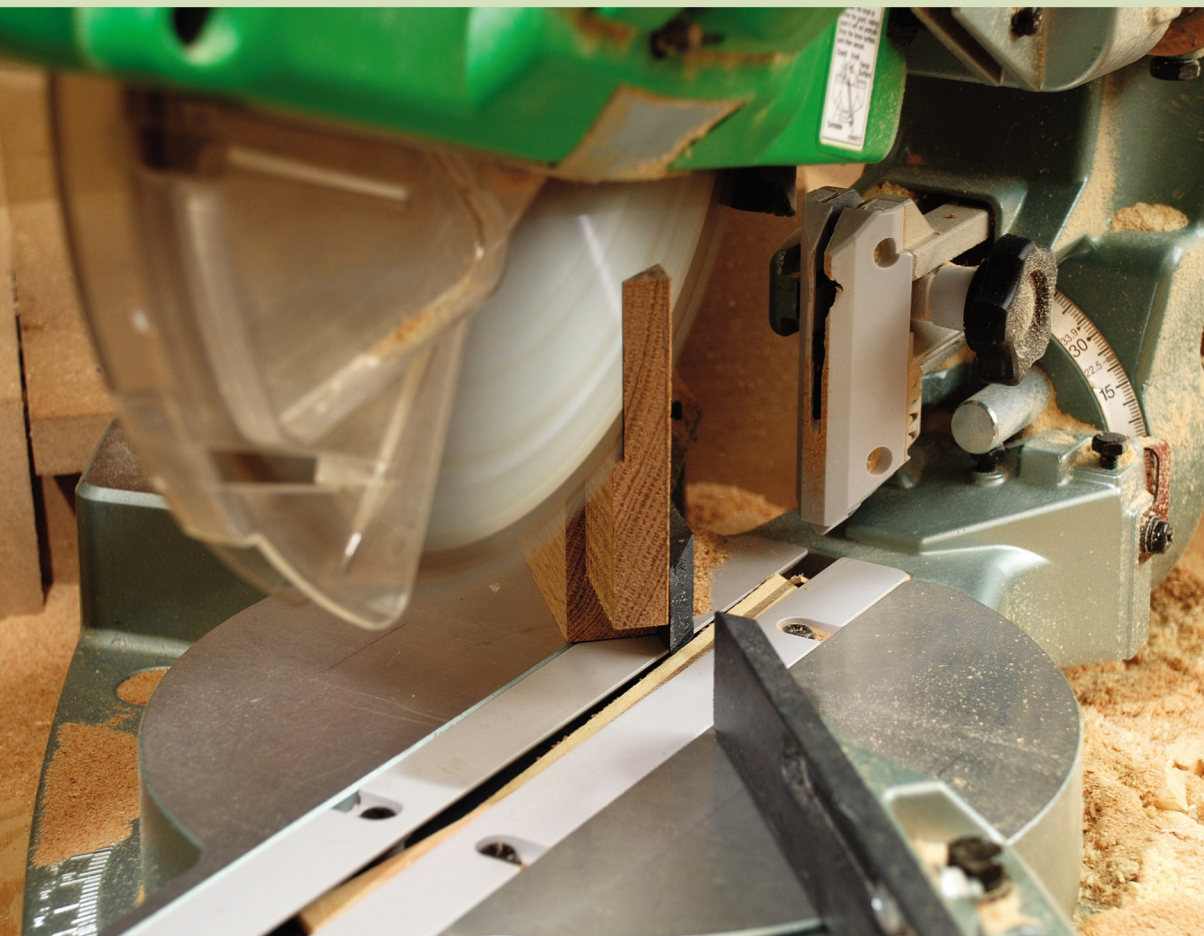


Woodworking

Nancy Macdonald



2ND
EDITION

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Woodworking

Nancy Macdonald

SECOND EDITION



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Nancy Macdonald

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Preface

INTRODUCTION

Woodworking is designed for an introductory woodworking course in high schools, colleges, and continuing education, but is also a must-have for adult hobbyists.

The focus of this book is on a step-by-step approach; it builds the knowledge of the learner by introducing the basics of woodworking — tools, materials, and safety — and then goes on to present the various techniques required for completing wood projects. It also offers a unique blend of basic and more advanced projects so that the book remains suitable for learners as they develop their skills and become more experienced in woodworking techniques. In addition, this book provides insight from practicing professionals in the industry by providing practical advice to those who wish to start a career or run their own business.

Comprehensive and complete with full-color photos and graphics, this book offers a project-oriented and colorful introduction into the world of woodworking.

HOW TO USE THIS BOOK

This book is logically organized into eight sections providing insight into the woodworking industry and a logical sequence to understanding the woodworking techniques and processes involved in building projects.

Section 1: Introduction to the World of Woodworking

This section includes everything you need to know to get started in woodworking. Chapter 1 provides an

introduction to the industry, including key information on finding and obtaining a job and getting ahead in this occupation. Chapter 2 offers important safety information on how to avoid hazards and develop safe practices in the shop.

Section 2: Tools of the Trade

Chapters 3 through 5 cover the necessary tools for completing various wood projects. Explanations on the use of hand, portable, and stationary tools are presented in these chapters, along with general safety rules for their use.

Section 3: Clamps, Fasteners and Adhesives

This next section includes Chapters 6 through 8, covering the materials required for assembling wood projects. Understanding how clamps, fasteners, and adhesives work, as well as their different types, is a critical component in woodworking construction.

Section 4: Woodworking Materials

Wood, panel products, veneer, and synthetic materials are discussed in Chapters 9 through 12. Coverage includes an explanation of the advantages and disadvantages of each of the materials, so that a woodworker can make an informed decision on how to choose the best material for the project.

Section 5: Joinery and Assembly

This section begins setting the foundation for all the chapters that are to follow, providing the basics of construction techniques. It includes Chapters 13 through 19, covering construction methods, stock preparation, case joints, frame joints, rail joints, housed joints, and making wide panels and thick blanks.

Section 6: Cabinet and Furniture Anatomy

Moving on to construction of actual wood products, Chapters 20 through 28 provide step-by-step instructions on how to build base and wall cabinets, doors and drawers, tables and desks, chests, beds, chairs, and the installation of hardware.

Section 7: Finishing

A project is not complete until the finishing touches are added, and this section explains how to accomplish this task. Chapters 27 and 28 provide direction on how to prepare the surface of your project to the final application of various finishes.

Section 8: Special Topics

This section provides a wide array of topics for the more experienced woodworker. Spanning Chapters 29 through 34, it offers instructions on bending wood, veneering, decorative techniques, designing a project, fabricating countertops, and, finally, running your own business.

With the comprehensive coverage of all these topics, this book provides all the need-to-know information for achieving success in the woodworking industry.

NEW TO THIS EDITION

- Substantially more in-depth coverage of stationary power tools to familiarize and help properly train new woodworkers in the effective use of various shop tools that they will encounter in the shop
- New and expanded information on casework, millwork, trim, and installation procedures for kitchen cabinets
- Increased emphasis on safety to highlight the importance of safe practices in the workshop to avoid injury
- New information on “green” practices, focusing on the importance of remaining environmentally conscious when working in the woodshop
- New visuals of various woods and descriptions of their characteristics, illustrating how these commonly used North American woods react with different tools and materials, and guiding woodworkers to make wise choices about their pieces in order to reach the desired results

- Project index offering a quick reference to the “Build It” and “Project Challenge” projects in the book so both new and experienced woodworkers can quickly and easily locate specific projects based on their interests

FEATURES OF THIS BOOK

This edition is full of robust features that will both enhance and facilitate the learning experience. Along with comprehensive coverage, each chapter provides a wide array of helpful tips, safety information, and step-by-step instructions to help learners complete projects.

A Learning Guide:

- **Full-color** photos from a professional woodworking shop illustrate tools and materials, various techniques, and accompany step-by-step instructions for the building process.
- **You’ll Learn** and **Check Your Knowledge** are presented with each chapter. You’ll Learn provides the learning objectives for each chapter, while Check Your Knowledge follows up the chapter with a complete set of review questions to evaluate comprehension of concepts.
- **Applied Science** and **Applied Math** boxes are integrated throughout the book. Chock full of interesting facts, these boxes make the connection between woodworking and the importance of understanding the characteristics of wood and various materials, as well as accurate measurement and calculations, for success in building projects.
- **History Fact** boxes provide interesting background on the history of woodworking so that learners may have a more well-rounded understanding of the industry.
- **Green Reminders** boxes present various ideas for more environmentally conscious woodworking.
- **Woodworking Tip** boxes are also integrated throughout the book, highlighting practical advice from the author on how to best achieve results through smart and safe shop practices.

- **What's Wrong with This Picture** challenges students to find the errors and safety violations in the given picture.
- **Activities** at the end of chapters combine the knowledge presented in the chapter with further research and study. Helpful as homework, or as an opportunity to expand knowledge of specific topics, these activities encourage independent learning and development of critical thinking skills.

A Safety Guide:

- **Chapter 2** recognizes safety as an essential element in success in the woodworking business. This chapter provides valuable information on general safety practices — including woodworking hazards, basic safety rules, shop dress, shopkeeping, and necessary shop practice. Exclusively focused on safety, this chapter should be carefully read prior to beginning building projects.
- **Caution** boxes are integrated throughout the chapters to help further emphasize this important lesson. Each box provides a caution or a warning about the use of various shop tools and particular techniques. These should be carefully adhered to whenever presented in the book.

A Guide to Building Projects:

- Step-by-step **Procedures** are integrated into the chapters; they provide instructions on various tasks that are essential to the completion of the projects at the end of the chapter. Each Procedure provides explanations along with photo sequences to help in understanding these basic concepts.
- Step-by-step **Build It!** projects at the end of the chapters provide a simple project based on the concepts learned in the chapter. It is here that learners can take their knowledge and apply it to the creation of an actual hands-on wood product.
- Step-by-step **Project Challenge** projects at the end of the chapters provide a more advanced project based on concepts learned in the chapter. A learner may tackle the more advanced project once they have mastered the Build It! project presented in the chapter.

A Guide to The Industry:

- A **Success Story** opens each section and provides insight and advice to the aspiring woodworker. Stories are drawn from practicing professionals from across the United States, describing different aspects of the occupation — the advantages and drawbacks, the dedication and commitment required, and the sense of accomplishment from a job well done. Each offers practical advice on how best to succeed in the industry.
- **Chapter 1** provides valuable background on the industry — its history, available careers, and practical advice on finding and obtaining work, and getting ahead in the occupation.
- **Chapter 34** provides the final wrap-up for the book, offering advice on how to start and run your own business successfully.

ALSO AVAILABLE TO ACCOMPANY THIS BOOK

Along with the *Woodworking* book, we are proud to offer supplemental products that will help support classroom instruction and involvement in learning about the world of woodworking.

Woodworking Instructor Resources This CD-ROM is full of helpful tools for the instructor teaching a woodworking course. Each component follows the chapters in *Woodworking* and is intended to help instructors prepare classroom presentations and student evaluations:

- **Instructor's Resource Guide** is available in electronic format and includes lesson plans with correlation to the accompanying PowerPoint presentations, as well as Answers to the Questions in the book and the workbook.
- **PowerPoint Presentations** designed to follow the lesson plans in the *Instructor's Resource Guide*, including an outline of each chapter along with photos and graphics from the chapter to help illustrate important points and enhance classroom instruction. These presentations are editable, allowing instructors to include additional notes and photos/graphics from the Image Gallery included on this CD.

- **Computerized Testbanks** are available in Exam-View format. Containing over 1000 questions and organized by chapter, questions may be edited, added, or deleted to suit individual class needs. Questions can be used in their current format, or instructors may easily create their own exams based on these questions.
- **Image Gallery**, containing graphics and photos from all the chapters in the book, provides an additional option for classroom presentations. Instructors may choose to add to the existing PowerPoint presentations on this CD, or may wish to create their own presentations based on the book.

Woodworking Workbook

Containing various types of questions based on the chapters in the book, in addition to skill sheets based on the Procedures in the book, this *Workbook* provides learners with a tool for evaluating their knowledge of the content. Its flexible format makes this a useful resource for homework assignments. Answers to the *Workbook* questions are provided in the accompanying *Instructor's Resource Guide*, available in print or electronic format.

ABOUT THE AUTHOR

Nancy Macdonald is a professor at the State University of New York College at Delhi, in the Technology Division/Woodworking Program. Her educational credentials include a B.A. from Hartwick College, an M.A. from Yale University, and an M.S. in Vocational/Technical Education from the State University of New York at Oswego. Ms. Macdonald is also the recipient of the NYS Chancellor's Award for Excellence in Teaching.

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Woodworking

Nancy Macdonald

SECOND EDITION

SECTION I



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Introduction to the World of Woodworking



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SUCCESS STORIES

Mario Rodriguez

Title

Furniture maker and restorer; partner and instructor, Philadelphia Furniture Workshop in Philadelphia, Penn.; author Traditional Woodwork: Adding Authentic Period Details to Any Home and Building Fireplace Mantels: Distinctive Projects for Any Style Home

Education

After getting a bachelors degree in Art and Applied Design from H. H. Lehman College, he began a four-year apprenticeship with the Carpenters and Cabinetmakers Union in New York City.

History

Mario's interest began with a sofa he bought: It arrived damaged, so he bought a few simple tools and a book and actually built himself a new one. "It was very satisfying," he says. "But I also recognized that I needed some proper instruction." So he went to the Carpenters' Union in New York City, took an exam, and was placed into an apprenticeship program. By day he did construction, and by night he went to class. After that, he got into cabinetmaking and stair building. In 1979, he opened his own business, which did architectural millwork, restoration, refinishing, and furniture reproduction. During that

time, he was an instructor at the Fashion Institute of Technology. He closed shop in 2001 to teach full time, and he helped found the Philadelphia Furniture Workshop in 2006. The school offers classes for serious amateurs evenings and almost every weekend. When he's not at school, he's at his own studio. Today, he makes six to 12 of his own pieces per year, sometimes commissions and sometimes his own designs on spec. He's also a frequent contributor to *Fine Woodworking* magazine.

On the Job

Since classes are held evenings and weekends, Mario's hours are unpredictable. He figures he works a 40-hour workweek, just not in the traditional 9-to-5 schedule. When he's not teaching or preparing to teach, he's in his studio at the drawing board or the saw. "I like the variety," he says. "If I were just spending time working in the shop I would not be as happy. Now I can design a project, base a class on it, and turn it into an article!"

Best Aspects

"The time I spend at the bench is still the most satisfying part," he says.

Challenges

Designing something is a process, he says — one that's not always easy. "It's rare I'll build something and it turns out beautiful the first time." Thus, it can be a challenge to teach this stage to students. It's also a balancing act, he says, to show them how to build efficiently while maintaining high standards.

Importance of Education

If you're interested in a woodworking career, "enroll in a serious structured program," Mario says. "The students that make the best progress are those who have done so, and have pursued very specific interests."



Image courtesy of Mario Rodriguez.

Future Opportunities

"I want to see us grow," says Mario. "I recognize a need to teach this for young kids. But I also want to reach out to other populations."

Words of Advice

Affiliate yourself with a local woodworking organization, Mario advises. These groups can be great resources for ideas, support, and even just socializing.

Story originally written by Margaret Magnarelli, 2008. Interview and photo provided by Mario Rodriguez.

The Woodworking Industry

You'll Learn

After studying the chapter, the student should be able to:

- Give a brief history of woodworking
- List occupations associated with the woodworking industry
- Be aware of the educational requirements for various jobs
- Utilize the Internet in researching career options
- Develop a résumé
- Present a professional appearance at an interview
- List work habits that will ensure a successful career

INTRODUCTION

People have been working with wood for centuries to create a variety of things, from shelters to the sailing ships they used to explore the world. Methods have changed considerably over the years, but we remain a society that appreciates wood for both its utilitarian qualities and its beauty. In this chapter, we will explore the history of wood usage, woodworking careers of the past and present, and ways to prepare for a career in the woodworking industry.

HISTORY

Early humans used wood for fire, which gave them both heat and a way to cook food. Wooden clubs were used as weapons. The first tools were made of stone and bone, often fastened to wooden handles. The discovery of bronze and iron enabled the development of more sophisticated tools. Some tools have not changed much since our ancestors first designed them. The planes, saws, and hammers used in ancient Rome look very much like the tools we use today. Although the introduction of metal made tools more efficient, it was still a long and laborious process to turn raw materials into finished products, since everything had to be done by hand (see [Figure 1-1](#) and [Figure 1-2](#)).

By the 1600s, the forests of Europe had been heavily logged. During the age of exploration, North America abounded in forests. The New World was a resource of incalculable value, and the forests were a great part of this value. There were literally millions of acres that had never been cut. The early colonists began to clear land for farming and harvesting the lumber. The white pine of the Northeast was highly prized by shipbuilders for masts. Wood was needed to build houses and public buildings.

During the 1600s and 1700s, much of New England's forest was stripped to make charcoal for the smelting of iron. The first source for soap and baking soda was potash produced by burning trees. The virgin long-leaf pine forests of the southeastern United States were decimated to produce pitch and later turpentine. Pitch was used in shipbuilding, and England in particular needed a supply. During the nineteenth century, turpentine was as important a commodity as petroleum is today, and like petroleum, it was used in a multitude of ways.

Early settlers needed wood for building homes, barns, business establishments, and the ships that transported goods. They built mills powered by **waterwheels** to grind grain for flour and to turn logs into lumber. The power to run machinery was generated by a large wooden wheel, which was turned by running water provided by a stream or by a mill pond from which water could be released. As the waterwheel turned, power was transferred to the tools through a system of belts and pulleys (see [Figure 1-3](#) and [Figure 1-4](#)). Mills also provided the power to run the looms in the manufacturing of textiles, which was a huge industry in the Northeast during the 1800s.

The number of water-powered mills in the United States grew rapidly, and they became more

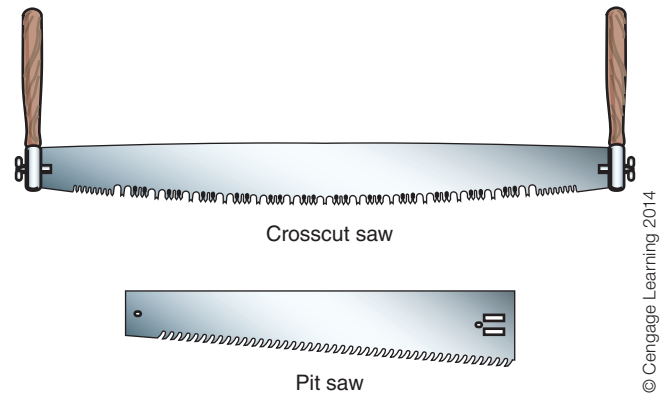


FIGURE 1-1 Crosscut and pit saws were saws that required two sawyers and were typically from 40" to 80" long. Crosscut saws were used to fell trees and cut them into movable sections.

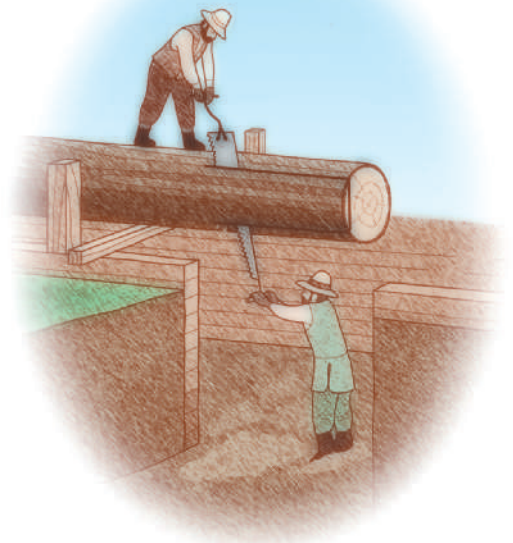
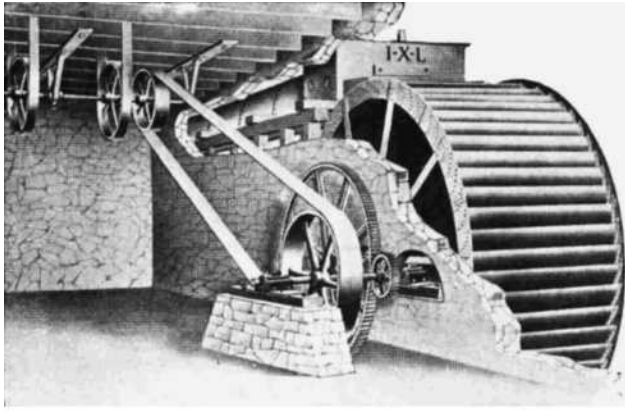


FIGURE 1-2 Pit saws were used to cut planks from the log. One operator usually stood in a pit (hence the name), while the other worked the saw from above.

powerful over time. In 1790, there were around 7500 small mills in operation, mainly for milling lumber and grinding grain. By 1825, there were about 16,000 mills in Maine, New Hampshire, Vermont, and New York. Twenty-five years later, in 1850, that number had mushroomed to 60,000. The largest waterwheels were 70 feet in diameter and were capable of producing as much as 250 horsepower. The industrial revolution was well underway at this point, and the mills



SPUR MASTER WHEEL ON END OF WATER WHEEL SHAFT

Image courtesy of The Society of Preservation of Old Mills, Glen Mills, Pennsylvania.

FIGURE 1-3 Power is transferred from the turning waterwheel to the belts that drive the machines.

provided much of the impetus for that period of enormous growth and expansion.

The advent of steam power and later electricity made it easier to process lumber, and allowed lumber to be processed much faster. The waterwheels could only operate when sufficient water was available, and they needed to be close to a water source. Electricity changed things tremendously: Tools once manipulated only by hand could now be powered by electricity. Working with wood was less laborious and could be accomplished far more quickly.

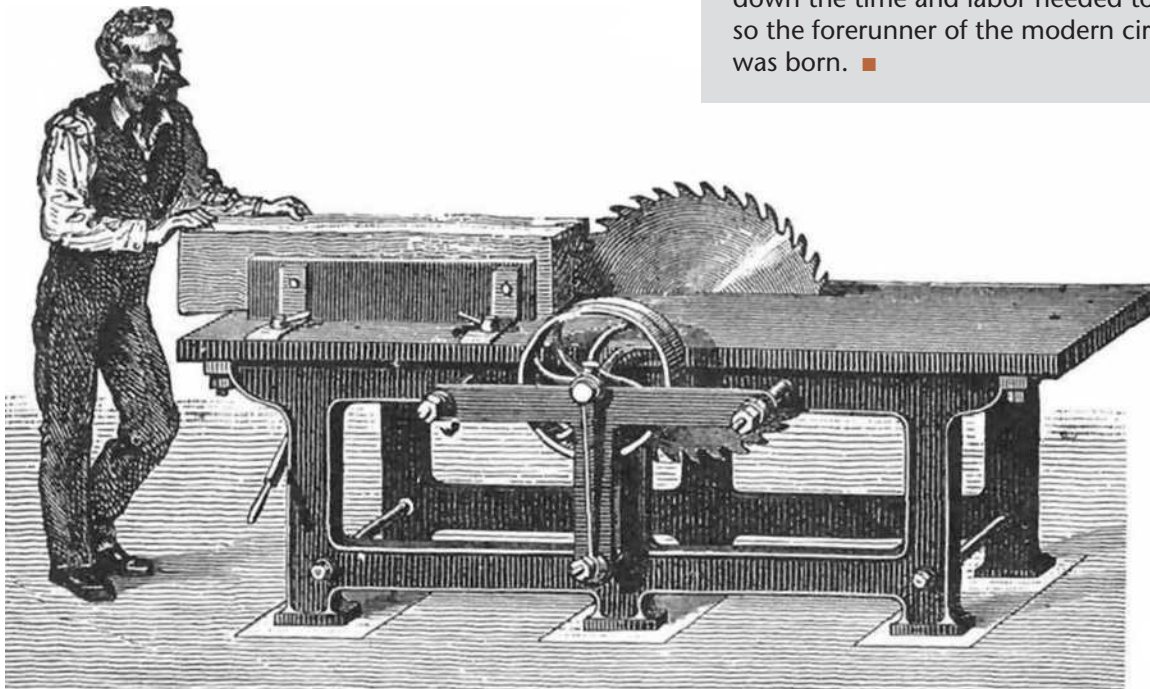


Image courtesy of The Society of Preservation of Old Mills, Glen Mills, Pennsylvania.

FIGURE 1-4 This early table saw is tied into the belt system seen in Figure 1-3, which spins the saw blade.

We rely on electricity so heavily today that it is hard to imagine living and working without it. Most shops today are full of both large and small electrical power tools, as well as air-activated tools. Technology has dramatically changed the way wood is processed. We have tools at our disposal that our ancestors could not begin to imagine. Computers are an integral part of the industry, used for estimating, creating drawings, and actually building products.



HISTORY FACT

The invention of the circular saw, which no carpenter today can imagine working without, is credited to the **Shakers**. The Shakers were a utopian community that flourished between the late 1700s and early 1900s. They were incredibly industrious and inventive, and they built furniture that is still widely admired and imitated today. The story is that a Shaker woman was sitting at a window, working at a spinning wheel. As she worked, she watched Shaker craftsmen sawing wood to length and width using handsaws. She had the inspiration that a saw blade that could turn like her spinning wheel would be more efficient. The Shakers, innovators who always looked for ways to be more productive, tried the idea. It worked incredibly well, cutting down the time and labor needed to saw wood; so the forerunner of the modern circular saw was born. ■

It is possible today for an operator using **computerized numerical controls (CNC)** to program a machine to perform a sequence of operations automatically, resulting in great precision and a high degree of reliability. The integration of computers with equipment has improved production speeds and capabilities, simplified setup and maintenance requirements, and increased the demand for workers with computer skills (see **Figure 1-5**).

CAREERS IN WOODWORKING: PAST AND PRESENT

During the Middle Ages in Europe, men working in the trades usually joined associations called *craft guilds*. The guilds were the forerunners of today's unions. A young man would be sent out to train with a **master** at the age of 7 or 8 and typically worked for him for a period of seven years. He was called an **apprentice**. The employer provided a place in his home for the apprentice and fed him in exchange for his labor; the apprentice was legally bound over to the master by his father. At the end of his apprenticeship, and upon demonstrating his skills, the apprentice gained **journeyman** status. They were called *journeymen* because they often left their towns to seek employment. Journeymen worked for masters, who trained apprentices and employed journeymen, who were paid by the masters; so the power and wealth of the guilds was concentrated in the hands of the masters. To gain master status, a journeyman had to

demonstrate his skills to the masters in his guild, and they decided whether he would be moved up or not. This was an extremely competitive process.



HISTORY FACT

The medieval craft guilds system became widespread in the eleventh century in Europe, as towns and cities started to develop after the Dark Ages. The word *craft* comes from the old English *craft*, which means *skill*. ■

Today, a good share of the workforce is involved in one way or another with the processing and manufacturing of products that originate from trees. More than two million people are employed in one capacity or another in working with wood. There are several broad categories of employment. These categories are forestry, lumber processing, papermaking, wood construction, furniture manufacturing, millwork, and the distribution of wood products. Of course, within each of these larger categories are smaller ones. For example, under construction there are three subcategories: *craft*, *technical*, and *professional*.

Craftspeople are carpenters, precision woodworkers or cabinetmakers, and millwrights (see **Figure 1-6** through **Figure 1-10**). The formal training and education required for craftspeople is less than that for technicians and professionals. A person entering one of the craft trades may attend a vocational school and work as an apprentice to a more highly skilled craftsman, or he may learn through on-the-job experience.



FIGURE 1-5 A CNC router.



FIGURE 1-6 Joists set for a deck by carpenters.

Image courtesy of C.R. Onsrud Inc. www.onsrud.com

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FIGURE 1-7 Deck completed by carpenters.



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FIGURE 1-10 The chairs seen here, and the casework in the background, were built by woodworkers.



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FIGURE 1-8 Porch roof framed by carpenters.



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FIGURE 1-9 Carpenters install hardwood floors.

Technicians include drafters, forestry technicians, and engineering technicians (see **Figure 1-11**). People working in these fields need a minimum of a two-year college degree in their specialty.

Professionals are foresters, furniture designers, teachers, and architects. Professionals need higher academic degrees, such as a bachelor's degree or higher.

Investigating Careers

There are two good resources you can utilize on your computer to learn more about careers in the various categories. One is the U.S. Department of Labor's **Bureau of Labor Statistics**, found at www.bls.gov. Here you will find information on wages by area and occupation, employee benefits, state and local wages, plus a lot more. A second good resource is the **Occupational Outlook Handbook**. It can be reached from the www.bls.gov Web site and provides information on the nature of the work, working conditions, employment, training and advancement, job outlook, earnings, related occupations, and sources of additional information.

Finding a Job

Use all the resources available to you as you search for a job. Talk to a career counselor at your school if you can. Read the help-wanted section in your local newspaper. Put the word out that you are looking for a job, and talk to people in your field of interest to find out how they got started. Most people do not mind being asked for advice, so go ahead and ask. Check the paper for job fairs and attend them, and find out what

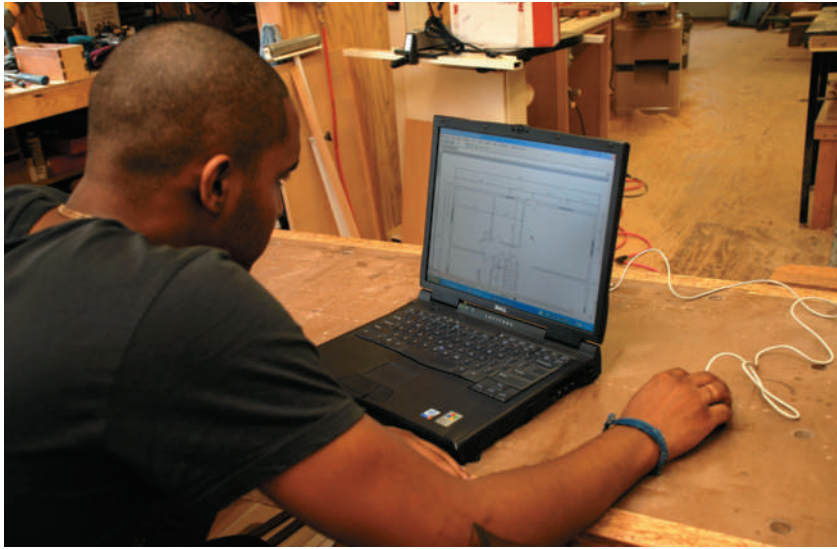


FIGURE 1-11 Plans being drawn using drafting software. Most drafting is done this way, and there is a high demand for technicians with these skills.

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opportunities exist in your area in terms of employment. Your local chamber of commerce can help with this.

You may have the opportunity to do an **internship** as part of your academic studies. An internship is supervised practical training undertaken by a student or recent graduate. It is a great opportunity to explore an area of work you are interested in, and you may develop some excellent contacts that will be useful when you are job hunting. You may even be offered a job by the company that sponsored the internship; and if you do an internship, or have related job experience, be sure to mention it in the “Experience” section of your résumé.

Many construction trades have **labor unions**, and you might investigate this path. A labor union is an organization of wage earners formed for the purpose of serving the members’ interest with respect to wages and working conditions. You start in a union as an apprentice. Today’s union apprentices are paid, although at a much lower rate than journeymen. The apprentice must successfully complete a series of classes and put in the required time, and then he is promoted to journeyman status and wages. If you are interested in learning more about becoming a union member, look up the local union office and set up an appointment to talk to someone.

There are numerous woodworking associations that may be helpful in your job search. An Internet search will yield a great deal of information. There may be a local group you might want to get to know, and these contacts could lead to a job.

Another source of good information is trade magazines, available at bookstores and newsstands. There is usually a classified section in which you may find jobs or apprenticeships advertised. You will also

WOODWORKING TIP:

Does your school have a local Skills USA chapter? Skills USA is a national organization serving high school and college students who are enrolled in technical, skilled, and service programs. Skills contests are held at the regional, state, and national levels. The organization promotes leadership, teamwork, and citizenship development, as well as skill development.

find numerous trade-specific advertisements, and perhaps you would like to work for one of these companies. Reading trade magazines will also increase your knowledge of the field.

Preparing a Résumé

Your first step in any job search is to develop a **résumé** — a brief account of your professional or work experience and qualifications, designed to give potential employers a snapshot of who you are and what you can offer a company. The first résumé item is your full name, followed by your address and phone number. There are a wide variety of résumé formats, and you should look at several. They traditionally include the following information, generally arranged in sections:

- Position sought
- Education
- Experience