRECT

MATERIAL SAFETY DATA SHEET (MSDS)

Refer to the MSDS in Figure 4-11 to answer the following questions:

- What is the product?
- What phone number would you call if there was an emergency involving large amounts of the product?
- At what temperature will this product ignite? Would you say it is highly flammable or not?
- What should be done if someone inhales the vapors of this product?
- What PPE is recommended for those working with this material?

FIRE

Sketch a floor plan of your school shop or your job site, indicating where fire extinguishers are located. List the classes of fires that can be extinguished with each fire extinguisher on your sketch.

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 Instructor's Resource CD, a printed Instructor's Resource Guide, and a Workbook.

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 **PowerPoint**, a **Computerized Testbank**, and an **Image Library**, as well as the chapter outlines and answers to review questions available through the electronic version of the print **Instructor's Resource Guide**.

PowerPoint

The series includes a complete set of customizable PowerPoint presentations providing lecture outlines that can be used to teach the course. Instructors may teach from this outline or can make changes to suit individual classroom needs.

Computerized Testbank

The Computerized Testbank in ExamView contains hundreds of questions that can be used for in-class assignments, homework, quizzes, or tests. Instructors can edit the questions in the testbank, or create and save new questions.

Image Library

Use the hundreds of images from the image library to enhance your PowerPoint® presentations, create test questions, or add visuals wherever you need them. These valuable images are pulled from the accompanying textbook, are organized by chapter, and are easily searchable.

Instructor's Resource Guide

An instructor's version of lecture outlines, the Instructor's Resource Guide 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. The Instructor's Resource Guide is available in electronic and print versions.

Workbook

Designed to accompany *Residential Construction Academy: Basic Principles for Construction*, Third 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.

Online Companion

The Online Companion is an excellent supplement for students that features many useful resources to support the *Basic Principles for Construction* book. Linked from the Student Materials section of <http://www.residentialacademy.com>, the Online Companion includes chapter quizzes, an online glossary, additional "Success Stories," related links, and more.

The Complete *Residential Construction Academy* Series

Basic Principles for Construction provides a foundation for other texts within the series, which covers carpentry, electrical wiring, HVAC, plumbing, masonry, and facilities maintenance. Each title offers a complete instructor curriculum package, including accompanying videos and a CD-ROM courseware series. Programs in these trades may be credentialed by the Home Builders Institute, providing national recognition for the program. In addition, students who successfully complete one or more of the trade programs can receive a certification of completion and may be eligible to enter in the National Registry. This registry provides a direct link between students and potential employers. For applications and the latest information, visit <http://www.residentialacademy.com>

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About the Author

The author of this textbook, Mark Huth, brings many years of experience in the industry to his writing—first working as a carpenter, contractor, building construction teacher, and then as a publisher of construction textbooks. His career has allowed him to consult with hundreds of construction educators in high schools, colleges, and universities. *Basic Principles for Construction* has been 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 has 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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Steve Miller
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The Construction Industry

CHAPTER 1

Organization of the Industry

CHAPTER 2

Working in the Industry

CHAPTER 3

Introduction to Green Building

Michael E. C. Surguy

TITLE

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

EDUCATION

Michael completed high school and attended vocational school studying carpentry. He later obtained his Associates 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 2 x 10-24 feet 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

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