# Chairmaker's Notebook

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*Peter Galbert*

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# Foreword

From the moment I first laid eyes on a handmade Windsor chair in the mid-1990s, I wanted to build a whole army of them. I read every available book on the topic, but I had so many questions about every aspect of the craft that I wasn't confident enough to give it a go.

If I'd had this book, however, things would have been different.

"Chairmaker's Notebook" is a landmark work – a description I use sparingly. I consider it a new benchmark, both for chairmaking books and explanatory journalism. Here's why.

Peter Galbert builds some of the nicest Windsor chairs I've ever seen. He's a technical virtuoso with an artist's eye, but that alone is not what makes "Chairmaker's Notebook" special.

Instead, this book is an important work because Peter spent years rethinking and refining the chair-construction process. He developed mind-blowingly simple ways to deal with the compound joinery in a chair's undercarriage and upper assembly. And he created simple tools and jigs that make it easy for a beginner to start building chairs.

Additionally, Peter came up with clever and clear ways of explaining his techniques – from using a drawknife to back-wedging a chair's spindles – so you will understand and be confident enough to build a chair using only this book as your guide. His explanations of complex ideas are so simple that they permanently crystallize in your head; you'll wonder why you didn't always see the wood, tools or joinery in this way.

And if creating innovative techniques and clever ways to explain them isn't enough, there are the 500 handmade drawings. Peter drew every illustration in this book (some of them three or four times) to amplify the text and provide clarity that a photograph cannot.

As a result, "Chairmaker's Notebook" is one of those rare woodworking books that is a perfect document. It's a joy to read, a pleasure to look at and something that will change the way you work.

I'm proof of that. Though I have successfully built Windsor chairs for 11 years now, editing this book fundamentally changed my shop practices, tools and techniques. I am the book's first and biggest fan. And it is our pleasure here at Lost Art Press to offer it to you.

Christopher Schwarz
January 2015
Fort Mitchell, Ky.

# Introduction

Chairmaking is simple. If you've ever split firewood or bent a stick until it snapped, you've encountered the basics. This might sound like a gross simplification, but after years of plumbing the depths of the tools, techniques and materials, I marvel at the simplicity that lies at the heart of the craft.

*A walk in the woods starts with finding the perfect walking stick.*

My earliest relationship with wood had nothing to do with making furniture. I recall wandering through the woods, playing with the sticks littering the ground. I could bend them into bows, sharpen them into spears or peel them smooth for walking sticks. I didn't think much of it, but I was using the material for its inherent strengths in the simplest, most direct way. The wood was everywhere, and it seemed like it could be made into anything.

At the time, it would have made perfect sense to me to take a straight stick and put it in the back of a chair. Had I suggested it, someone probably would have told me that furniture parts are sawn from larger boards and weren't simply sticks that had been shaped a bit. I was, however, more correct than wrong in my assumption.

In the ensuing years, I learned that wood is a hard, dry and expensive thing that comes in rectangles and can be cut with blazing speed and accuracy with the help of power tools. While there are huge advantages to working this way at times, this starting point has limitations, both in the results and the experience of reaching them.

## Suited up for Work

In the mid-1990s, I worked in cabinet shops in New York City. I spent long days building boxes and milling planks or plywood while wearing a respirator, eye protection and hearing protection. I was paying my bills, but my future seemed bleak because my real goal, working intimately with the wood, seemed no closer.

On occasion, chisels and handplanes came into play, but advances in power tooling had nearly eliminated their use altogether, especially in the time-hungry competitive world of cabinetry. The closest that I got to a hand tool was usually sandpaper. And I was teased by my co-workers for trying to find a place for hand tools in the process. Looking back, I realize that few of them knew or needed to know how to use them. The lesson I took from those jobs was that hand tools cannot compete with power tools on the turf of modern production methods. But looking around, I noticed that almost all of the work was made up of 90° angles and few curves. The materials and machines seemed to push everything in that direction; any deviation from flat and square proved time-consuming and difficult.

I was determined to find a different way, so I rented a 20' x 12' workshop that I shared with a guitar maker, and I set out to figure out what I could make with wood and my hand tools that could sustain me.

I brought with me an idea that I believe plagues many woodworkers. I defined my achievement and skill by my ability to manipulate the wood to fit my will, regardless of its properties. How many war stories have we heard and told about overcoming the properties of tough wood? Then, to top it all, being able to say that it was done with hand tools is the epitome of mastery. As I tried different projects, I discovered that these ideas get stale as the bottom line starts aching. Like John Henry racing the steam drill, you can do it, but it'll perhaps merely kill you or your business in the end.

There are many wooden objects, such as tables, where building them by hand gave little competitive advantage – except you could say that it had been done by hand. And even then, I would be competing with factories set up to make similar furniture at a price I could never match.

It was discouraging, and I was close to throwing in the towel on my woodworking career.

I jealously watched my shopmate use simple hand tools to make gorgeous archtop guitars. Watching him transform the wood into a lovely object was one thing, but then to hear the music pour out of it made me think differently about my expectations, the tools and the material. He wasn't battling the wood, he was working with it. I am not musical, so I began to seek both the technology and the object that could give me a similar connection to the wood.

*Not my favorite outfit.*

## My First Chair

Chairs seemed a natural choice. They had always fascinated me for the endless design options and because of the intimate relationship we have with them. I had done enough research into their construction to think they would free me to work differently.

First, I looked into making Chippendale chairs. In addition to the exacting square joinery, they had a rigid posture that didn't seem inviting. The turning point came when I abandoned the pursuit of the flat and square and started thinking about the green-wood Appalachian ladderback chairs that had always interested me. Reading "Make a Chair from a Tree" by John (now Jennie) Alexander was my first introduction to the direct link between green wood and chairs, but Appalachia felt like a long haul from the streets of Manhattan.

After thought and research, I decided to make a Windsor chair. I built it based on a photo in a magazine article by Curtis Buchanan. It took me the better part of six months to pull it off. It took so long because I was not only working on it between jobs, but I was also delving into a whole new approach to woodworking. I had never worked green wood for furniture, nor turned on a lathe, nor made tapered joints. And the list goes on.

After completing my first chair, I realized I had sidestepped all the problems I'd faced when building "flat" work. No longer did I need more space, more machines, more materials, more electricity and more time. Once I was further along the learning curve, the pace with which I could work – from a log to a finished piece – was practical, measured in days, not months. And there were the benefits to doing things by hand. I found that I was no longer competing with power tools; they simply didn't meet the requirements of the task.

Woodworking was like playing again, and I was sold. Splitting, shaving and bending wood was a clear path to a comfortable, durable and beautiful chair.

Even for parts made from dry wood, such as the seat,

*Appalachian ladderback, Birdcage Windsor, Chippendale – all very successful chairs.*

there are good reasons to carve it by hand. I can waste away the bulk of the wood from a chair seat in about 5 minutes and get it ready for finish in about 30 or 40 more. The tools that I use to shape the seat are so sharp and effective that I am left with little scraping or sanding.

## Embracing Tradition

I was always interested in the tools and technique of the past. Woodworking is a trade that was fully formed before the advent of electricity, and I wanted to understand how it was done. I was never going to be satisfied just using machines without understanding how the world worked so well without them. But employing traditional technology is not the same as reproducing the work of the past. As a matter of fact, my education in art had left me with an aversion to anything that smacked of reproduction. Perhaps the fact that you have already picked up this book is proof that you don't suffer this hang-up, but I still think it's worth describing how my own attitude changed.

Abandoning the aesthetics of the past is the birthright of every generation. One group wants nothing more than to cover their wood floors while the next works tirelessly to unearth them. Our connection to the past is distorted by the attitudes of our own time. Making traditional furniture can be viewed as relegating oneself to subservience to the past, a role devoid of imagination, traveling on trails blazed by others. The results are often valued less than an "original," therefore the choice to engage tradition can be seen as inherently limiting. Although the execution might be exemplary, it doesn't carry the spark of originality.

Initially, the aesthetics of the traditional Windsor didn't hold much appeal for me as I had encountered or understood them. What encouraged me to break through this idea was the deep desire to take my tools and materials in a different direction, regardless of where that path originated. I can honestly say that my attitude changed almost instantly as I recognized the possibilities that building chairs this way afforded. My interest in whether work was "original" was supplanted by other more intriguing qualities and options that this way of working afforded.

By ditching all the assumptions and processes that come along with working with planks and starting with the log, I found making chairs to be the equivalent of a fresh tomato versus canned: perhaps a little less convenient is some ways, but engaging and full of potential that was previously impossible or impractical.

At first it may seem strange that I would need to turn to a craft that is centuries old to find a "fresh" way to work with wood, but then again, the folks who made chairs in the 18th century had a very different relationship to their world. Back to the food analogy. Seasonal food was a way of life, and while there were certainly means of preservation, the limited options available gave them a framework for making decisions that I think has real value, especially in today's world with its excess of options.

You may wonder "Don't you feel limited by the technology and aesthetic of the Windsor form?" My answer is "absolutely not." I've found that the "limitations" of the form have given me a deeper understanding of the tools, materials and goals involved in making chairs. Chairs have a broad range of shapes they can take, but they must always conform to the needs of the human form. All successful chairs must address this, and once you begin down the path of chairmaking, the similarities and solutions become apparent. I've found that the technology involved in Windsors is beautifully suited to meeting the needs of the human form, and as far as aesthetics go, I see such a wide range of possibilities that I cannot imagine coming to the end of them. When I have spent time attempting direct reproductions, I always come away with new awareness and inspiration. Walking in the shoes of those makers of the past is a privilege, and the lessons of their lifetime of effort are free for the taking. What you do with that information is up to you. This is well stated in the oft repeated quote "poor artists copy, great artists steal."

It's not uncommon for me to encounter a student who is interested in the technology, in spite of their feelings about the appearance of "traditional" chairs or creating "reproduction" furniture. I have yet, however, to see one who has not been engaged by the simple brilliance of the process. And even if they never make another Windsor, it always informs the other work they will build.

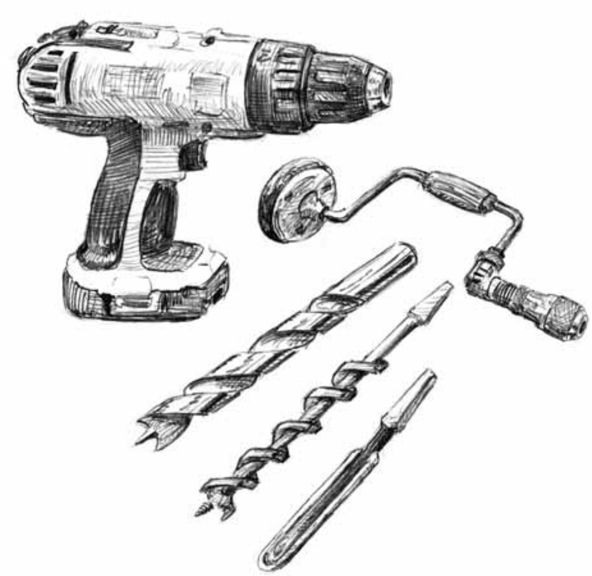
I always seem to turn to food as a metaphor for building furniture. In cooking, the freshness of the ingredients and working with them from their most raw state gives a level of control and involvement that can readily be appreciated by the cook and the diner. It's no exaggeration to say that my experience making chairs within this tradition is very similar. From the fresh air in my lungs as I split the log to the subtleties of the tool marks that show my path to completing it, I am engaged. And this is reflected in the final product. I started my furniture making by placing a premium on originality, but now I focus on whether my process and product has life.

Forgive me if this sounds far afield; we are still talking about furniture, right? To make the point, I'll go back to food because it's a topic where we have all spent a lifetime refining our tastes and awareness. Just like an exceptional meal, there are qualities in furniture that engage us as makers or consumers that make it feel vital and alive. I became aware of this as I started making chairs, but even more so when I saw the public's reaction to them. This is how I sustain my interest and judge my results.

## Tradition & Tools

Addressing the topic of tools, especially those used in the service of a traditional craft, can be a sticky business. Through the years, I've found tools and techniques that match my interests. This is something you will have to work out for yourself as well.

The simplicity of the tools definitely factored in my choice to make chairs, and I thoroughly enjoy their role in



***Brad-points, augers and spoon bits all do a great job in their own way.***

my work. But through the years, a variety of tools, some quite unexpected, have proven their value in my shop. Like any valued employee, each tool must earn its keep in my small shop. And while I have affection for certain tools, I try not to let that cloud my judgment concerning their usefulness.

In my thinking, the impulse to advance a tradition is a vital part of partaking in it. We honor the past by listening and linking to it, not just attempting to repeat it. Time has a way of weeding out lousy ideas, while the worthwhile ones march on. In looking back at the history of woodworking and chairmaking, it's easy to make assumptions about the reasons certain tools and techniques were used. I try to keep in mind that every craftsman was modern at the time and tried to match the quality of the chair produced with the demands of the market.

When I became interested in chairmaking, I didn't have any specialty tools associated with the craft, and my budget was tight. So instead of seeking out a set of quality auger bits and a brace, I grabbed my cordless drill and reground some old twist bits into brad points with long center spurs.

Not only did they cut great, but by setting the clutch low on the drill, I discovered that I could get blow-out-free exit holes.

Perhaps the bit and brace would have become my pride and joy, but not because they were "historically accurate." Sure, at some time in the past, auger bits were used in chairmaking, but that doesn't make them more appropriate than the cordless drill. Auger bits were a late 19th-century tool, so using them on an 18th-century chair isn't any more "accurate" than using a brad-point. Historical accuracy is a worthy pursuit, but it is not my personal priority.

I hope to show there are many successful ways to achieve results, and plenty of room to conceive of new methods. Moments after showing me how to split parts from a log (and blowing my mind in the process), Dave Sawyer showed me it could also be done on the band saw. Although the band saw was slower, it ensured that we were able to get two parts from an undersized billet, which suited Dave's Yankee urges.

There is much to be learned from the tools and techniques of the past, especially if it leads to the realization that a quiet, hand-tool driven shop can be a place of refuge that is also highly productive.

Setting the correct expectations for each tool and task takes time and practice. I've found that the tools in chairmaking perform with a speed and accuracy that makes the process flow. Hand tools are easier and more effective when working with wood that is split or cut parallel to the fibers. That's because the cutting direction will always be toward the thinner portion of the workpiece, and the cut can be made on all the faces without concern of grain reversals. While electric saws can ignore fiber direction, hand tools are sensitive to it, and simplifying the direction to cut is essential to getting good results.

## The Right Tool for the Job

One recurring theme I've come across is that each tool, used in its proper place and to the maximum extent of its ability, will speed the process and leave less work for the next tool. Switching tools too early can make a job laborious. This is always the case, from the moment that I decide to switch from wedges to the froe, all the way to moving from the travisher to the scraper.

"What are the essential tools required to make a chair?" The question is partially answered by the type of chair you wish to make, and the speed and ease with which you want to make it. A seat can be carved with a gouge and a scraper. It might take more time, but you can get the job done. For my first chairs, I bent a piece of steel into a "U" shape. I ground one edge to make a scorp of sorts and dug away. I never bothered to harden the steel, so it cut poorly; perhaps this is where I learned the importance of skewing and slicing across the grain.

Couldn't a machine be rigged to do it in less time? Perhaps. If you were producing a large quantity of identical chairs, it might prove effective to mechanize the processes. Such mechanization on the small scale, however, often serves to sidestep the real time-saver, which is well-honed tools and skill.

There is a character to a handmade chair that a factory chair, with its strict uniformity, can't match. Our eyes quickly pick up on the sameness of machined construction and cease to explore the form. The skilled process of building a chair by hand is reflected in the final product. When a viewer approaches the chair, the crisp tool marks become visible and inviting to touch. When the person sits down and experiences the unexpected flexibility and comfort, he or she immediately registers the difference. The quality of the parts and the chair as a whole rests firmly in the maker's eye and hands.

I believe that much of the evolution of the Windsor

*Even a full set of tools for chairmaking represents a small collection.*

forms can be attributed to this expanded role of the craftsman. Over time, and in hands of so many makers, it is no surprise that the form changed into so many interesting and refined forms. Sometimes the change came incrementally; other times there were leaps, such as the continuous-arm chair, that pushed the craft into new territory. As a modern maker of a traditional form, I feel most indebted to the craftsmen who were willing to step up and nudge the form forward.

In David Pye's book "The Nature and Art of Workmanship," he delineates between the craftsmanship of risk and of certainty. The difference is how much of the result is predetermined by the jigging and how much is left to the hand and skill of the craftsman. It's never solely one or the other, but a negotiation of the two. One of the joys I find in chairmaking is traveling close to the risk side of things, which not only suits the technology and results, but commands my focus. Each maker must fit his or her own priorities into the equation to learn where the line between romance, power overkill and appropriate technology lies. I don't want to run a factory. I don't want to manage employees. I don't want my designs written in stone. The limitations imposed by my tiny city shop led me to discover chairmaking and, more importantly, that matching the tools to the materials and the process is one of the keys to being competitive using hand tools.

## What is a Windsor Chair?

There are a few characteristics that define a Windsor chair, such as turned legs, a carved seat, thin spindles and even carvings on more ornate examples. To me, however, it's the structure of the chair, not the styling, that best defines a Windsor. The legs and top parts terminate at the seat. Unlike Chippendale, Appalachian ladderbacks or Shaker chairs, no part extends from the floor to the top of the piece. Using the seat as an anchor creates some limitations, but it also opens up a wide variety of design possibilities within a durable, time-tested framework.

The forms that we recognize as Windsors have been continually produced for centuries. Through time, the style has paid a high price for its success. As factories replaced individual craftsmen, the parts became thicker, the turnings clumsier and the overall beauty diminished. The heavy, artless and uncomfortable chairs that lurk in dark restaurants often occupy our thoughts when we hear "Windsor," but they don't do justice to the brilliant technology involved in Windsor chairmaking.

*This well-proportioned comb-back high chair designed by Dave Sawyer is a good example of the strength and flexibility possible with the Windsor technology. It's just wide enough for me to squeeze into, and very comfortable when I do.*

The many innovations with Windsors belong to countless craftsmen through lifetimes of thoughtful work. But making a Windsor by hand is more than mere nostalgia, it's an entry into a whole different kind of woodworking where hand tools and a simple shop can create an elegant chair.

## Why Windsors?

There are lots of different ways to make wood add up to a chair. So what is it that makes the Windsor such an enduring and interesting form?

When I began building chairs, I found the tools and techniques were in tune with the characteristics of the wood and the end product. Like wool for yarn or hops in beer, it simply felt like the right thing to do with hand tools and wood.

Before I made chairs, my approach to wood choice was largely a matter of color; cherry is red, oak brown and maple blonde.

Visitors to my shop often ask: "What kind of wood is it?" They expect the chair to be made from a single species. I explain that unlike wooden furniture where the materials are largely chosen for visual appeal, the species in Windsors are chosen for their strength, workability and the role that they play in the chair.

Ring-porous hardwoods, such as oak, hickory and ash, make up the bent parts and spindles. They split easily from the green logs and shave along the fibers to make parts of maximum strength and flexibility. The seat is made of large trees such as Eastern white pine and poplar that are easy to dry and carve. The turnings are made of dense hardwoods, such as hard maple, that have great strength and hold crisp detail. Of course, there can be variation on the choice of woods, but the primary requirements of strength and workability are key.

***Parts split and shaved along their long fibers retain the strength of the tree.***

This use of riven wood as a structural material yields many advantages in meeting the goals of the chair. The parts can be made unexpectedly thin, which gives the chair a lightness and flexibility that sets it apart from other wooden chairs. Working split wood also speeds the process by eliminating the need to reverse the cutting direction. This is a huge advantage when using hand tools.

Splitting wood by hand for a chair isn't a romantic gesture, but a way to bring about qualities in the chair that would be impractical to achieve by other means.

Unlike rustic furniture, which celebrates the raw materials and simple design, I found Windsors interesting because the end product goes beyond its humble organic origins. When I first looked at the chairs, I couldn't imagine a process that would begin with a log.

## A Practical, Not Historical, Approach

Obviously there is a long history to the Windsor chair. And along the way, I'm sure that just about every imaginable technology has been used to build them and all sorts of design innovations have been tried. I am neither a historian nor a wood technologist; luckily, there are a number of good books on both subjects. In setting out to write this book, I wanted to make chairmaking accessible and open a door into a gratifying kind of woodworking.

Looking back, I recognize that my own transition into working with green wood took place in stages. I remember simply wanting to see what a drawknife could do, and I didn't care if it was on a split piece of oak destined for a chair or a 2x4. I encourage you to act on your impulse to explore and play. These are vital steps in the learning process.

Even though I could simply lay out a single path to success for making a chair, I recognize that each of us comes from a different background, workshop and skill set, so I've tried to stress the principles that you'll encounter, knowing that you will apply the information that best suits your ability and interests.

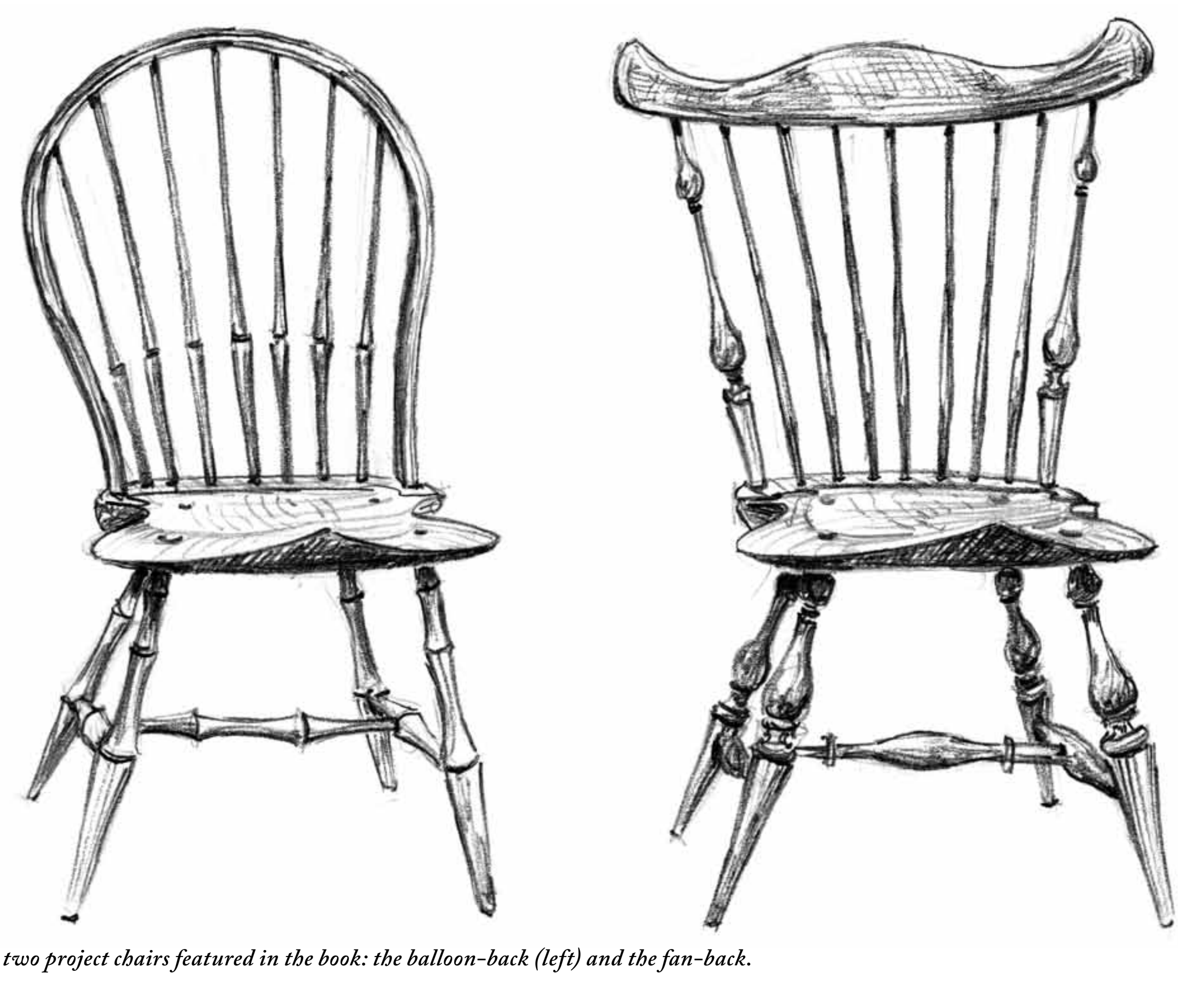
I've structured the information so that the basic concepts are illustrated, and if you want to go deeper into the topic, you can delve further into the text. Illustrating the book myself was an obvious choice for me because not only do I enjoy drawing, but I also hope to impart as much visual information as possible. Plus, the chairs, with their thin lines and crisp silhouettes, translate beautifully when drawn.

The project portion of this book details the process of building the two chairs shown below. While the process for building a chair is simple, there are many opportunities to learn more about the materials, tools and techniques.

The project chairs were chosen both for their similarities and differences. Besides some aesthetic elements, the chairs are structurally identical from the seat down. That way, making one chair will give you experience that will serve you in the other. From the seat up, the difference is both aesthetic and technological. If you have access to green wood, you will find the balloon-back attainable. If you are limited to sawn (hopefully air-dried) lumber, you can make your way through the fan-back, which lacks the extreme bend, yet it has slightly more complex joinery in the crest.

Another reason that I chose these chairs is that they point the way toward two different families of design within the Windsor tradition. The balloon-back is a great introduction to the classic forms, such as the continuous-arm, sack-back and comb-back.

If your interest runs more toward more modern options, the fan-back leads to other designs with clean



*The two project chairs featured in the book: the balloon-back (left) and the fan-back.*

*Drawing of two "families" of chairs to which each project chair belongs.*

Asian-influenced lines, such as the birdcage and the step-down-crest styles. My unpainted contemporary designs are mostly rooted in the technology that begins with the fan-back form.

I also cover options for building these chairs using the lathe in a limited way, or without using a lathe at all. While turning is the most efficient way to make the legs and joinery, not having experience with or access to a lathe should not stop you from making a fine chair.

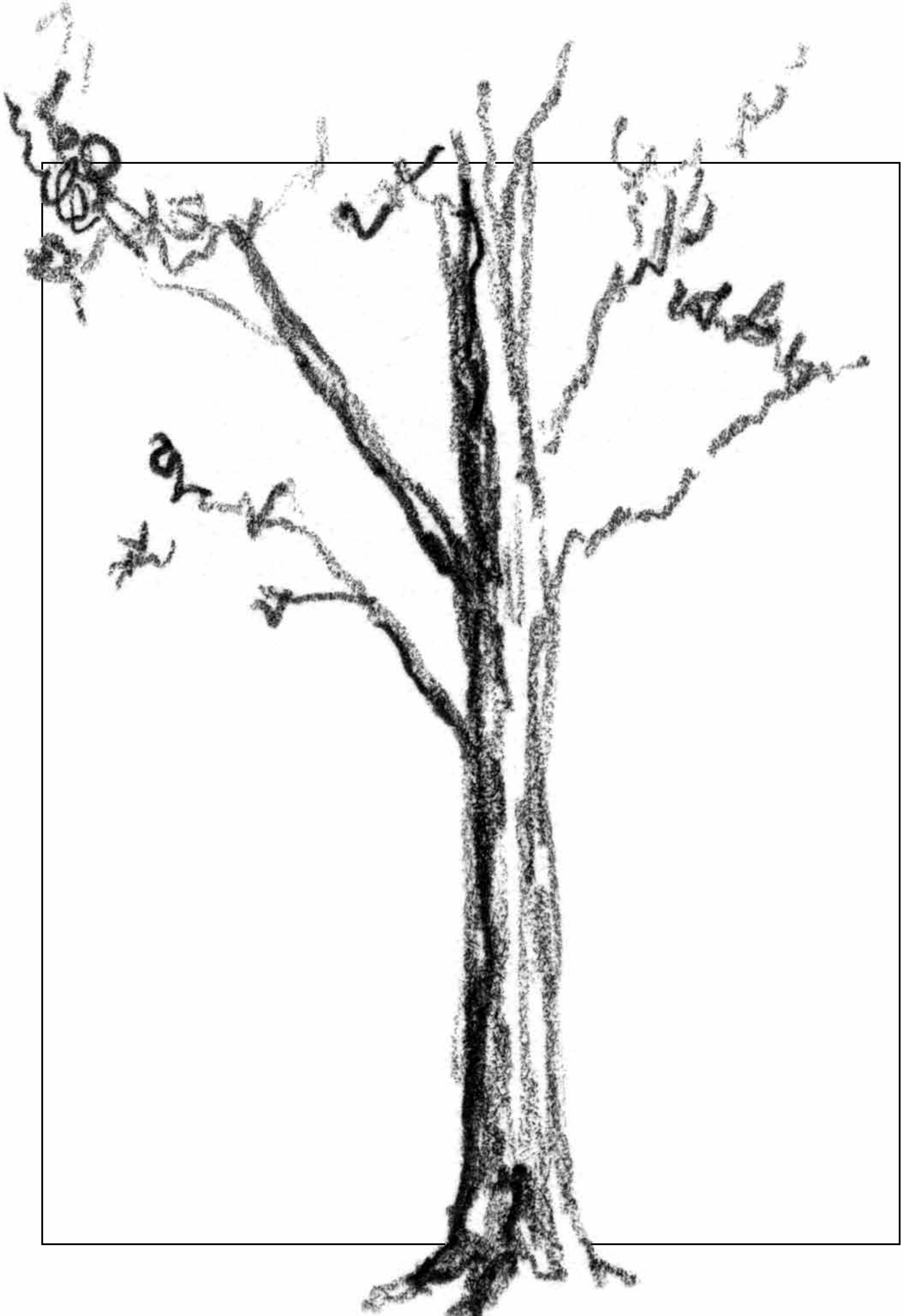
In this book, I've tried to address the questions that riddled me as I ventured into chairmaking and share some of the lessons and discoveries I've found helpful along the way. I spent most of my earlier years as a woodworker poring over books to squeeze out the information that I needed. One thing that struck me was that I got something new each time I returned to my favorite texts. My goal here is to not only demonstrate ways to achieve the tasks, but to show some of the common problems you might encounter and how to address them. Because of this, some of the descriptions might make more sense to you once you've worked with the process and found a problem for yourself. If the depth of the information here ever seems daunting, take a deep breath and rest assured you can make a chair that will exceed your expectations with only the basic concepts in hand. Once you've grown comfortable with them, the rest of the information might be more inviting.

Even for experienced furniture makers, each process will likely introduce new challenges. From splitting wood to turning, steam bending to carving, it's a different way of looking at making a piece of furniture. While there are many steps involved in making a successful chair, and mastering the process can be a lifetime pursuit, a little effort and resilience will pay off at each turn.

My hope is that the information here encourages you to build your first chair, or perhaps just your latest.

Peter Galbert
2014

*For my mother, Arlene, for absolutely everything*



# 1

# Why Green Wood?

Using wood fresh from a log has a number of advantages for the chair and chairmaker. But that being said, lack of access or experience with green wood should not prevent you from exploring chairmaking. Once you understand the concepts behind the use of green wood and the advantages it imparts, you'll see there are ways to use dried wood with the same or similar results. Ideas for starting with dry wood are included at the end of this chapter. The process may not be as easy using dried wood, but I recognize that for some woodworkers, the plunge into chairmaking and green woodworking might take place in stages. With a little success in chairmaking, I have no doubt that the excitement will nudge you ever closer to the log.

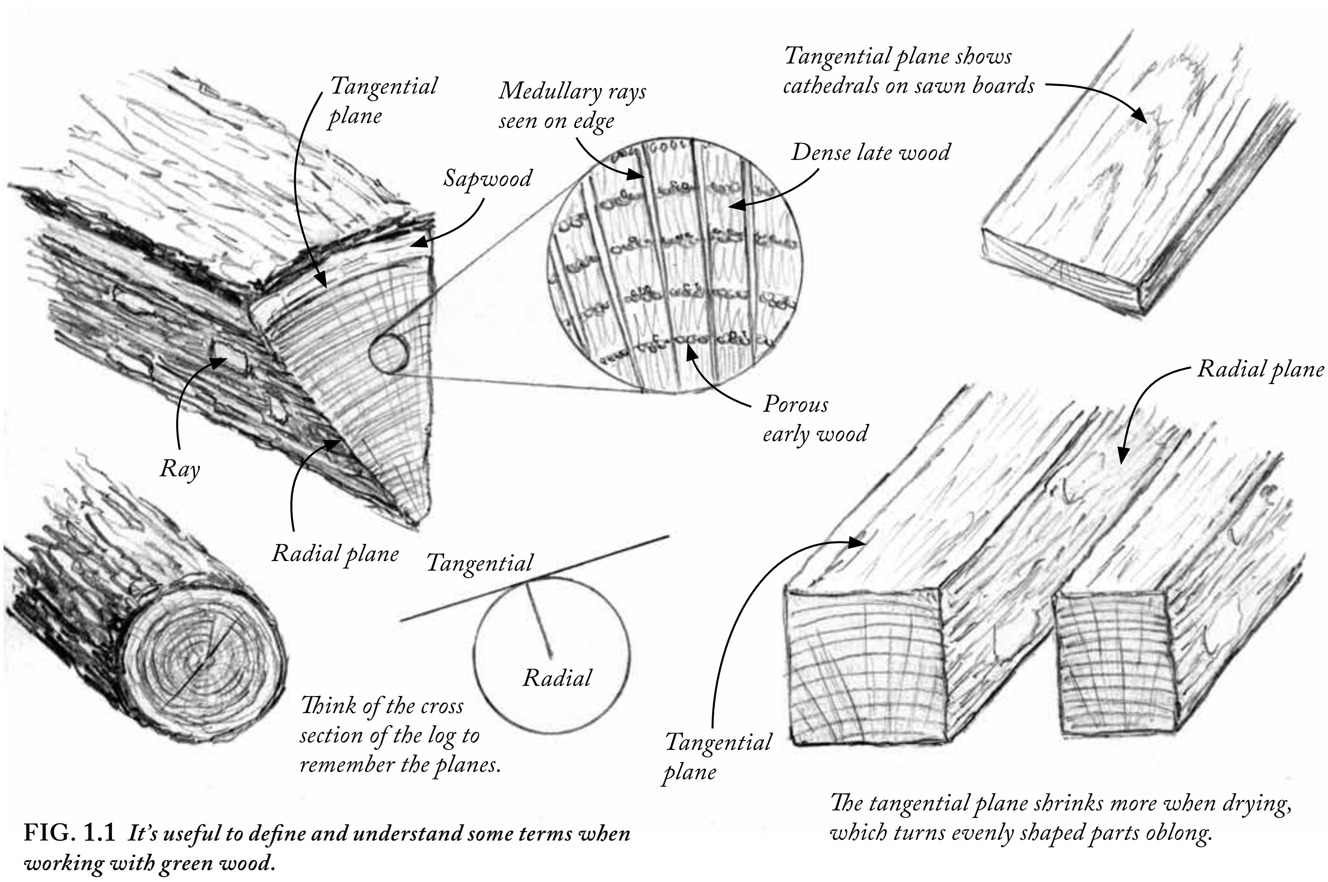



**FIG. 1.1** ***It's useful to define and understand some terms when working with green wood.***

## Why Split Wood?

While the softness and flexibility of the green wood is obvious, you might wonder what the advantage is of split wood. Working from split wood can be a tough concept to grasp, even for the experienced furniture maker.

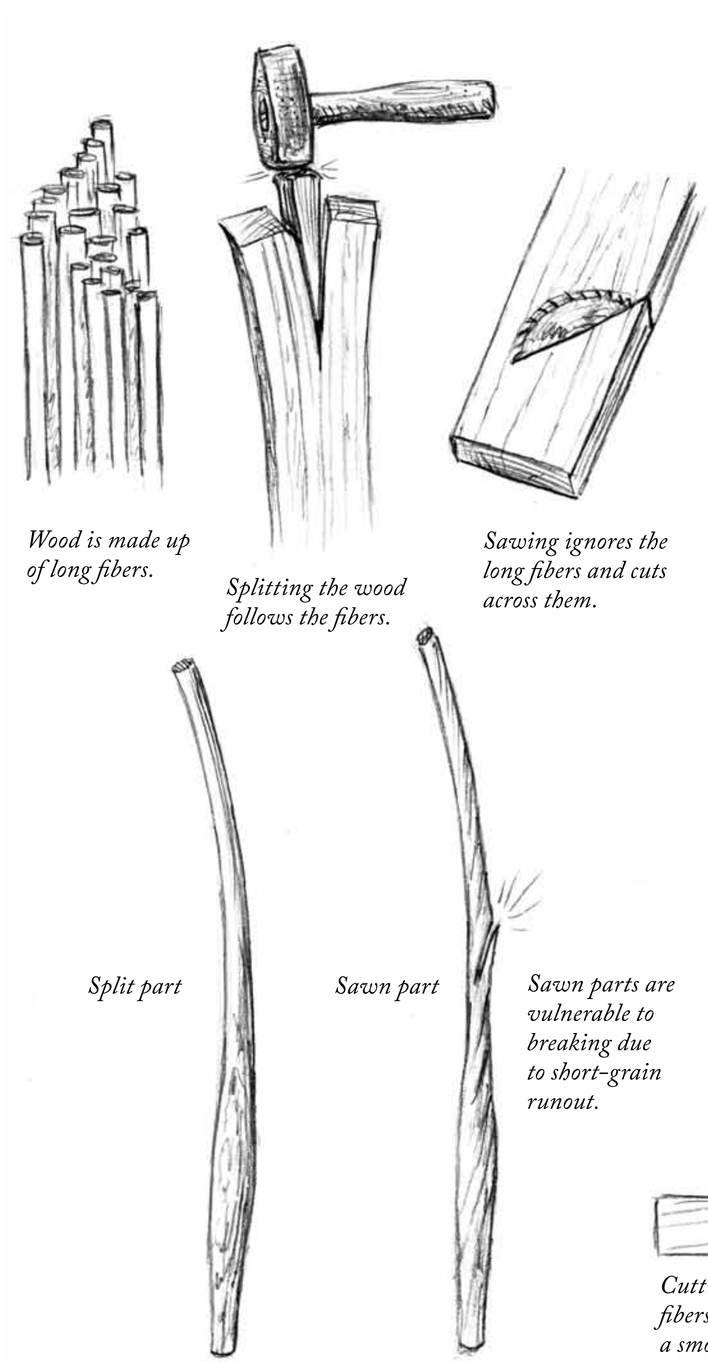



**FIG. 1.2** *Splitting wood preserves its strength.*

Trees don't have any flat or square parts, and wood is not a homogenous material that's indifferent to the way it is cut. Trees are a bundle of fibers, and once the tools and techniques to split and shave these fibers come into play, hand-tool jobs that would be difficult or tedious with sawn planks become simple and fast.

One way to compare sawn wood to split wood is that a saw blade ignores the fibers and cuts across them. Splits follow the fibers, which yields strong parts that display amazing flexibility without a loss of strength.

But there is more to this story.

Whenever sawn wood is shaped, shaved or cut with hand tools, the direction of cut is of primary concern. A smooth surface can be created by cutting or shaving the fibers in the direction that they ascend from the sawn board. Cutting in the opposite direction, where the fibers descend into the board, will cause the cutter to grab the exposed end grain and lever out small chips. This "tear-out" leaves a rough, undesirable surface and takes more effort to cut.

On sawn boards, the direction can change from one area to another, especially if the tree didn't grow straight. The showy grain patterns so prized in cabinetwork are the result of milling across the fibers, whereas split and shaved pieces will have uniform – perhaps even boring – figure.

But showy grain can force you to constantly change your cutting direction to avoid tear-out, which slows the process. Plus, when shaving round parts from sawn wood, you will usually have to change direction as you shave around the surface. On the lathe, changing direction is impossible.

But when parts are split and shaved to follow the fibers, the direction of cut is simplified. You always head from the thick area to the thin. On round parts, this allows you to work around the entire piece without changing direction.

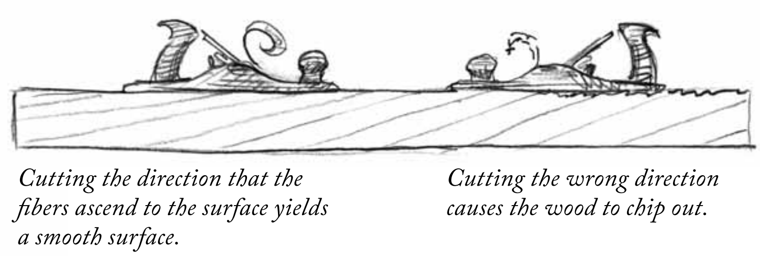



**FIG. 1.3.** *With sawn lumber, grain direction is paramount.*

This enables you to rely on the shape of the piece to dictate the tool's cutting direction instead of constantly interpreting the surface for clues.

Split wood can be worked in either direction when shaved parallel to the fibers. Once the fibers are carved across, the direction of cut is always toward the thinner area.

This simplifies and speeds the shaping process. Trying to shave a sawn spindle that has fibers that are not parallel to the axis of the spindle requires a constant changing of the cutting direction, which renders the process impractical.

## Green Wood

The easiest wood to split and shave along the fibers is green wood. The first question folks usually ask about working with green wood is, "How green is green?" While I'd love to have the tree right off the stump for reasons that I'll explain below, that's generally out of the question when I'm not cutting down the tree myself.

When I refer to green wood, I am talking about wood that is above the "fiber-saturation point." The fiber-saturation point is the point in the drying process where the moisture captured inside the cells is gone and the wood begins to lose the moisture stored in the cell walls. It is similar to the way a wet sponge behaves when it is wrung out. At that point, the water in the cells is gone, but the water in the cell walls remains. The sponge remains swollen until the water in the cell walls starts to leave. Then the sponge shrinks and hardens.

Wood dries in the same manner; when the moisture leaves the cell walls, the wood begins to shrink and harden. Beyond the science, it's the experience of

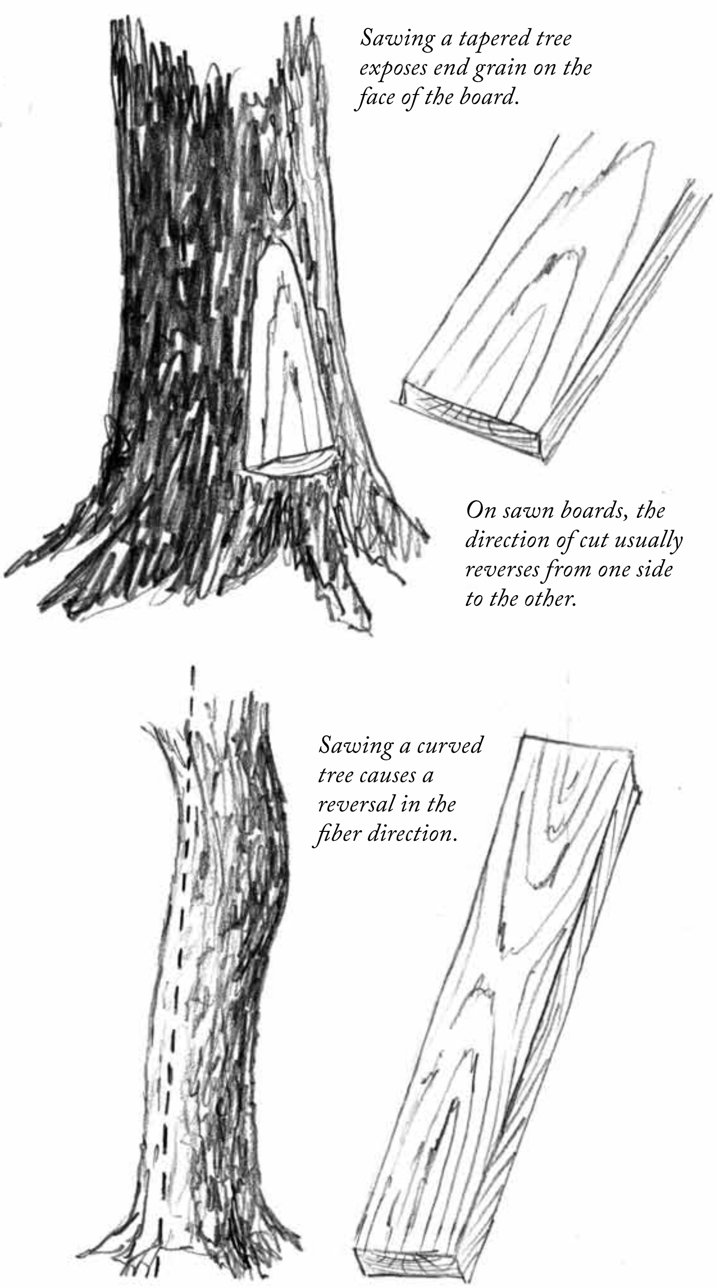



**FIG. 1.4.** ***Common challenges with sawn boards.***

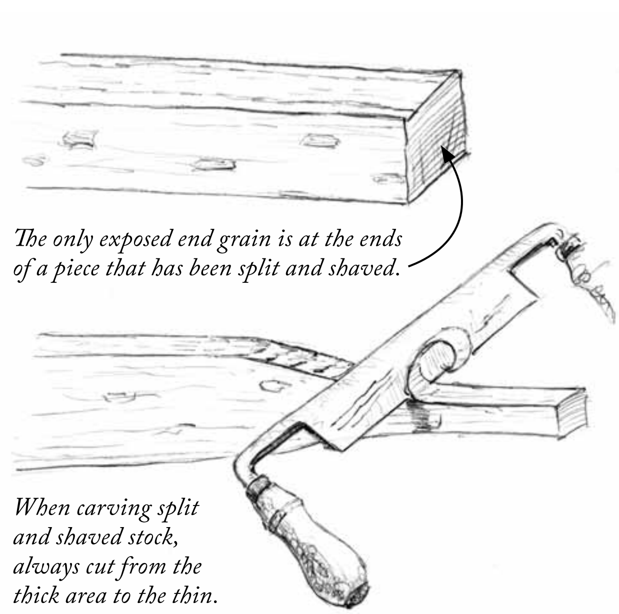



**FIG. 1.5** ***Cutting direction on split stock.***

working with it that counts. A little experience working with green and not-so-green wood is the best teacher.

When green (above the fiber-saturation point), the wood's fibers and the lignin binding them are soft, and a drawknife can follow them with ease. Think of a perforated sheet of stamps, easily separated by hand by tearing along the weak lines. Working with dried wood is more like separating a sheet of stamps that is stuck to a piece of paper. Sure, you can cut along the lines, but it will take much more care and some tooling (scissors).

It is difficult to relay exactly how easy it is to work with green wood. When green, even notoriously hard and dense woods such as hickory and oak cut easily with hand tools. It's one more reminder that our ancestors didn't just work hard, they worked smart.

But isn't green wood going to shrink, warp, crack and take forever to dry? Yes, no, no and no.

These are problems that plague boards that are sawn from logs, especially imperfect logs. Wood from straight logs that are split into small chair parts will dry quickly, with relatively little distortion and no checking. The only question that is answered "yes," which is the shrinkage, can actually be used to make chair joints tighter and more durable. By aligning the parts so that they will move together seasonally, and controlling the moisture content of the parts when sizing and assembling the joints, the parts will lock tight and stay that way.

The timing and the process of moving from a log to a chair can be daunting at first, but it doesn't have to be. Here is the basic timeline that follows the various parts through the process. There need not be any mystery to this once you understand the benefits and requirements of the process at each stage.

In the first stage, the wood is processed from the log.

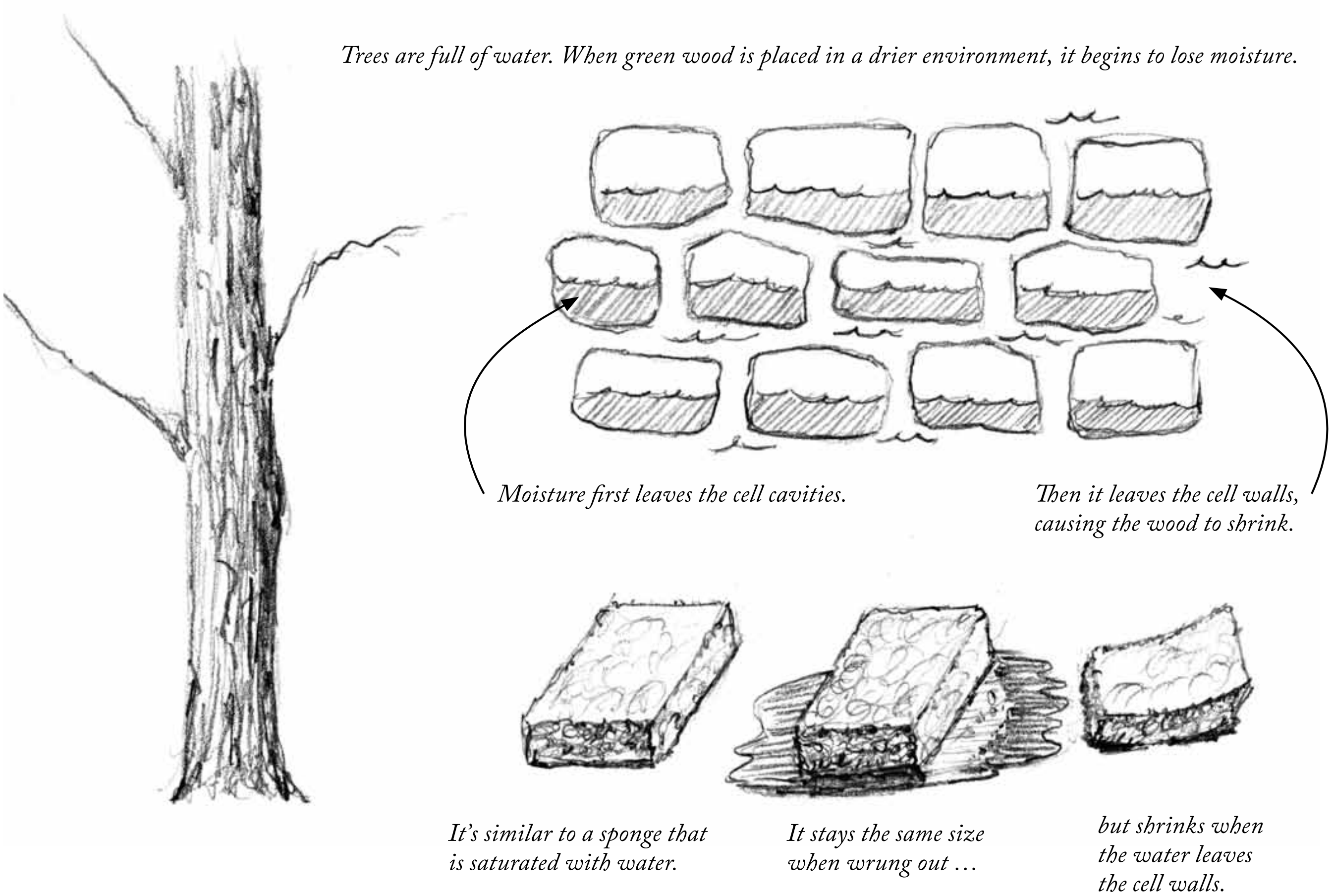



**FIG. 1.6** ***Understanding how wood loses moisture makes the process predictable.***

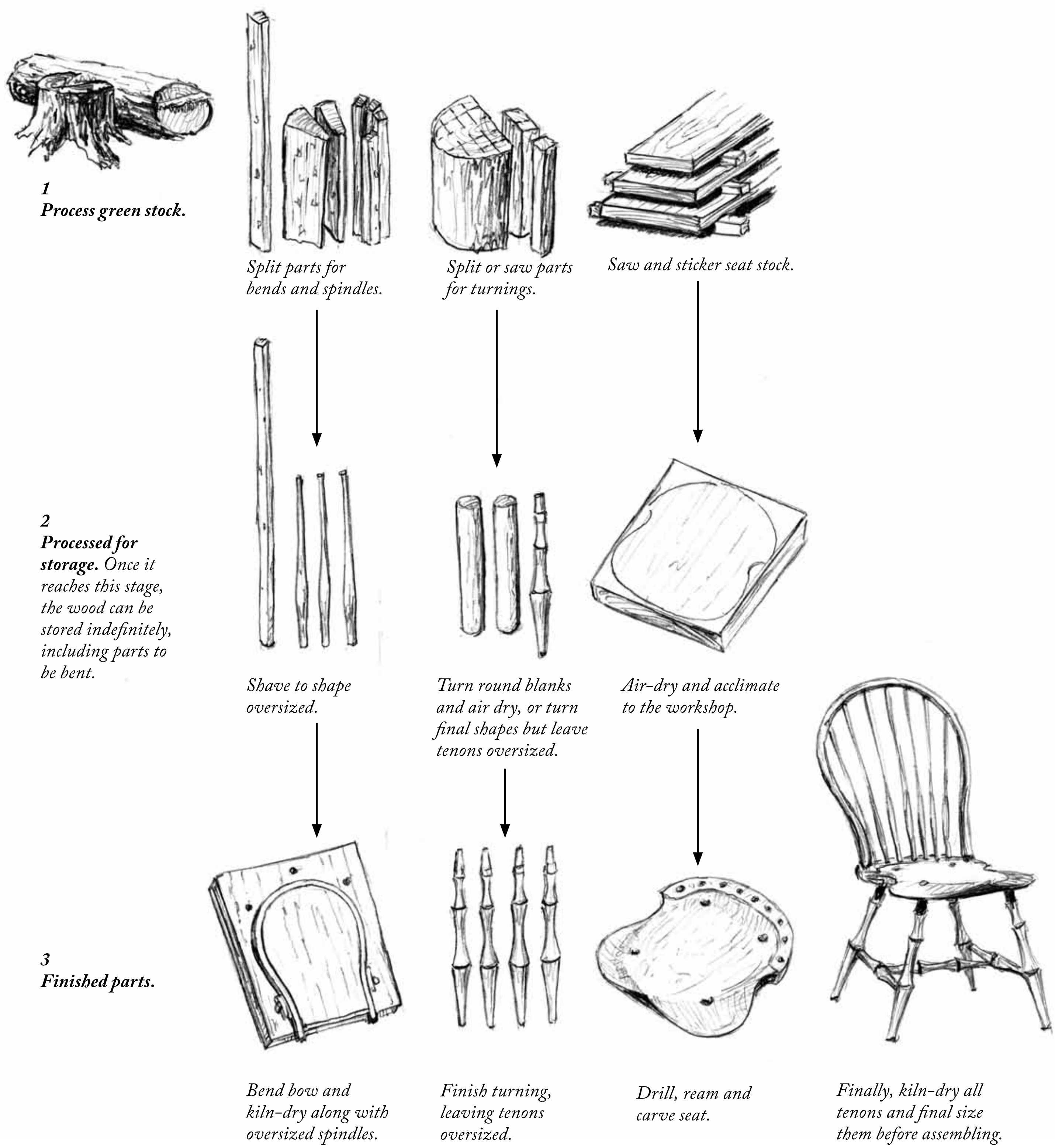



**FIG. 1.7** ***The stages of moving wood from a tree to a chair.***

For the ring-porous parts of the chair, I split up a portion of the log as needed. I rarely take the time to split out more parts than I need. Once split, the parts need to be worked to nearly finished to take advantage of the soft nature of the green wood. If allowed to dry in the split state, the parts become tough to work, and the natural ease with which the drawknife finds and follows the fibers is lost.

The rest of the log can be successfully stored, especially if it is rot-resistant oak or the weather is cool.

For the legs, which I usually make with maple, it is wise to split or saw the entire log to avoid having any fungal deterioration creep into it. If it is cold outside, say less than 50°F, this isn't a problem. Unlike the spindles and bends, there is no rush or benefit to doing more than rounding the parts. Once split and rounded, the lathe makes quick work of shaping wood, even if the wood is air-dried; and once the wood is split or sawn along the fibers, the strength is there. I have come to prefer turning air-dried wood because of the quick drying times and lack of distortion in the end product. When turning green wood, you must not only compensate for the shrinkage of the diameters, but also for the differential in shrinkage between the large and small details. If you turn a green leg that looks great, you might be surprised to find that the final leg looks less robust because the shrinkage causes the large diameters to shrink more in size.

So for leg stock, I round the blanks and let them sit for a couple of weeks; then I can turn them knowing that the shapes I turn will be what I put into the chair.

The seat stock should be immediately sawn, stacked and stickered to allow air to move freely around the boards. The seat must be fully air-dried before being used, otherwise the removal of material during carving can cause the newly exposed surfaces to lose moisture unevenly and the seat may crack or warp excessively. I usually dry my seat stock outside with rain and sun protection, such as steel roofing panels, for a year – or at least the three warmer seasons. Then I bring it indoors into an unheated space for permanent storage. After about six months, I bring pieces that I plan to use in the next six months or so into my heated shop space to acclimate them to the final moisture content of the furniture that I plan to build. After a month or two, I check to make sure the seat stock has stopped losing weight and use it. This low-tech approach to drying errs toward giving the wood extra time to acclimate to each environment. A simple way of checking the weight loss of a piece is to rig a balance like the one shown above.

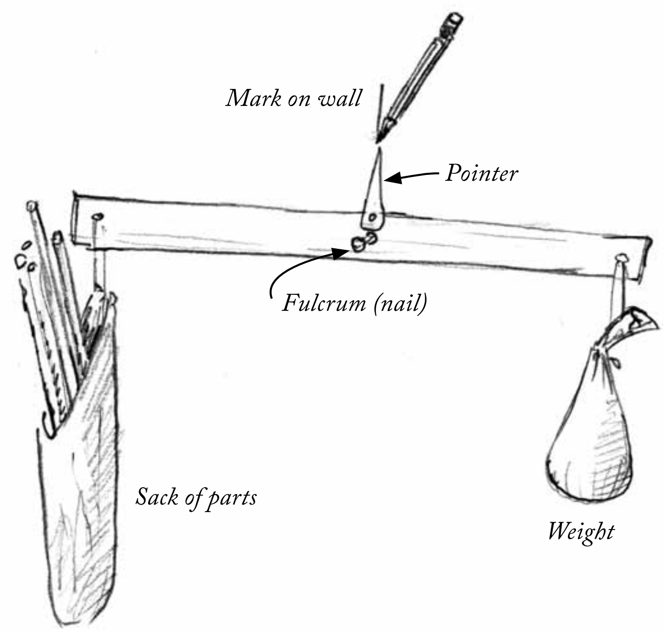



**FIG. 1.8** ***Monitoring the weight of parts as they lose moisture will help you learn to estimate drying times.***

Place the wood in the bag opposite the weight and move the pointer at the top to a mark on the wall. The next time you weigh the parts, the pointer will have moved toward the weight side. If it doesn't move, then the parts haven't changed their weight and have reached equilibrium with the environment. Kiln-dried wood is suitable for seats as long as it has been dried without incurring too much tension or defects.

Once past the initial shaping, the parts can be stored indefinitely. While green wood takes less time to become flexible in the steamer (usually around 30 minutes), air-dried wood steamed for an hour or more bends just as well.

When the time comes to finish the joinery and shaping of the parts, the spindles and bends are dried in the kiln, as are the tenoned ends of the turned parts.

In the beginning of the process, the emphasis is on preserving the wood from decay or rapid moisture loss; at the end, it is on making sure that the parts are correctly dried and sized. In between, there is a lot of time that doesn't need such careful management.

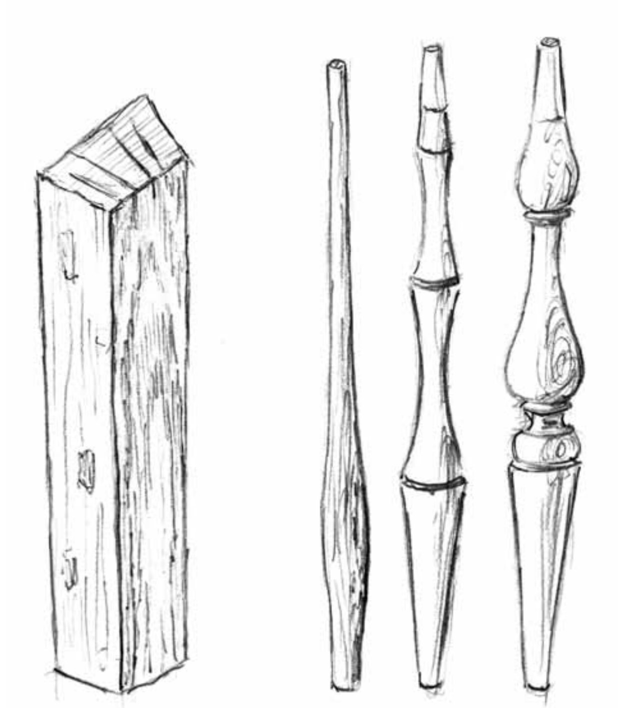
A common misunderstanding that I encounter about wood is the belief that kiln-drying wood creates a permanent, fixed result with a constant moisture content. Wood absorbs and loses moisture throughout its life. Kiln-dried wood has simply been through a process at one point to bring its moisture content down and harden the lignin and sap; after that, the wood will acclimate to its environment. Kiln-drying wood is like making toasted bread. You've changed the properties of the material but not the fact that it will absorb moisture. Wood that is kiln-dried and left in your garage will equalize with the surroundings and is going to shrink and move if brought into a heated area. One significant difference between green or air-dried and kiln-dried wood is the diminished ability of kiln-dried wood to bend. Just like moisture won't turn toast back into soft bread, steaming kiln-dried wood will not return the properties of air-dried wood. Kiln-dried wood would always be my last choice when attempting extreme bends.

When using dried woods, machines can have an advantage compared to hand tools, especially when it comes to the major shaping of the material. A jointer and planer make quick work of milling boards, but when the goal is extracting small flexible parts from the tree, hand tools and green wood give the best results.

A word of warning about kiln-dried oak, especially white oak: I have had trouble in the past with kiln-dried oak that looked fine until I brought it into my shop or crosscut it. If you purchase oak in 8/4 boards, it is likely that it has been improperly kiln-dried. I assume this is because it shares kiln space with thinner or more easily dried woods, and the pace of the drying process is geared for the speed that the other species or dimensions can tolerate. The results might be checks that are invisible (because of the moisture that the board has picked up after kilning) or worse, honeycombing. Honeycombing is a defect where the interior of the board has fissures throughout. This happens when the outer surface is dried improperly and "case hardens" so that when the interior shrinks, it pulls itself apart. I look at any thick oak that has been kiln-dried with a jaundiced eye before accepting it.

## How Wood Dries

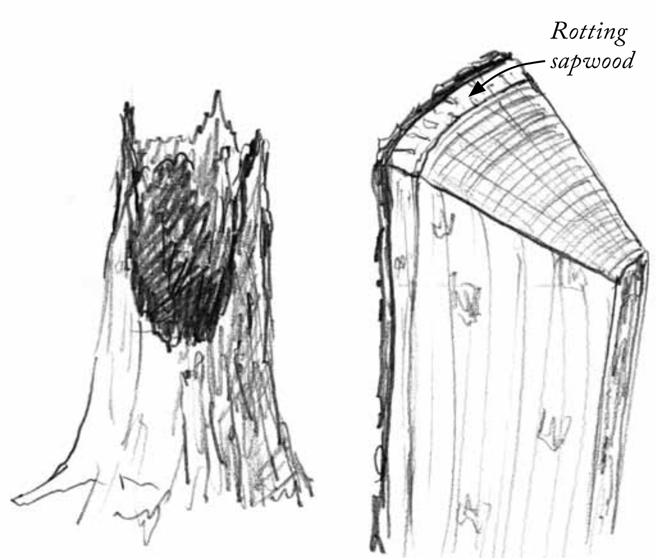
The good news about air-drying split wood is that the parts for chairs are so slender that the relatively small mass-to-surface-area allows the wood to dry with speed and ease. If the tree that the parts come from is straight and free from defects, then the parts will be as well.



*Large splits lose moisture mainly through the end grain, causing cracks.*

*Shaping parts thins the cross section and exposes end grain down the length of the piece, speeding the drying process and reducing the chance of splitting.*

**FIG. 1.9** ***Shaped parts dry evenly.***




*When the tree is standing, the center rots because it has no living immune system, only chemical protection.*

*After the tree is cut, the sapwood no longer has active immunity and rots faster than the heartwood.*

**FIG. 1.10** ***Decay in wood.***

When working from a log, storing the log and parts is the primary concern. The length of time that a piece of green wood can be stored depends on its resistance to decay, the size of the section and the environment that it's stored in. Often, the color is a sign of the wood's resistance to rot. The dark color is usually in the heartwood and is a sign of the chemical shift that the tree makes when the wood dies (heartwood) to preserve it. The dead wood in the heart of the tree provides most of the structure of the tree, but it no longer has an immune system to shield it from decay, so a chemical cocktail does the job (and changes the color and density).

Warmth and moisture hasten the growth of wood-destroying organisms, and once the tree is cut down, any part that was living tissue (sapwood) is left without its immune system or the protective chemistry of the

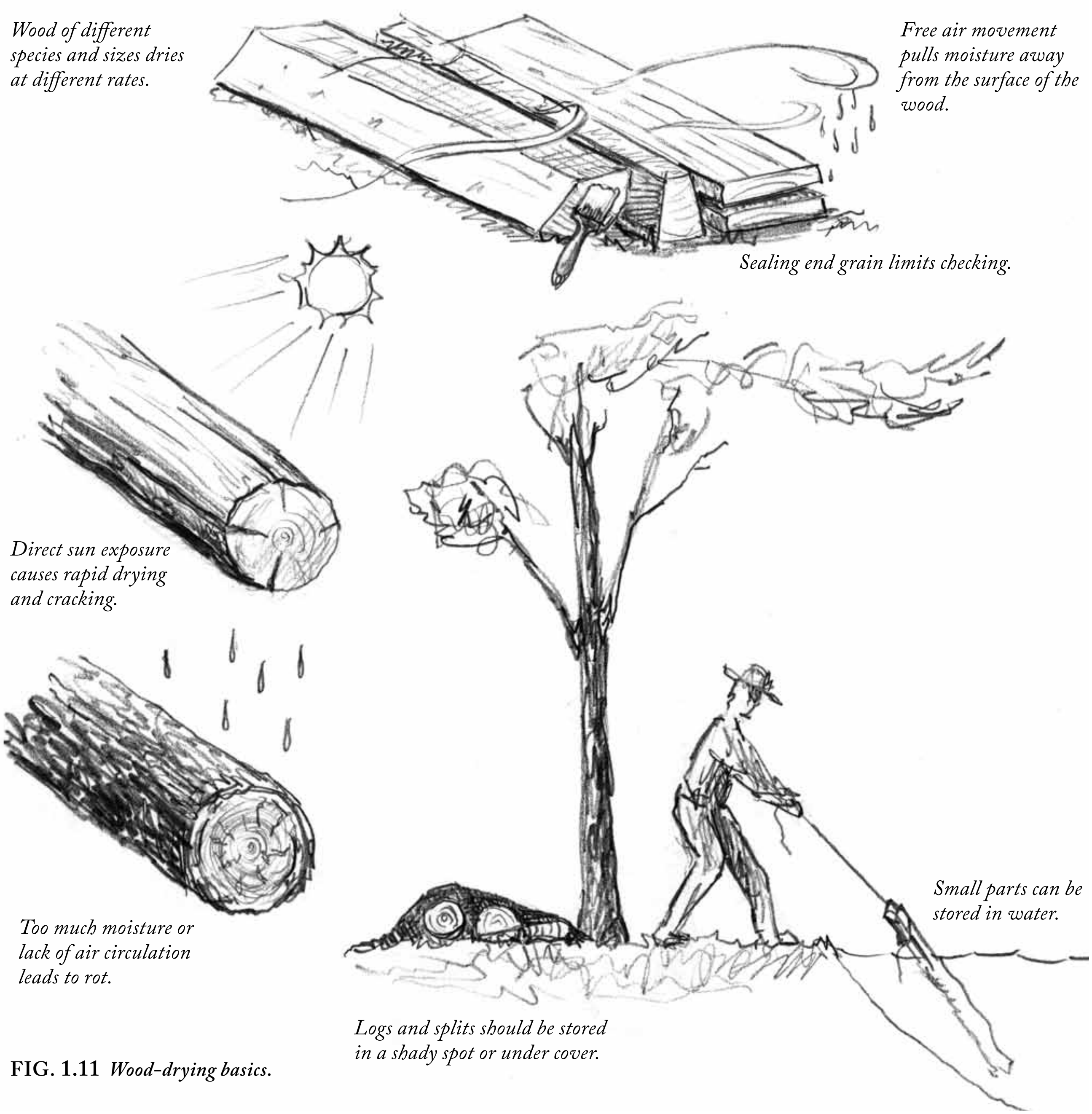



**FIG. 1.11** *Wood-drying basics.*

heartwood. In the summer, green sapwood will quickly rot, which weakens the wood. A freezer can store turning blanks that you want to keep green. Or, more simply, the splits can be rounded or stacked to dry with plenty of air circulation.

Generally, I avoid getting a fresh maple log in the beginning of summer because the sugars in the wood make it a prime target for spoilage. I shop for maple and hickory logs in the fall, when I know that I've got the entire New England fall, winter and spring to attend to them. When summer starts bearing down on me, I split out and round all of my maple.

When storing rot-resistant woods such as the oaks, I keep them in large sections to minimize any drying or decay. Submerging them in water also preserves the wood.

For my needs in the shop, I rely on experience (having made many mistakes) and a low-tech understanding of how wood dries. Luckily, there is lots of room to develop your judgment before you create real problems.

The rule of thumb for drying sawn planks is to allow one year for each inch of thickness. This is a gross simplification, and it can deter anyone interested in working with green wood. Who wants to wait two years to get started? Much of the reason I love woodworking is the instant gratification. This silly "rule" is enough to direct anyone down the path of using kiln-dried wood and the tools and techniques that follow. I think this is a shame, because a slightly different approach can grant a more spontaneous experience.

Once the tree is cut down, the process of it equalizing moisture content with the air around it begins. If the process is too slow, the tree will rot. If the process is too fast, it will crack. Immediately sealing the end grain prevents excess moisture loss and checking on the ends of the log or boards. I use Anchorseal, which is specially formulated for the job.

When processing logs, seal the end grain of a board or log immediately after cutting. Small cracks, invisible to the eye, can begin immediately. This is because the moisture exits the open pores of the end grain much faster than on the sides of the boards. This uneven moisture loss causes the ends of a board to shrink faster than the middle, and the result is the familiar cracks in the end grain. Left round, logs tend to develop large cracks in at least one point. This is not a problem, and it gives you a good clue as to where to place the wedges for your first split. Regardless of how soon I seal the end grain, I always leave a couple inches of length to trim.

Perhaps the greatest danger to a green log is contact with direct sunlight and exposure to overly dry air and wind. Direct sunlight can introduce micro-cracks to the surface of a log, and even though you think you've shaved beyond them, they have a nasty habit of showing up later. Once wood is split and shaped into small pieces, the moisture loss will occur relatively evenly and quickly, making the challenges of drying seem simple.

Wood dries in stages. First, the outer layers and end grain begin to lose the moisture trapped in the cells (free water). This causes no change in the dimensions of the wood because the cell walls are still soaked with moisture (bound water). It's when the cell walls begin to lose their moisture that the wood dips below the fiber-saturation point (FSP), the wood begins to shrink and we begin to measure its "moisture content."

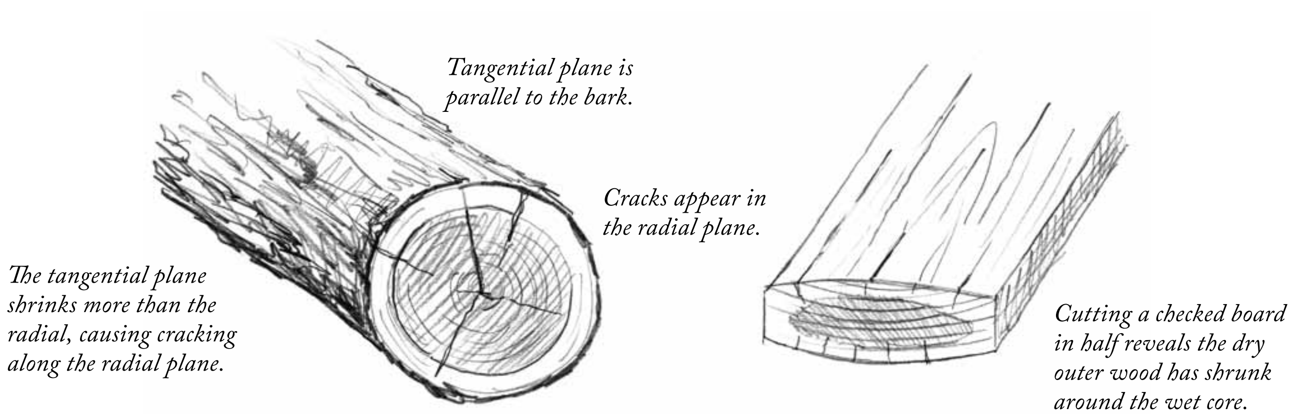



**FIG. 1.12** ***Excessive cracking is usually the result of rushing the drying process.***

One source of trouble can be that the radial and tangential planes of a board shrink at different rates. The radial plane generally shrinks about one-half as much as the tangential, depending on the species. This causes an internal tension as one dimension contracts more rapidly. This is the reason that the cracks are always in the radial plane in the firewood pile, and sadly, often on lumber.

The different rate of shrinkage between the radial and tangential planes causes problems if you rush the drying.

Other problems in drying often occur when the outer layers of a board or log lose their moisture much faster than the middle. In this case, the outer parts shrink around the unchanged middle and splits result. It's rather like the rind of a lemon contracting around the fruit until it splits.

So it seems that the goal should be to get the wood to lose its moisture evenly, which means slowing down the process enough to avoid too much tension from uneven shrinkage, while not letting the wood stew in its own juices to rot. Free movement of air is essential to drying wood. When the moisture-laden air that forms around the wood is pushed away, the wood will begin to equalize with the fresh, drier air and give up more moisture. Hot air is more capable of holding moisture, which is why heat enters the equation. Every kiln, from a high-tech industrial unit to my little shop-made lightbulb in a box, needs air movement to dry the wood. Otherwise, all you'd have is a steamy box of wet, soon-to-be-moldy wood.

I treat my more rot-resistant logs, such as the oaks, like a block of cheese, only slicing what I need and keeping the rest in the largest section to avoid staleness. I try to err toward patience. Once split, chair parts have a ratio of surface area to mass that almost eliminates worries about rotting and checking during air-drying. Think of my sliced cheese: A slice goes stale quickly and evenly once all that surface area is exposed.

Patience also extends to how I treat my parts after they are shaped. I simply leave my pieces, once shaped and bent, sitting around the shop as long as I can. I don't rush green wood into the kiln, courting disaster. About two or three days sitting in the shop is enough to prepare a green piece for the kiln. Then it is into the kiln at 140°F until the piece stops losing weight. To be honest, I never weigh the pieces. I simply judge by how well they hold the bends, and how light they feel. Extra time in the kiln is the rule, not the exception.

Experimentation is the key to learning to use your kiln. Wood will always seek to equalize its moisture with the air around it. The sense of mystery about this can be quickly dispelled by taking one piece from completely green to bone dry in just a few days.

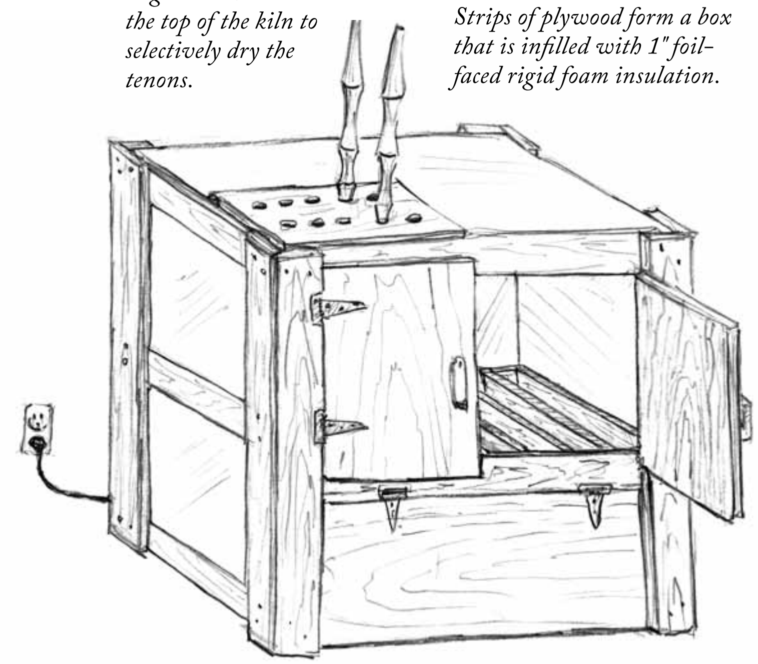
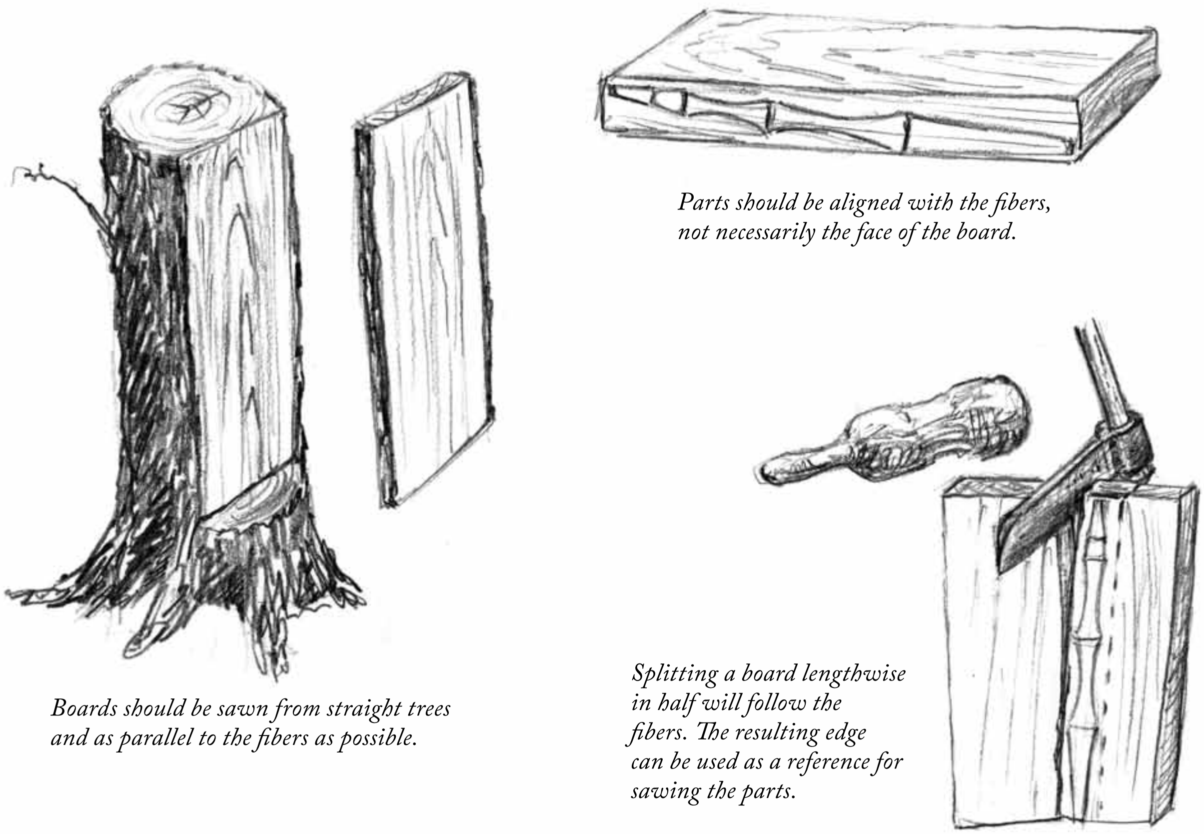



**FIG. 1.13** *A kiln for drying parts.*

## Working Dry Wood

Orienting the fibers parallel to the axis of a part need not be the result of splitting green wood alone. A carefully sawn board from a straight tree can yield plenty of good chair parts, such as the turned parts, especially if the stock was air-dried. Turning green parts is nice because the soft wood turns easily; dried wood will turn fine – not as easily but perhaps with better surface quality. Air-dried wood can also pay dividends when it comes to bending because the cells are not full of moisture, which can cause hydrostatic pressure to build on the compression side of the bend and result in failures.

At right is an image of a board, which could be air- or kiln-dried, and some of the chair parts that can come out of it with the same structural benefits of using split wood.



*Parts should be aligned with the fibers, not necessarily the face of the board.*

*Boards should be sawn from straight trees and as parallel to the fibers as possible.*

*Splitting a board lengthwise in half will follow the fibers. The resulting edge can be used as a reference for sawing the parts.*

**FIG. 1.14** ***Cutting parts from sawn boards.***

Selecting the proper board will make the process much more productive.

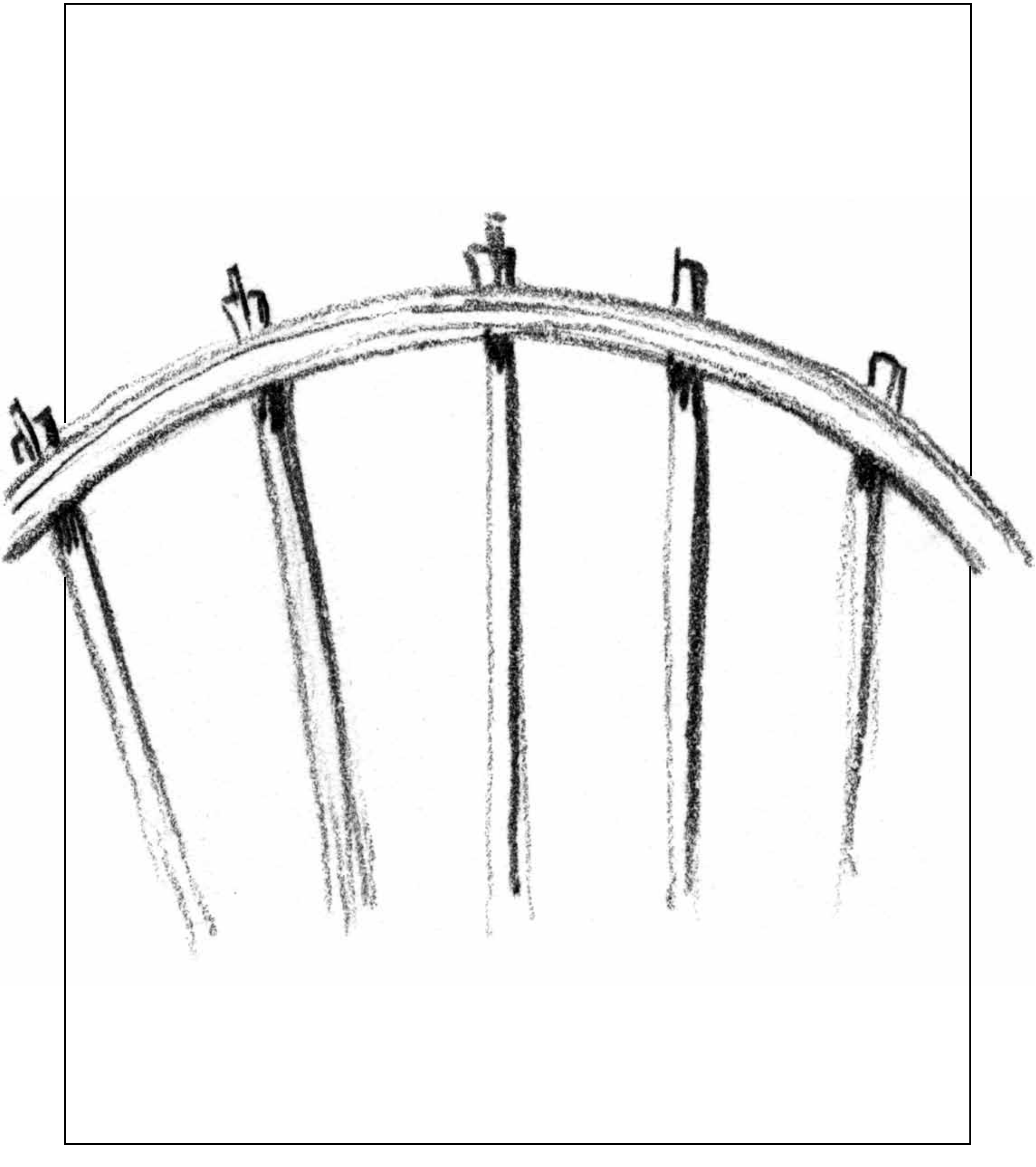
With care, dried boards can yield parts with the fibers intact along the entire length.

It might take a bit more effort to extract these parts, but it can be done with no loss in quality to the end result. One pitfall to avoid is adding mass to sawn parts to make up for a lack of straight grain. While this may give the impression of strength, it's usually at the expense of some other factor, such as comfort, beauty, lightness or durability. When parts don't flex, the stresses put on the chair run straight to the joints and cause premature failure.

There is a learning curve when selecting and using green wood. But the excitement, fresh air and newfound options will ease the way. My first log choice was poor – a gnarly red oak – and I certainly worked hard to get my chairs from the beast. Over the years, I've had a range of experiences, but I am always excited to go in search of my next log.

I think it's important to not get too overwrought with moisture content charts and the science of wood drying. You will quickly recognize wood that splits and shaves easily. When the parts are split to a size that is suitable for chair parts, even freshly cut wood can be perfectly dried within a week. This may be a tough concept for those used to sawn lumber, but seeing it happen just once is all it takes to become a believer.

Remember: A brief walk in the woods can remind you that wood is not just a "product" in stacks at a lumberyard, carrying the effort and expense of all the handling that got it there. Wood is plentiful and forgiving, and once you observe it cycle from tree to chair, you will never look at it the same.



# 2

# Windsor Joinery

Once you've learned to pull the parts from the log and shape them, joining them together is the next step to creating a successful chair.

Like any load-bearing structure, chairs balance the strength and flexibility of the material with the size and shape of the joints. Unlike tables and cabinets, chairs must withstand forces in multiple directions. When a person plunks down in a chair and starts shifting about, the stresses reverberate throughout the structure. A Windsor chair is akin to a bridge or a hammock, wherein flexible parts with a high tensile strength disperse stress across many joints. More than the strength of any one part or joint, the real success of the Windsor is the design that allows the joints to support each other in a flexible yet sturdy web.

While I enjoy my time shaping parts until they please my eye, when it comes to the joinery, I strive for all of the accuracy I can muster. The longevity of the chair demands it.

When I worked in furniture and cabinet shops, much of my time making joints was spent setting up machines. Once a machine was set, I could run one or 1,000 parts with the same results. Of course, if the machine setting was a hair off, I had one or 1,000 poorly sized joints. So I spent a lot of time fiddling with machinery rather than working wood. This way of working suits mass production and accuracy, but looking back, it seems like I was more of a machine operator than a woodworker.

Making chair joints is different. For instance, each leg is fit into a mortise in the seat, then those parts are forever

**FIG. 2.1** ***Chairs and bridges rely on thin parts joined together for a balance of strength and flexibility.***

assigned to each other. This might seem foreign or inefficient, but it is actually a fast, effective way to work, and it limits the telegraphing of errors throughout the chair. In a factory, with designs set in stone and a large investment in tooling and process development, there would not be an advantage to this, but it suits the small shop beautifully.

Instead of trying to make each part fit numbers on a drawing, I make it to fit the chair. The same goes for the lengths of many other chair parts. The priority is that the part fits the chair, not the drawing. So measuring the exact length of a stretcher based on the distance between the legs gives great results, even if some previous steps were flawed.

With any joint, the first consideration is the strength of the species used and the sizes of its components. When parts are selected for their strength, split from the log, properly joined and supported by other joints, the overall size of each joint can be surprisingly small.

It's also important to note that tools cut different species of wood differently. A hole drilled in a dense wood generally comes out smaller than a hole drilled with the same bit in a soft wood. It's a mistake to assume that a tenon at exactly .5000" will fit a 1⁄2" hole bored into white pine, especially with a vibration-prone drill. The softer wood will give the bit just enough of a chance to move so that the hole may be larger and the joint loose.

Another problem that can wreak havoc in production-style work is a humidity shift. Sure, you can cut dozens of tenons to within a couple of thousandths of an inch, but the next day, after a shift in humidity, you have dozens of

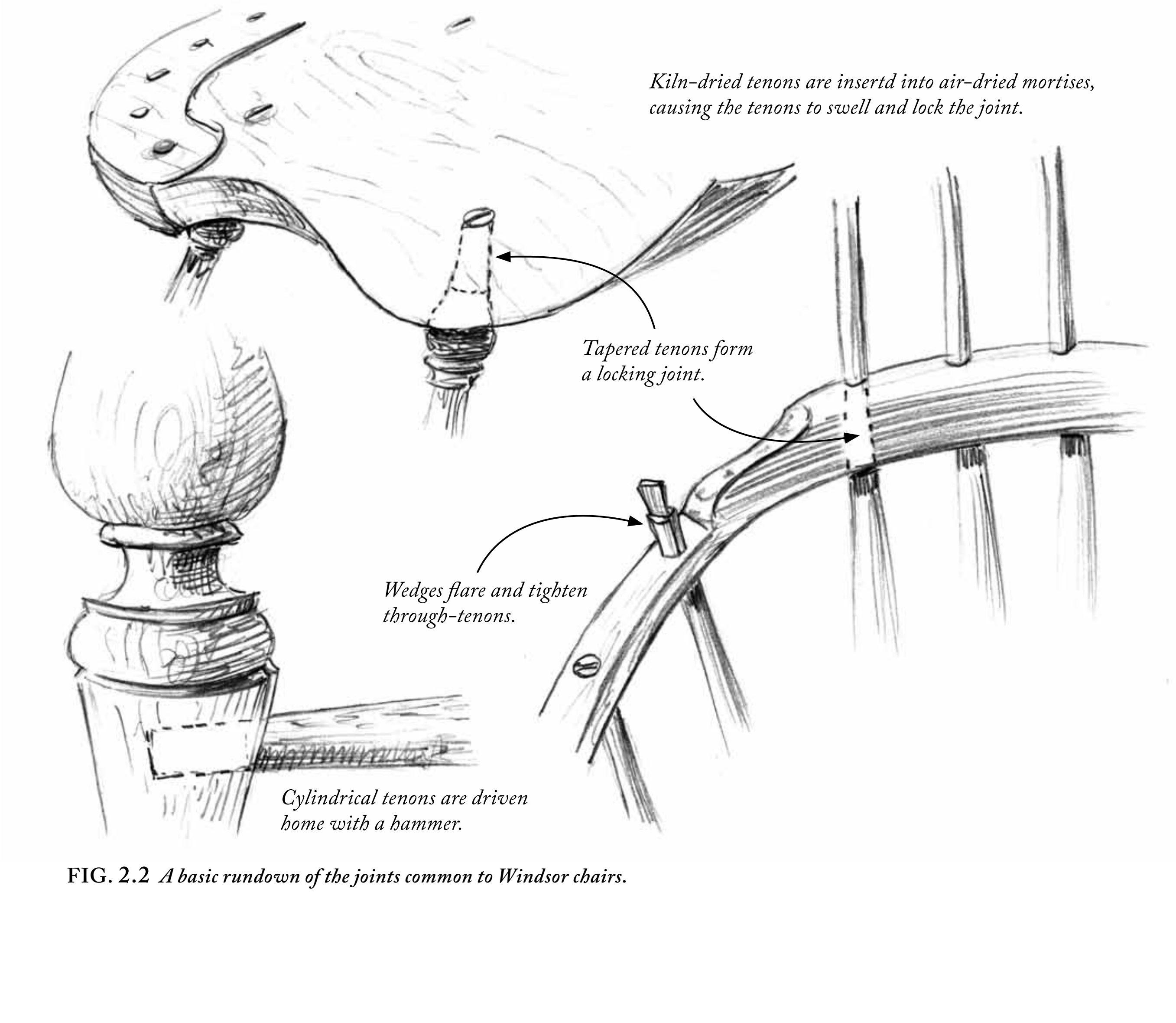



**FIG. 2.2** *A basic rundown of the joints common to Windsor chairs.*

tenons that don't fit. When making a chair, I don't have this problem because I control the tenons' moisture by drying them in a kiln before sizing them, then I make sure they are in the kiln for at least 24 hours prior to assembly.

When joining pieces of wood together, there are many variables. The size of the good gluing surface goes hand in hand with the tightness of the joint. The best glue surfaces are had by joining long-fiber sections together. Any end grain in the joint does not add significant glue-bond strength to the assembly.

There are a number of joints in the chairmaker's arsenal, most of them based on a round tenon and mortise. Round joints are easy to make with simple tools. Plus, boring a hole at an angle is simple, which suits chairmaking. On the downside, however, round mortises are largely made up of end grain and are poor glue joints when compared to the broad expanses of long-grain fibers in square mortises.

To make up for the paltry glue surface and the intense stresses that they suffer, chair joints must be tight – so tight that full test-fits of the undercarriage should be impossible. For instance, the joints between the stretchers and the legs should only fit about one-third to one-half of the way in during a test-fit.

There are other portions of the chair that require the joints to be tight enough to hold but loose enough to assemble. When assembling the top of a chair, multiple joints need to come together at once, and while the joints should by no means be sloppy, they must slide into position in unison. The goal is that they should slide together without squeaking (which means they are too tight) or rattling (too loose).

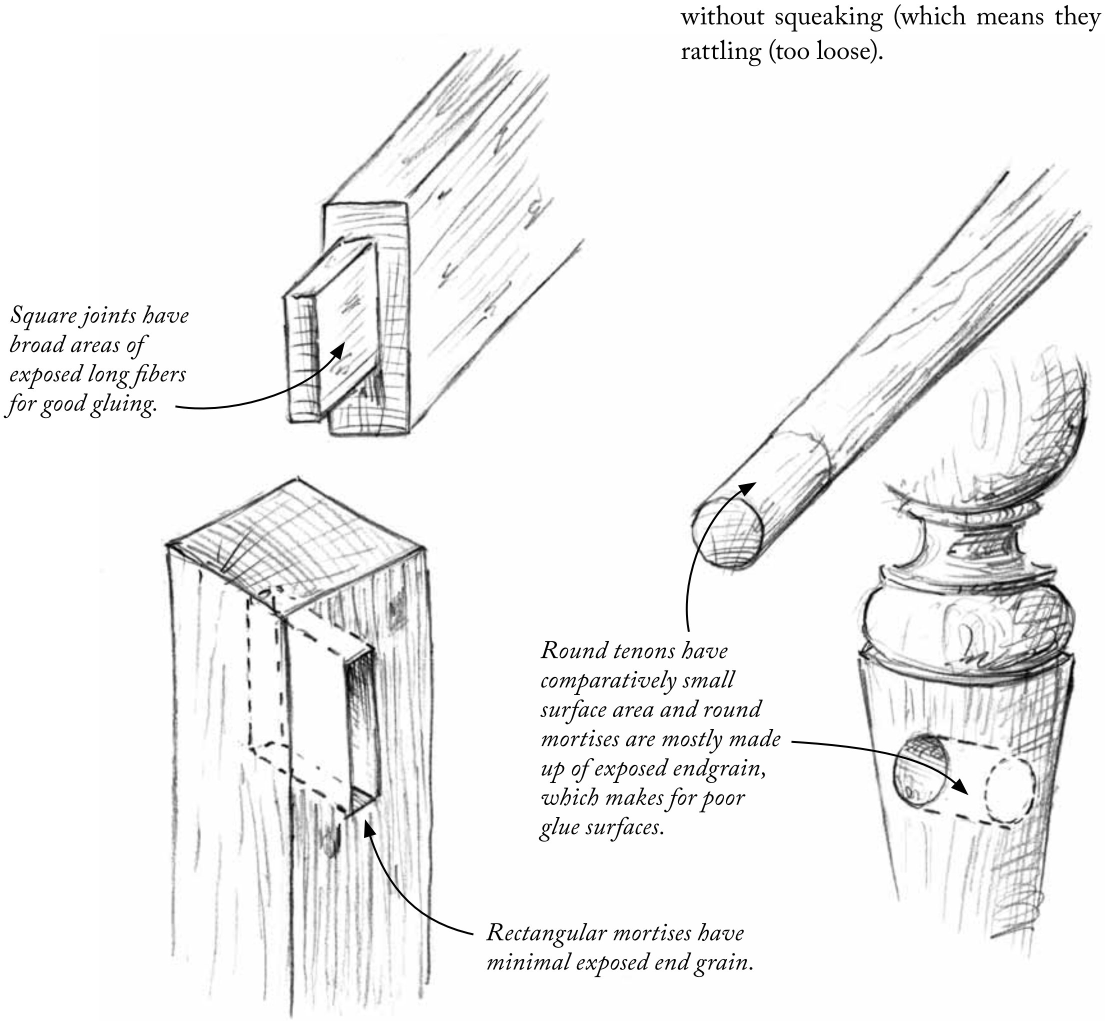



**FIG. 2.3** *A comparison of the glue surfaces between round and square joints.*

## Tapers

Another way to gain strength and to ease assembly is to use tapered mortises and tenons that lock into final position.

Tapering a tenon and reaming the mortise to fit creates a locking joint, as can be illustrated by the Morse taper used in machinery such as lathes and drill presses. Tapering a mortise and tenon is simply one step beyond making the joint with cylindrical parts. The tapering process offers a chance to refine the angle at which the mortise was drilled and makes assembly easier because the joints don't lock until they are completely inserted.

The angle of the taper that works best is below 14° inclusive, which is the range where it forms a mechanically locking joint. For reasons that I describe in the reaming section, I prefer a 6° taper angle.

## Wedges

One option to tighten the joints is to wedge the tenons where they pass through the mortised part, such as where the short spindles pass through the arm, and where the legs pass through the seat.

On some joints that suffer forces from multiple directions, I adjust the mortise to create a locking joint. Use a file to remove material from the mortise where the tenon will exit, removing only enough wood to create a gap slightly more than the diameter of the tenon and only on the end-grain portions of the mortise. The inserted wedge then flares the tenon and creates a mechanical lock that prevents the tenon from retracting in the mortise. This is the same joint used to secure handles in hammer heads. (I don't flare the mortises in seats for the leg joints because there is no upward stress on them, and the weight of the sitter keeps the tapered joint solid long beyond the life of the glue.)

On joints that have little surface area, such as where the tapered tenon on the top of the arm post passes through a thin arm, I opt to use two wedges to better distort the tenon into a flared lock.

It's important to plan for seasonal movement in any joint. When gluing in the wedges, I apply glue to only one side of the wedge. This allows for a gap to open next to the wedge when the tenon shrinks during seasonal movement. By directing the stress to a harmless spot, you protect a more vital part of the joint. If both sides of the wedge are glued, seasonal shrinkage of the tenon might cause the tenon to pull away from its mortise wall, weakening the joint.

## Moisture Content

Another aid to making tight joints is to manipulate the moisture content of the wood. This is especially helpful where the stretchers enter the legs, because they are "blind" joints (they don't pass through) and can't be wedged as easily as through-tenons. The so-called "wet/dry" method is especially suited to chairmaking (although I think it is better described as the "dry/super-dry" method because no part of the joint is actually "wet"). When a correctly sized, super-dry tenon is driven into an air-dried mortise, the tenon will draw moisture off the mortise and swell, locking it in place. If the mortise is too wet, the tenon may swell excessively, damaging the surface cells of both parts. I've tried oversizing the tenon for these joints by a few thousandths of an inch, which works great, and lots of chairs made this way have withstood the test of time without glue.

Most of the time, I size all of my "hammer-fit" tenons as exactly as possible to the mortise. When this is done correctly, I can push the tenon into the mortise about one-third of the way before it seizes and requires a hammer or mallet. This is helpful during assembly, and I am confident that once the moisture equalizes, I'll have a long-term joint.

I have rarely gone so far as to concern myself with measuring the actual moisture content of parts. Instead, I've relied on the temperature of my kiln, which I've keep anywhere from 120°F to 140°F. At this temperature, I am certain that when my parts stop shrinking and losing weight, they are much drier than the ambient moisture of my shop where I keep my air-dried parts. Rather than delving into "equilibrium moisture content" charts, I simply observe the wood as it shrinks in its environment and follow a few simple rules to avoid problems.

One such sticking point is the timing of the drying and assembly.

One comparison is to say that a tenon is to a kiln what an ice cube is to a freezer. You wouldn't take an ice cube out of the freezer to put into a drink tomorrow, or even in a few hours. And on the same note, a tenon must be fully dried in the kiln before being finish-sized and then stored in the kiln for a day or so before assembly to ensure that it doesn't swell prematurely and make assembly go awry. That being said, there is lots of room for leeway and human error as long as the basics are observed.

I also like to leave fresh green wood that has been shaped into parts outside of the kiln to air-dry for a

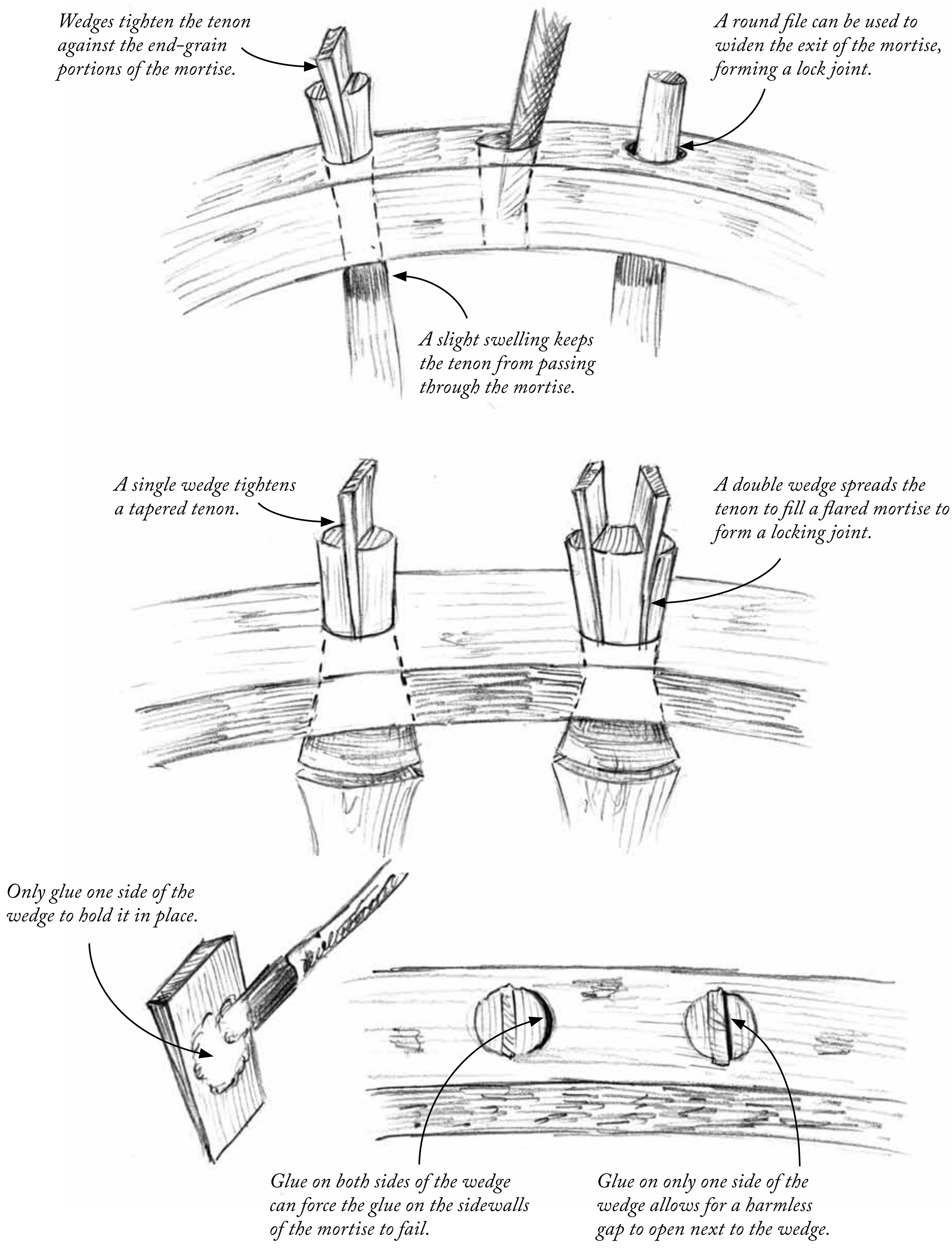



**FIG. 2.4** ***Wedging makes for a tighter joint than you could hope to fit together.***

few days if possible to avoid shocking it and potentially checking it. The need for this varies by species. Dense hickory has a tendency to check, while the open pores of red oak let out moisture evenly and quickly. I always try to err on the side of caution when pushing the wood to dry faster. This is one of those times where a little experience (and some failures) can make up for scientific accuracy (and failures).

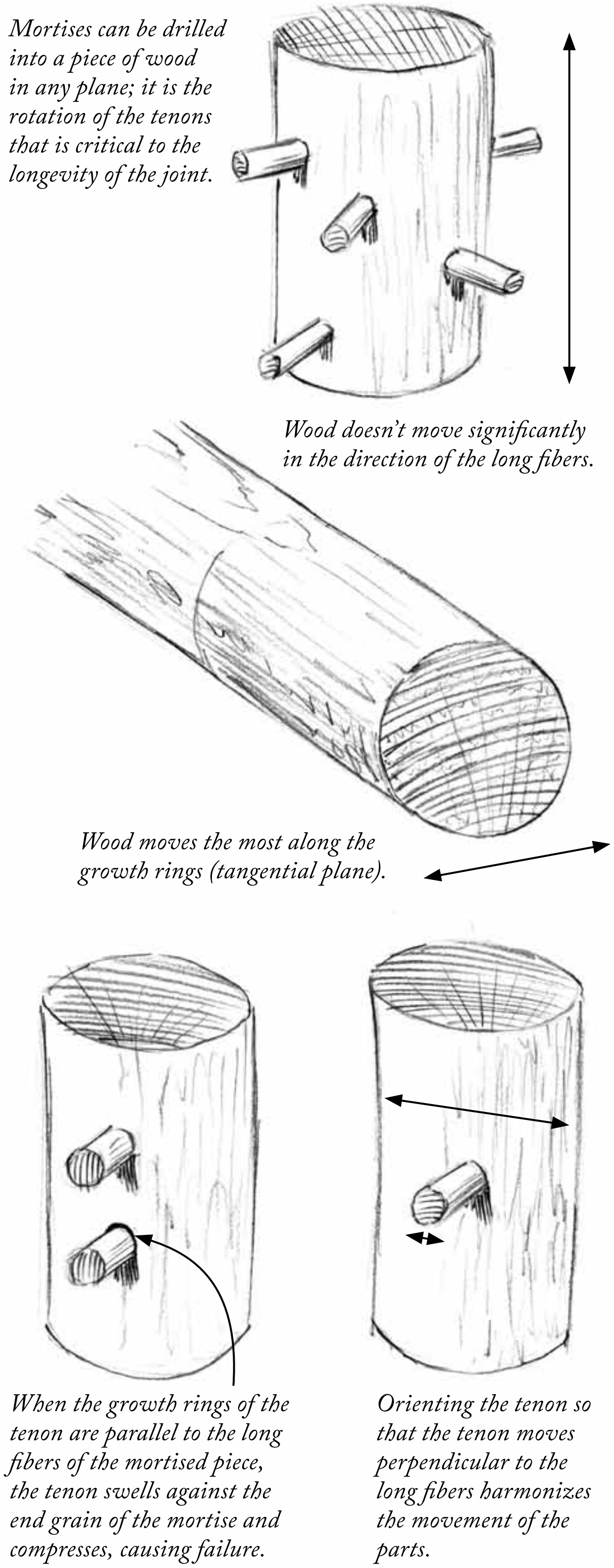



**FIG. 2.5** ***How to rotate the tenon to keep the joint tight.***

## Orienting Tenons to Mortises

Beyond the initial equalizing of moisture in the joint, seasonal moisture differences will also cause wood to move throughout its life. The tenon must be carefully oriented to harmonize the movement in the mortised piece.

This can take a bit to wrap your head around. It's easy to confuse which part is the variable here.

Basically, the hole (mortise) can go into a piece of wood anywhere without regard to whether it is in the tangential or radial plane. The critical factor is the rotation of the tenoned piece to make sure that the parts move in relative harmony. When you are looking at the mortised piece, you should only be concerned with the direction of the long fibers. The seasonal movement of a piece of wood along its long fibers is negligible. With this in mind, the goal of orienting the tenon is to make sure that the direction that the tenon swells the most is the same as the direction that mortise moves the most.

In other words, if the tangential plane of the tenon, which moves the most, is rotated parallel to the long fibers of the mortises piece, which don't really move seasonally, the tenon will get permanently compressed by swelling against the end grain of the mortise. This is a recipe for a loose joint.

One way to remember which way the tenoned piece is going to move the most is to look at the rings on the surface of a workpiece and imagine that they change shape seasonally. What you see now as an oval will become a circle in the summer. This overstates the reality, but it might help you remember which is the significant plane of movement.

The simple rule of thumb is that the growth rings on the tenoned piece should never be parallel to the long fibers of the mortised piece.

I know from teaching this over the years that it can seem daunting. Keeping straight which piece to look at to determine the rotation of another can be confusing the first time through. I focus on which piece of a joint has a tenon, then I rotate that piece so that the growth rings are perpendicular to the long fibers in the mortised piece. Running through it a few times and then comparing your rotation to the images here will help set the priority.

## Glue

There are plenty of choices for glue to use when building a chair, but my first consideration is that my chair should stand without it. My first close-up experience with a properly made chair was with one that was left behind in my New York City apartment when I moved in. It's a sweet little factory-made sidechair with some decorative painting that was clearly done by the previous owner trying to dress it up. I enjoyed sitting in it for years, and then one day, I lifted it up by the rear posts and the top came apart! I put it back together, and it sat just fine. This piqued my interest, and I started looking into chairs that didn't rely on glue to hold them together. I suppose this was the nudge that pushed me into making Windsors. Many of the joints are made so tight as to not need glue, especially those in the undercarriage. And some joints, such as the tapered leg joints, are designed to resist the force of the sitter and actually tighten under your weight if the glue fails. To my way of thinking, glue should be an afterthought to the design and execution of the joinery.

That said, of course I use glue, but my decision reflects a number of factors. I use hot or liquid hide glue in my chairs mainly because it is the only glue that is both

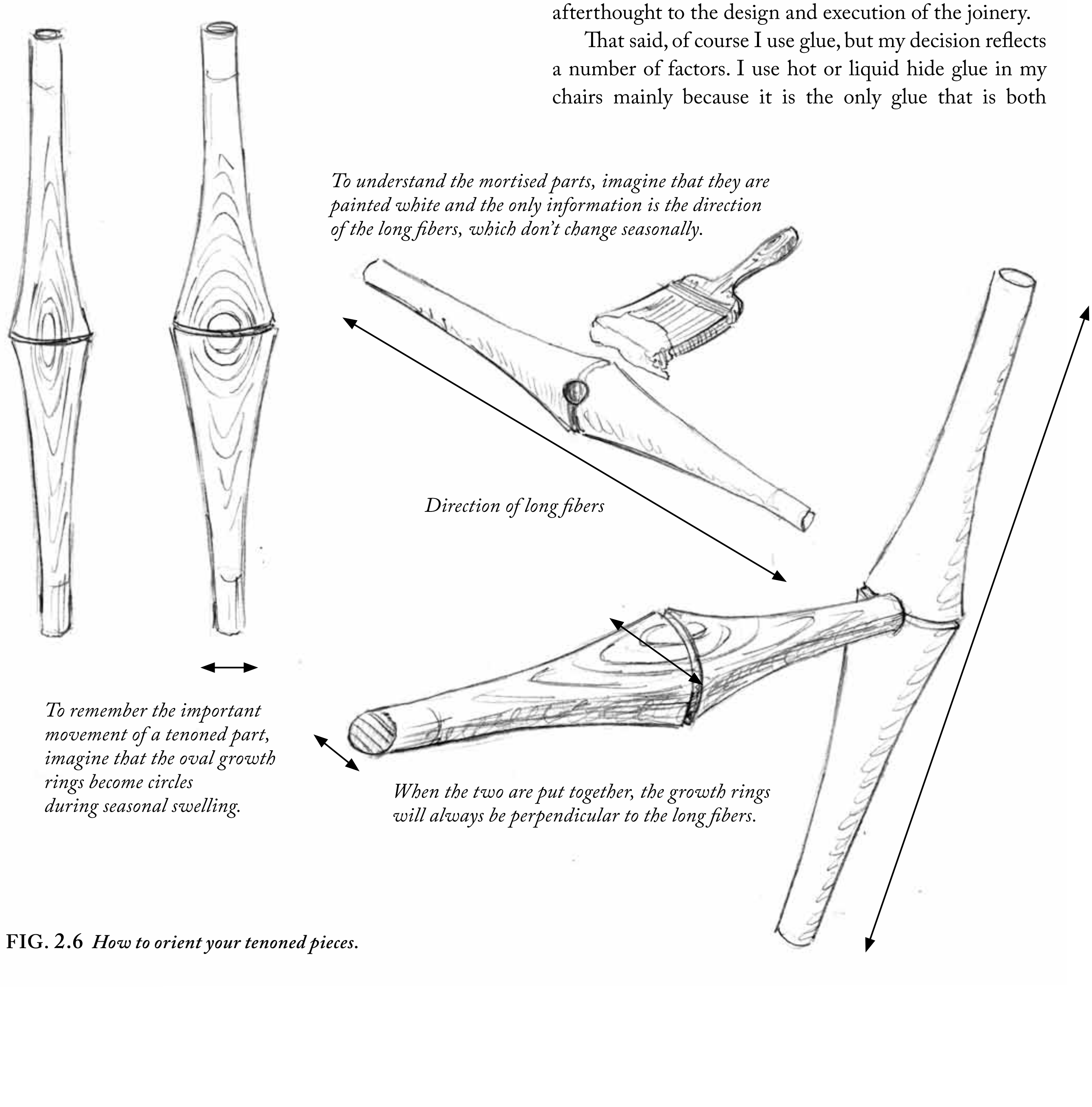



**FIG. 2.6** *How to orient your tenoned pieces.*

**FIG. 2.7** ***Glue pot options: premixed liquid hide glue, a dedicated glue pot (center) and an electric pot (right).***

cohesive and adhesive, meaning it will stick to other things and, more importantly, to itself. This means that I can repair a loose joint by introducing a little heat, moisture and fresh glue. There is some confusion about the term that is most often used to describe this characteristic: reversible.

Yes, you can unseat a joint that has been bonded with hide glue by applying heat, moisture or both, but that isn't the idea with chairs. For instance, I can imagine a loose joint where a spindle passes through the armbow, but I wouldn't fix it by trying to unseat all the supporting and connecting joints, just to get inside the loose joint. If the chair was well made, it just won't happen. But wiggling the loose spindle a bit to work in some fresh hide glue is quite simple.

Another factor that I prize is the freshness of the glue. If I use dry flakes and make the glue myself, the flakes will last virtually forever, and I can mix up just enough for the chair that I am building. If I am using liquid hide glue, I purchase it from a company that tracks its freshness. When I buy a new bottle, I immediately pour it into a plastic zippered bag and place it in the fridge. I pull out small portions of the cold-gelled glue as needed, heating it to 75°F or so until it is liquid again. I can store gelled glue like this for a year in the fridge.

The first response that I get when I mention hide glue is usually, "Doesn't hide glue stink up the shop like roadkill?" I'm happy to say that the answer is no. Fresh glue has a distinct smell, especially when heated, but it isn't unpleasant. I heat hot hide (and liquid hide glue) when the temperature of my shop is below 75°F.

Hide glue is basically a food product, and if you were to leave any food product constantly or repeatedly warming on a heat source in your shop, it would stink. But the bad smell isn't the reason to avoid constant heating or reheating. The reason that I mix fresh stuff up and only reheat it a couple of times is that its bonding ability breaks down with repeated heating.

I test my glue by putting some on my fingers and pressing them together. After a few seconds I pull them apart. If I see a bunch of web-like filaments fly away, I know that it has bonding strength. Much has been written comparing the strengths of different glues, but when properly used and applied to clean, unburnished, non-oxidized joints, they are all stronger than the wood, so a published strength test is not my greatest concern.

Even premixed liquid hide glue can benefit from a heat source if the shop is cool. While there are pots made for keeping glue at a consistent temperature, a cheaper solution is simply a pot of hot water or an electric pot filled with water (be sure to keep the glue container off the heating element). I set the heat to the lowest setting, using a double boiler to gently heat the glue when I need it. A bamboo skewer through a plastic cup suspends the cup in the water and is a handy place to tip the excess glue off of the brush. The hot water in the pot also helps with clean-up. Be careful not to boil the water and the glue; that will break down the proteins that make up the glue's bonding strength. Keeping a glue pot heated constantly makes sense if you are in a large shop and have many workers dipping into it, but for me, a small bit of glue, heated when I need it, is more efficient.

Another plus in the hide glue column comes during assembly. Often, a glue manufacturer will list the "open working time." This is basically the time that the joint can sit unassembled before the glue starts to set. But during the assembly of tight joints, these same glues (namely aliphatic resin, or yellow glue) can cause the joint to seize under pressure. This can lead to a hectic glue-up or split parts due to the added force needed to free the bond of a frozen tenon. Hide glue, mixed to the right consistency, acts almost as a lubricant and helps the joint slide together. Some of the major yellow glue manufacturers are in the liquid hide glue market, but I've found that their glues have some of the same issues as yellow glues, namely fast-setting and tacking.

The other response that I get is usually, "But isn't it a pain to mix up?" Again, no. A few proportions and a little forethought make the job simple. Following the manufacturer's instructions is the best way to be sure that you are using the glue properly. The usual method for mixing hide glue is to soak an amount of glue in cold water overnight. You will be amazed at how much water the glue can absorb. Then melt the mixture in a double boiler and strain it if necessary before using.

Just like with my liquid hide glue, I store the majority of my glue in the refrigerator and take a small portion, about the size of a couple of ice cubes, out to use. When I am done with the chair, I generally pitch the remaining glue in the compost.

Another advantage of hide glue is that you can slow the set-up time with additives. Urea, commonly found in fertilizer departments in nursery stores, will retard the set-up time. So will table salt. Add only as much as you need to keep the glue workable for your needs and no more. I've read that you should never exceed more than 20 percent (by weight) of additive to glue.

One of the greatest assets of hide glue is that it cleans up with warm water – forever. You can go back to a dried glue spot years later and soften and remove it with heat and moisture. To find glue spots, I employ a UV flashlight that takes advantage of the glue's natural tendency to fluoresce. When the light shines on a glue spot, it glows green. I've even added a drop of UV-responsive dye to my glue to make sure I can spot any residue. Cleaning up glue is important because it can prevent milk paint from sticking. And if the chair is to be unpainted, the glue will prevent the spot from oxidizing with the rest of the chair. So months or years later, the glue spot will be quite evident.

Doesn't hot hide set up too fast to glue up a chair? Well, it depends on the temperature in the workshop, the temperature of the parts and the amount of retarder that you have added. Usually in the colder months, I use liquid hide glue, which already has as much retarder as you would want to add. I make sure the shop is as warm as I can get it; above 70°F is ideal. Keeping parts in the kiln or heating them prior to assembly with a hair dryer or heat gun can slow the setting time as well.

The other glue options are white glue, yellow glue and epoxy. My only problem with white glue is that there is no simple way to repair the joint. Many chairs have been reglued only to give way a few weeks later. And that's because the only way to reglue a joint glued this way is to separate the parts and remove all of the old glue. And scraping the joint components will most likely be of no service to the fit of the joint!

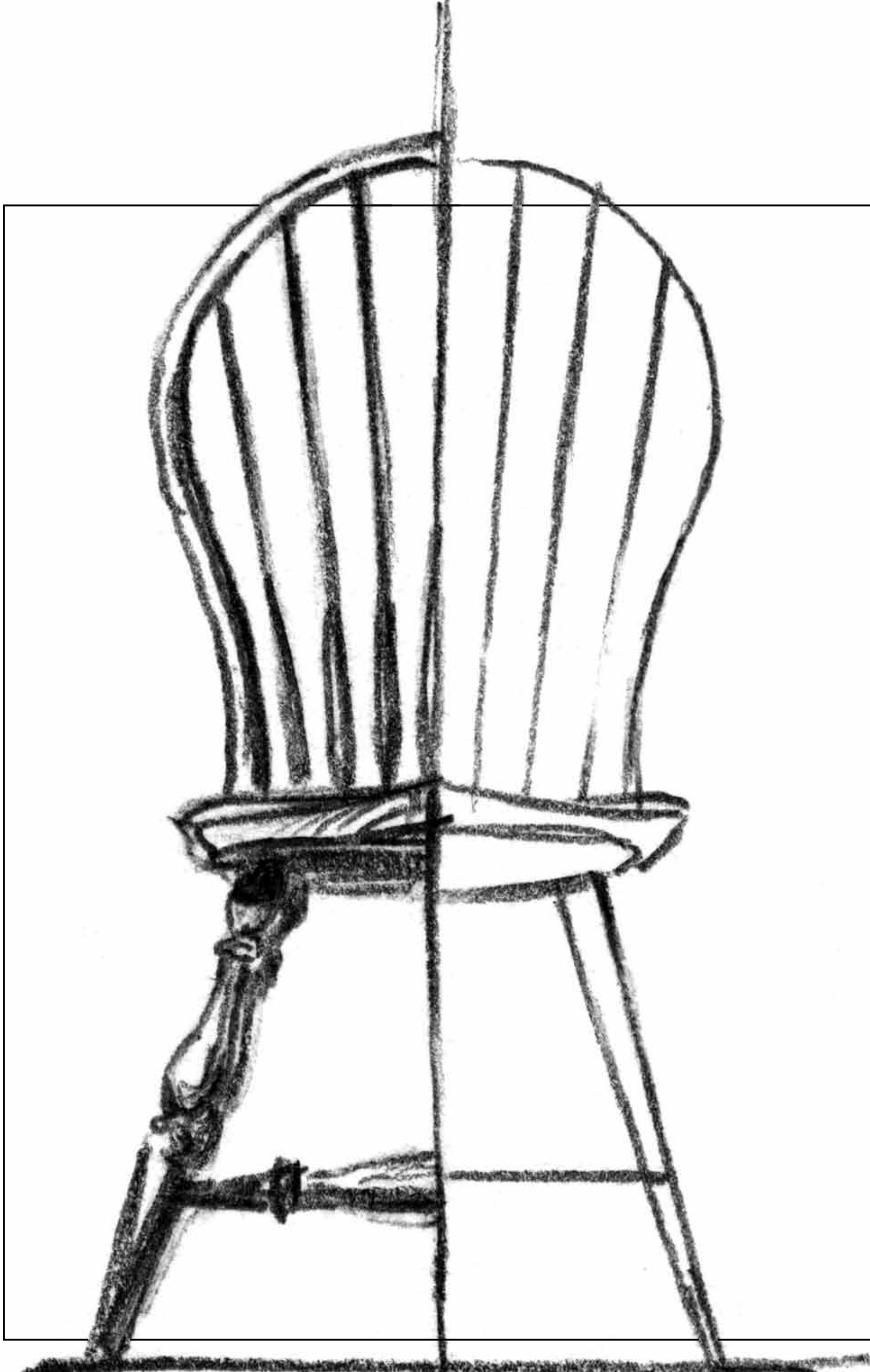
As I mentioned, yellow glue has a bit of a nasty disposition when the joints are hammer-fit tight. Epoxy can adhere to itself, but I don't want to spend my days mixing it up, and its stability over time is still a question in my mind. Glue is a tool, and my choice is influenced by the same process as with all of my tools. I assess the history, longevity and ease of use. Which glue you choose to use is probably going to be a mix of availability and your comfort level with it, but I recommend trying liquid hide glue; I have had the most success with it.

## Conclusion

I've made lots of furniture and cabinetry. For the most part, I have been more impressed by the machinery used to cut precise joints than the ingenuity of the joints themselves. I prided myself in figuring out the most accurate and fast way to make the joints and figured that the joints were usually a base for the glue to hold the pieces together.

When building chairs, what inspires me is the simplicity of the joints and the way that they lock the parts into the structure. Building a chair without glue helped me to think differently about the potential of these joints, and now I build every chair with a focus on joinery that reduces the dependence on glue.

I feel akin to a basketmaker, knowing that a web of thin pieces, properly linked, takes full advantage of the properties of the material and results in a product of exceptional comfort and durability.



# 3

# Chair Design & The Plans in this Book

Chair design is a vast topic, encompassing endless combinations of shapes, sizes, materials and uses of the final product. It's no wonder that many woodworkers avoid it.

The first Windsor chair that I built was a birdcage side chair, and I was not aware that I was taking on one of the most complex Windsor forms. I'm still amazed that it turned out as well as it did – beginner's luck.

A good chair design harmonizes the characteristics of the materials with the needs of the user, both physically and aesthetically. I think, however, that if I approached the task so broadly, I'd shrink from the enormity of it.

Instead, I like to look back on all of the great, and not so great, chair ideas of the last couple thousand years and apply those lessons to my own work before going too far out on a limb. Design ends up as more of an evolutionary process, in which I look at a finished chair and decide where there is room for improvement or departure. Sometimes, I'll design a chair just to shake up my preconceptions, other times I'll let an exploration of strength or comfort guide the process. But to be honest, the driving factor is always whether the chair is fun to build.

Designing any piece of furniture requires you to understand the materials and the goals of the finished piece. I believe it's a mistake to think that some folks are just born talented in this way. The truth is that all good designers have a history of lousy furniture under their belts. Some pieces are not strong enough, others are uncomfortable and (perhaps the most egregious sin) some are just plain ugly.

A sense of design comes from lots of looking and trying. Just like knowing what foods you enjoy and how you like them prepared, it takes time to find your own vision and strength. My painting teacher gave me some sage advice about painting, which was to make all my bad paintings as soon as I could so that I wouldn't have to make them later. Designing is simply the expression of experience and opinion, and the more times that you attempt your designs, the sooner you will find success. And along the way, questions such as the thickness of parts or the comfort of your chairs will work themselves out through a process of elimination. Every choice that you make will deepen your understanding and strengthen your design muscles, so I encourage you to look around and start making.

However you approach the process, it doesn't have to be overwhelming. Windsor technology relies on a few basic elements and relationships. If you understand and work with these elements and relationships in the most simplified version of the chair, it will quickly lead you to more complex forms and possibilities. If this is your first chairmaking experience, some of this might seem a bit heady, which is to be expected. But when you have been through the process once, or have read the whole book, this information will be easier to understand.

Following are drawings of the two project chairs in this book. After the drawings, I point out the factors that loomed largest in my decision-making process while designing these chairs. While there are plenty of aesthetic details involved, I focus more on the elements needed to create a successful structure.

Beyond the drawings of the project chairs is my method to draw and convert my ideas into chairs, as well as some important information on how I handle angles. There is an appendix Creating & Using Sightlines that further explains this helpful technique. This is nuts-and-bolts information that isn't necessary to make your way through the project chairs, but it will help you dig deeper into what makes them tick.

## Designing the Project Chairs

I've designed these chairs with interchangeable turnings so that they can be tuned to your taste and work in almost any home's interior. They could also be built without a lathe by splitting and shaving round cigar-shaped legs and stretchers.

I've stuck to traditional joinery and construction techniques, but I've tried to provide options for the technological limitations you might face. Those with access to green wood can build either chair, but those working with air-dried wood will get the best results from the fan-back chair because of its less-demanding bend.

The idea underlying the design of any chair is that it should fit and support the human form. People come in a variety of shapes and sizes, so designing a chair for a wide array of users must be a compromise. Once the basic angle and shape of the back is realized, that geometry can be applied to most chairs with success.

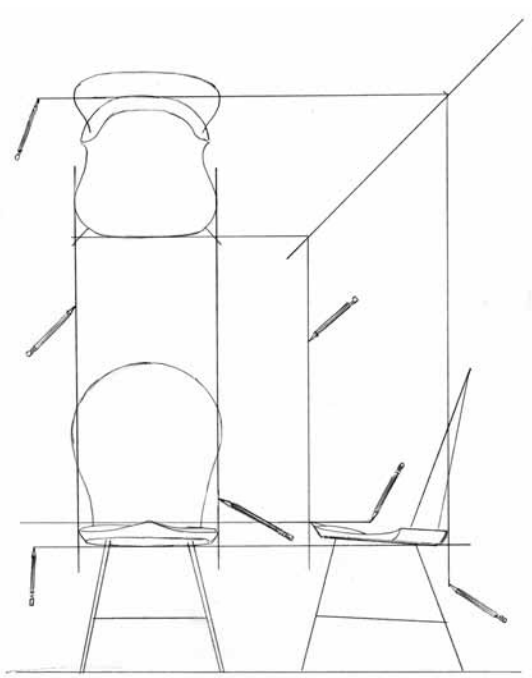


**FIG. 3.1** *A typical three-view drawing.*

Regardless of the whether you make the fan-back or the balloon-back, the seat carving is identical. I chose the size of the seat and the angles of the legs so that multiple chairs can be fit around a small table more easily.

The shaping of the spindles fits both chairs, and the angle of the center spindle to the seat deck is the same. For the center spindle angle, I prefer 7° to 10°. I like this for dining chairs without arms. Either chair can be made with "bamboo" lines incised on the spindles to match the double-bobbin stretchers, or they can be bulbous to match the balusters. If you are a capable turner, the spindles could also be turned to have more realistic bamboo nodes. I don't usually turn my spindles because I don't enjoy the process. A few minutes with a carving gouge or a file can create details where I want them.

The location of the holes for the posts in the fan-back and the bow in the balloon-back are the same, but they are drilled at different angles and with different sightlines.

The shape of the bow on the balloon-back is largely an aesthetic choice. My main goal was to balance its size and shape to the base. The fan-back's crest rail is also proportioned to the chair, but it has a curve that directly impacts its construction and comfort. If the back is too curved, it forces the shoulders of a larger sitter forward, which can create a weight imbalance and result in a slumped posture. Soon, you'll find the sitter with his or her elbows on the table to escape the back.

While the deeper curve looks great and can simplify some construction processes by keeping the spindles' relationships more consistent, I prefer the flatter crest for comfort. People come in many shapes and sizes, and the goal is to accommodate as many types of people as I can.

While more complex chairs feature more joinery and details, they start with the same principles as these two chairs. Once you've worked through a side chair, other chairs become surprisingly easy to build.

When designing both the chairs and the processes to build them, I prize the ability to change and innovate. This keeps me grounded in low-tech solutions rather than jigging up for a level of uniformity that I might be unwilling to modify. One of the joys of Windsor chairmaking is working to the chair, not the drawing.

For instance, the lengths of parts are often measured directly from the existing points that they join, which is a fluid and forgiving way of building. Working in this manner gives me a great deal of freedom and enjoyment to explore chairmaking with a speed and confidence that feeds my interest to this day.

## Draw the Chair

Most furniture begins with drawing, and rightly so. Renderings are usually the best way to get a sense of the proportions and impact of your design decisions, as well as creating a forum for making these decisions. Chairs are notoriously difficult to render. Because a chair is viewed from all directions, and it usually incorporates curves that don't reside solely in one of the three views, creating a representation on paper is difficult and can be misleading. Even so, a drawing can help work out some of the basics and allow you to understand the angles involved.

For many of the elements of a chair, the details can be worked out on paper by creating an orthographic projection that shows the front, side and plan (top) view. I've found that breaking the chair into these three views is helpful as I start to recognize the significance and relationship of the parts. By aligning the front view below the

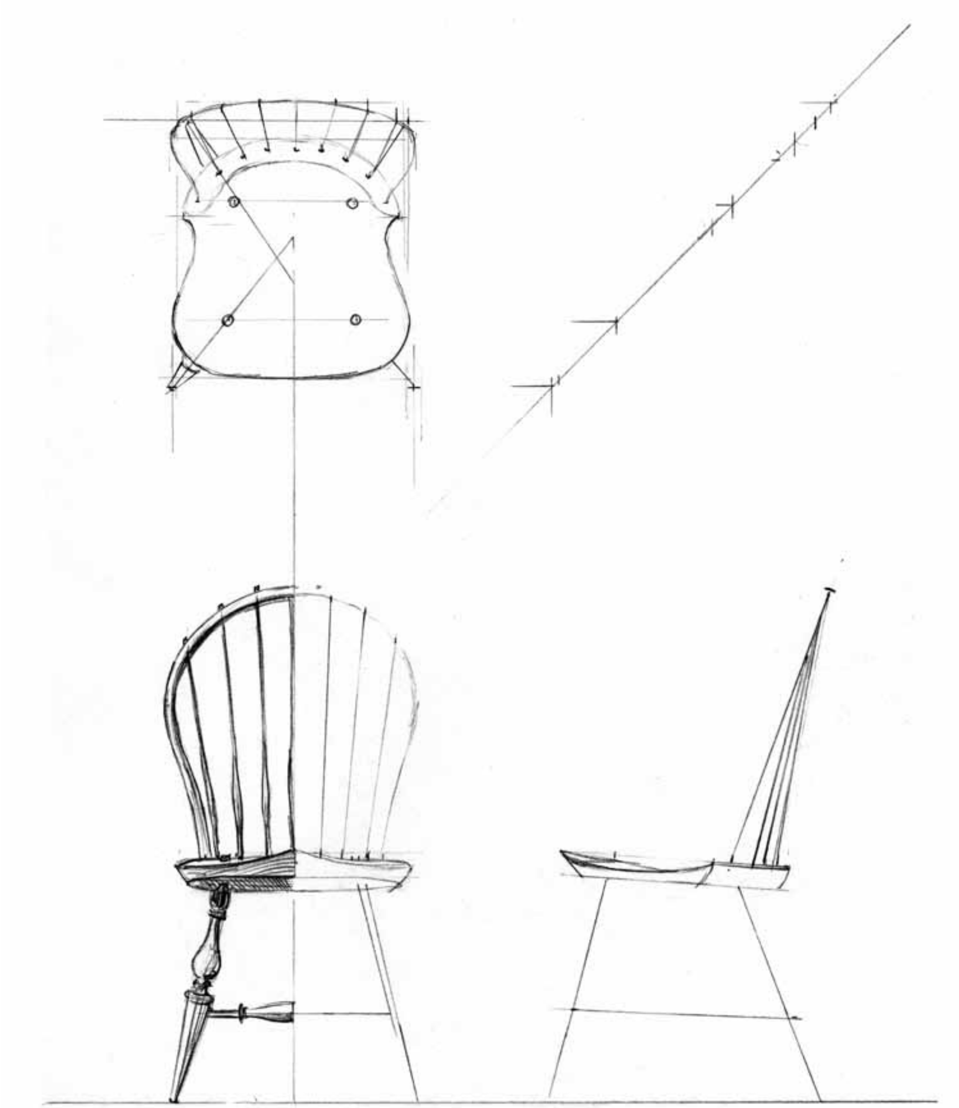


**FIG. 3.2** ***The balloon-back chair.***

plan view and beside the side view, specific points can be located and projected. Also, a 45° line above the side view and beside the plan view can be used to project points between the plan and side views.

This is how the angles of the components can be worked out. The front view shows the splay of the parts, the side view the rake. To begin, I draw the seat's width and depth, and the location of the legs, and I set the seat height above the floor plane. Then I choose pleasing angles for the rake and splay of all the legs. I work to make the footprint of the chair stable without looking awkward, which I judge based on the height of the chair. I usually leave these drawings as "stick" drawings so I can work out the angles, then I flesh out the parts if I want a better vision of the dimensions and proportions.

The factors when you design the undercarriage are similar for most chairs. It's important that the legs are not splayed and raked apart in a way that will create undue stress, or so straight that the chair will tip easily or be unsafe. A look at existing chairs gives a good vision of these limits, but a line drawing can expose a precarious design.

The angles of the legs, along with their design, help give the chair a "gesture." Whether the desired result

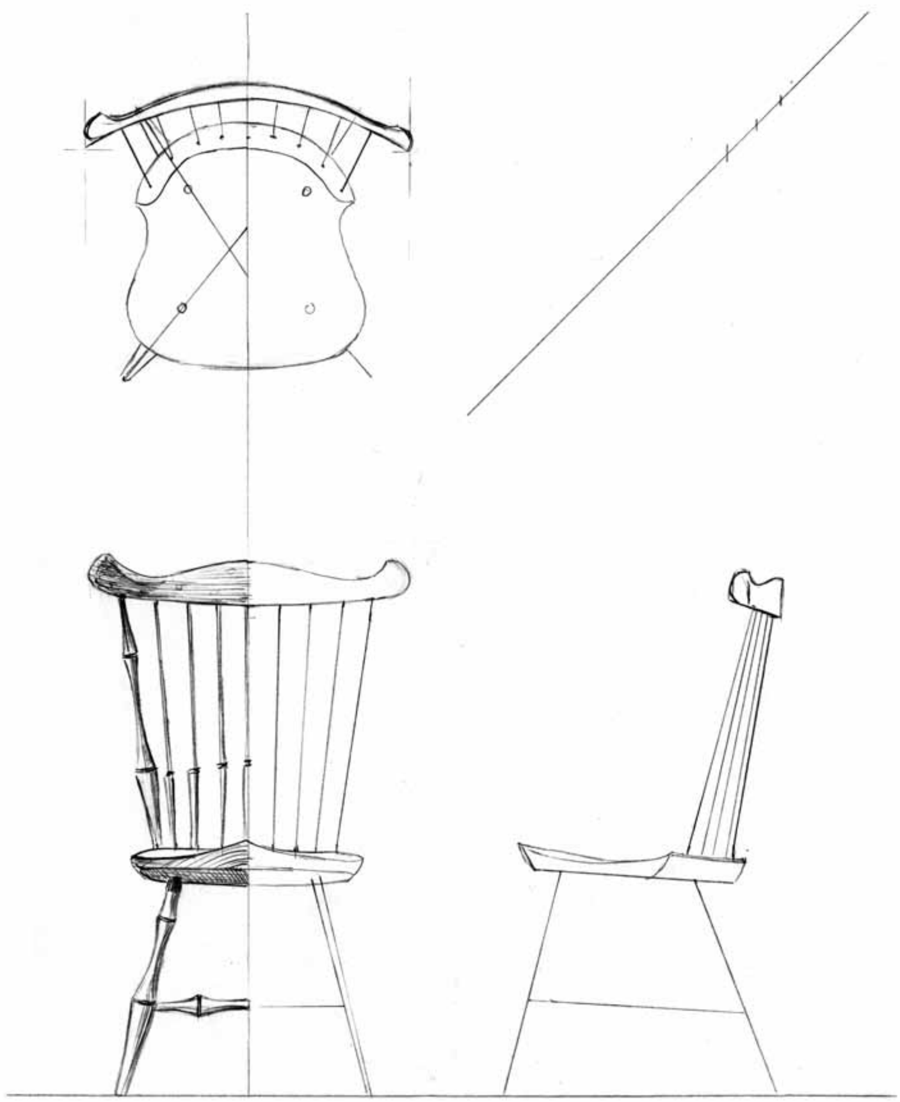


**FIG. 3.3** *The fan-back chair.*

is a visual lightness and sense of action or stability and weight, angles are important. More vertical legs tend to give a static feel that might be appropriate in a more formal chair, whereas exaggerated angles might add a vibrance and stability to a more lively design for an occasional chair. Correctly relating the footprint of the legs to the top can also help prevent frequent toe stubbing as you walk past the chair.

The relationship between the floor and the angle of the seat plays a role in the comfort and function of a chair. Seats that are more parallel to the floor plane work well as task or dining chairs because they allow the sitter to shift

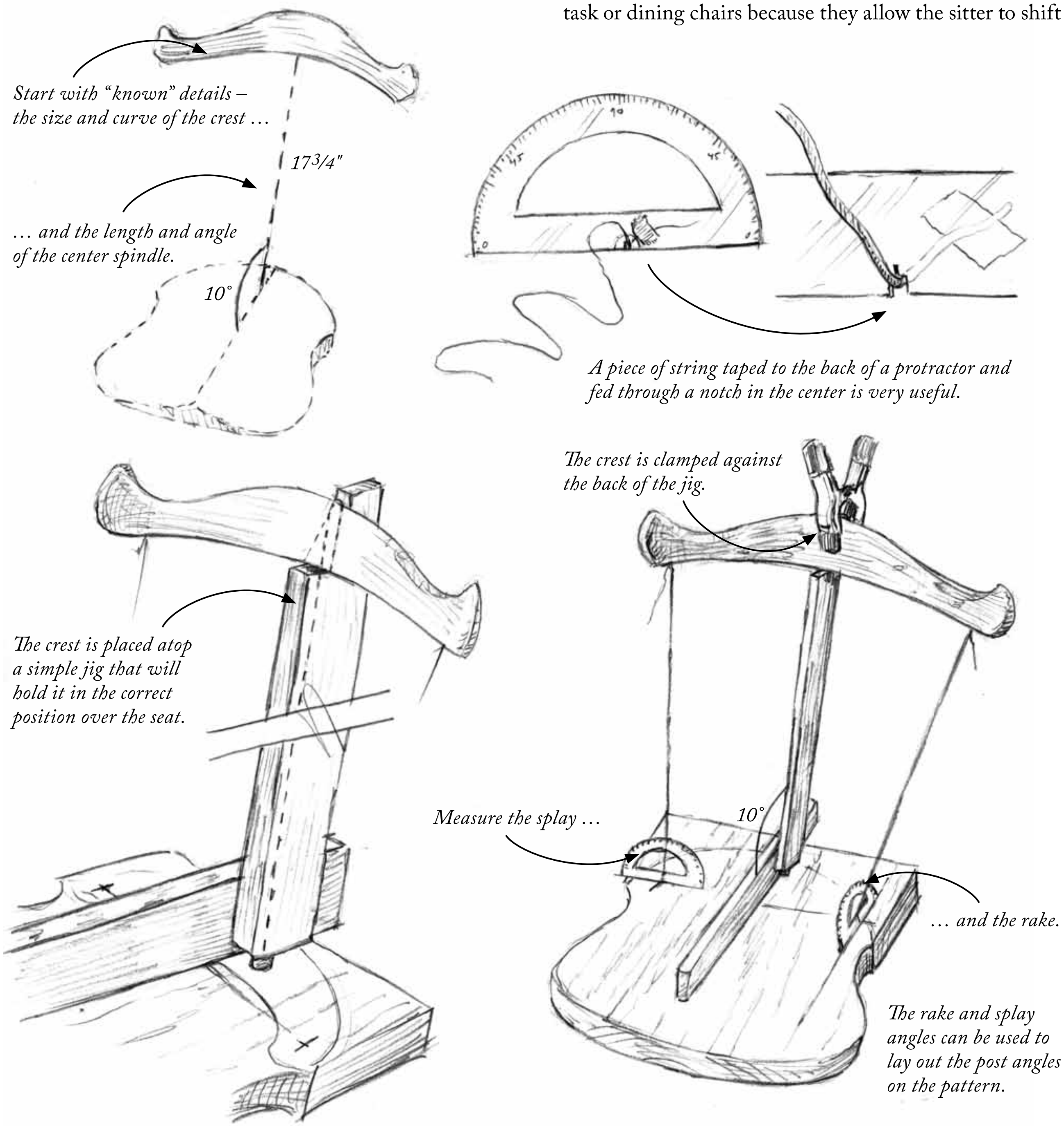



**FIG. 3.4** *A technique used for finding the angles for the fan-back posts.*

weight forward more easily, while seats that tilt back are better for lounging. The relationship between the back and the seat also factors into this. I think of the back as assisting and supporting the sitter in the position determined by the angle of the seat to the floor.

Designing the upper portion of a Windsor can be trickier; the intersections of multiple curved parts are difficult to depict in a drawing. For complex chairs, a mock-up is usually in order. Luckily, there are a few key details that help to set the more elusive details in place. Key details are the shape of the seat, the curve of the bow and crest, and the height and angle at which the center spindle relates to the seat. You won't need to do this to build the project chairs, but it shows how I go about using

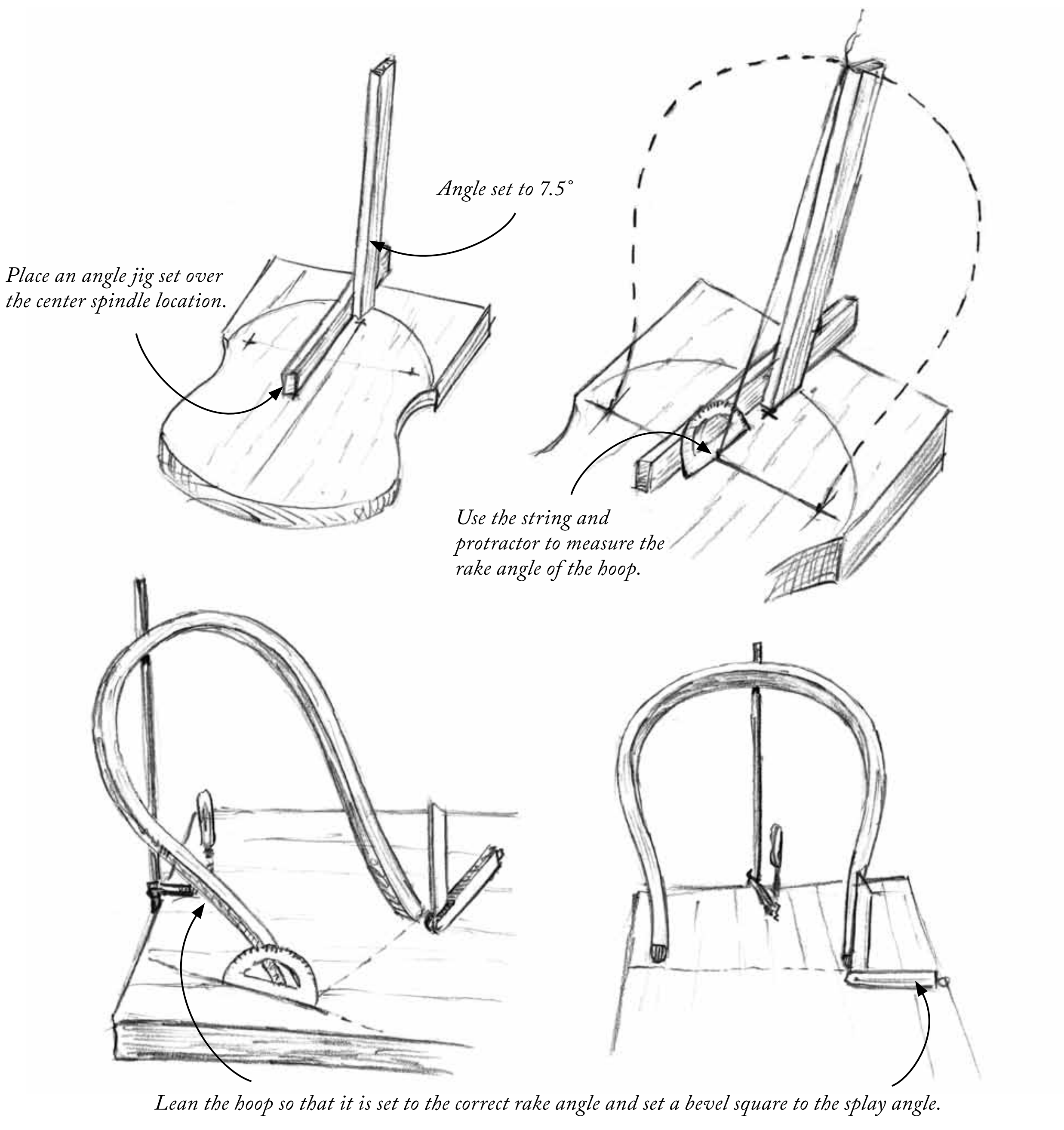



**FIG. 3.5** ***A technique used for finding the angles for the bow.***

a few known parts and angles to determine the angles of the others.

By deciding the angle at which the center spindle relates to the seat plane, most of the other parts can be located in relation to it. Most chairs allow for this kind of process, where the position of each part in the chair is located by its relationship to the existing parts. It's a natural way to develop a form, and once you understand the few elements that affect the strength, comfort and beauty that you are pursuing, the rest falls into place. Over the years, I've developed processes for building my chairs according to these relationships, which is very freeing. Now I rarely take the time to completely draw a chair and instead rely on previous successes and the goals that I am pursuing to guide me.

## Using & Understanding Angles

Perhaps the most critical aspect of designing a chair is the location and angles of the parts that join the seat. While the front and side views are helpful in the drafting stages of chair design, they become cumbersome when working on the three-dimensional object. Positioning a leg that tilts in two directions is awkward and can be confusing. Luckily, we are not stuck looking at the chair from only the front and side views.

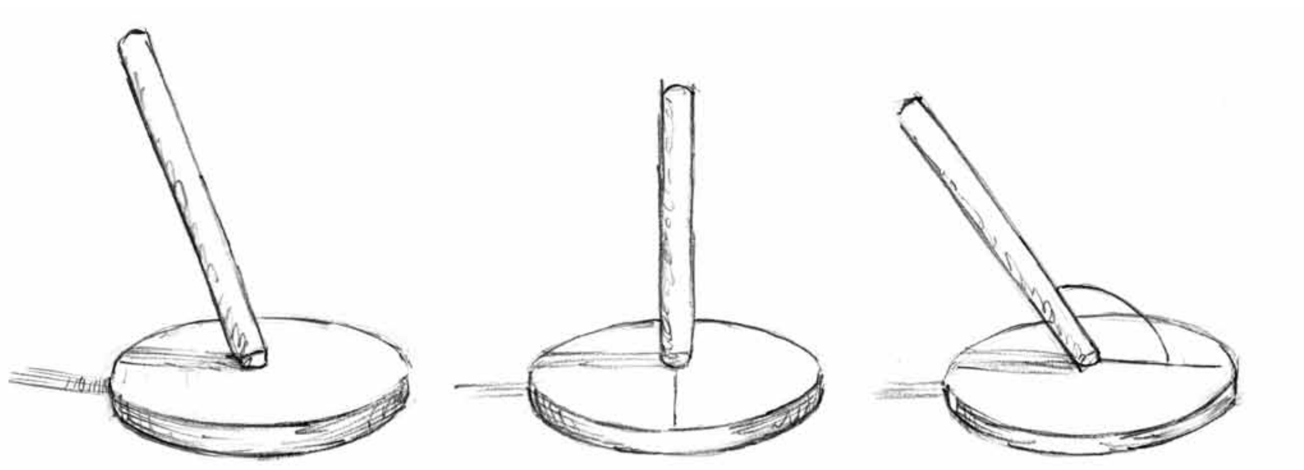
Take a look at the round seat in the image below with the single part sticking out of it at an angle. If we wanted to measure and reproduce this angle, how would we do it? After all, there are no identifiable front or side views.

Here is one solution. Rotate the seat until the leg looks vertical (as shown below) and draw a line on the seat noting the direction that you are sighting. This is called the sightline. Then rotate the seat again and measure the angle of the part to the sightline. This is called the resultant angle.

Now we have the information we need to reproduce this relationship and can mark the seat pattern with the position of the sightline and the angle to drill. Sightlines make for a clearer description of the angles of your parts and easier drilling.

Just as the human body comes in many shapes and sizes, chairs can be designed and adapted to meet them. It's the meeting of this complex problem with the simple tools and materials that interests me. We are all experts in chairs; we know what we like and don't like. Getting on the other side of the equation from evaluating to creating is both thrilling and daunting. Once you master the basic concepts of the construction, it is generally a short leap to change the chair you are building. And that is the first step toward designing a chair yourself.

For more information about understanding and creating sightlines, turn to Creating & Using Sightlines.

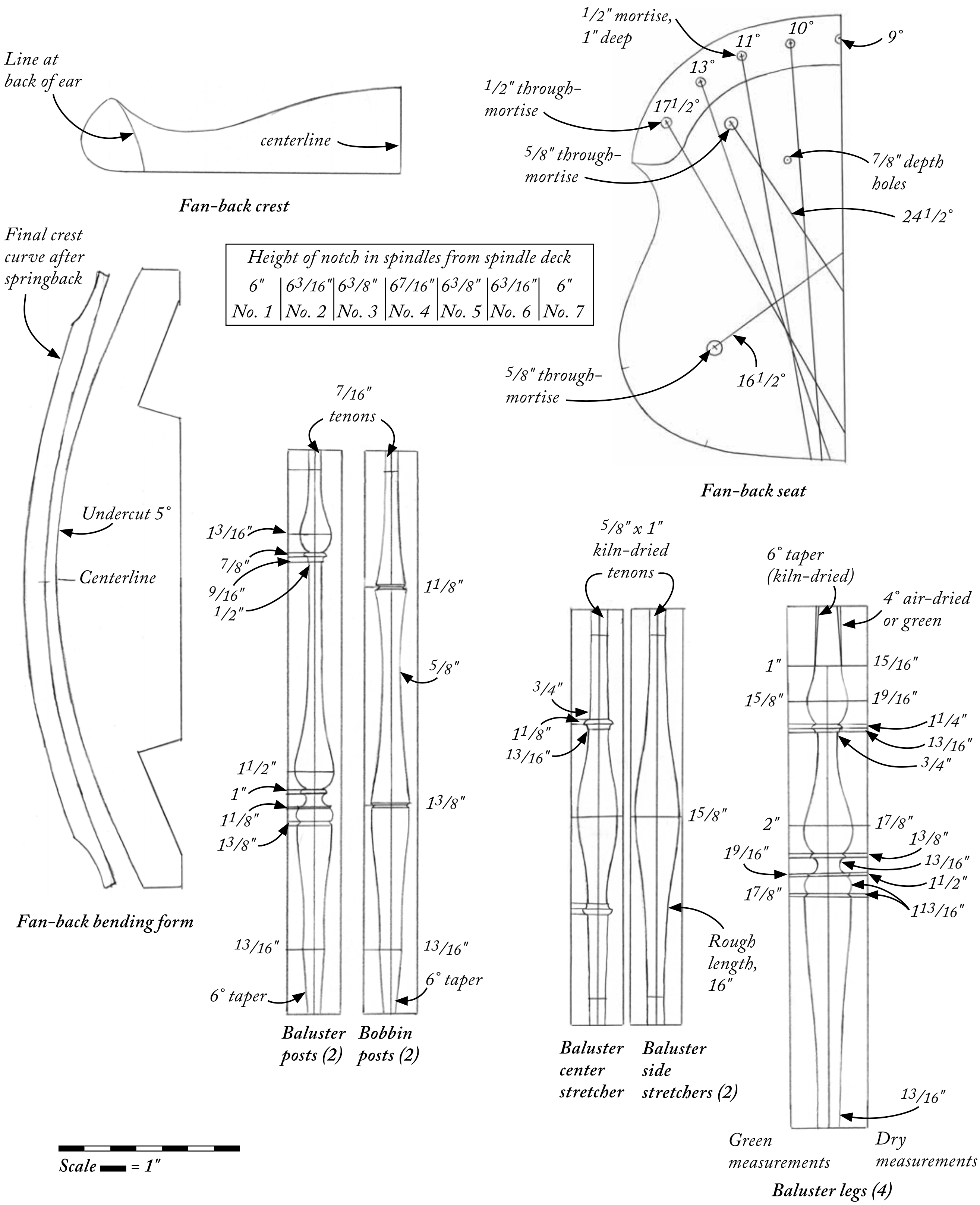


*When looking at a round seat, there is no front and side to measure the rake and splay of the leg.*

*Rotate the seat until the leg appears to be vertical and draw a line on the seat noting the orientation of the seat. This line is the sightline.*

*Measure the angle between the leg and the sightline to determine the resultant angle.*

**FIG. 3.6** ***Understanding the sightline and resultant angle.***




*Height of notch in spindles from spindle deck*

| 6" | 6 3/16" | 6 3/8" | 6 7/16" | 6 3/8" | 6 3/16" | 6" |
|---|---|---|---|---|---|---|
| No. 1 | No. 2 | No. 3 | No. 4 | No. 5 | No. 6 | No. 7 |

**FIG. 3.7** *Project plans for a fan-back chair. Enlarge illustrations 540 percent for full size.*

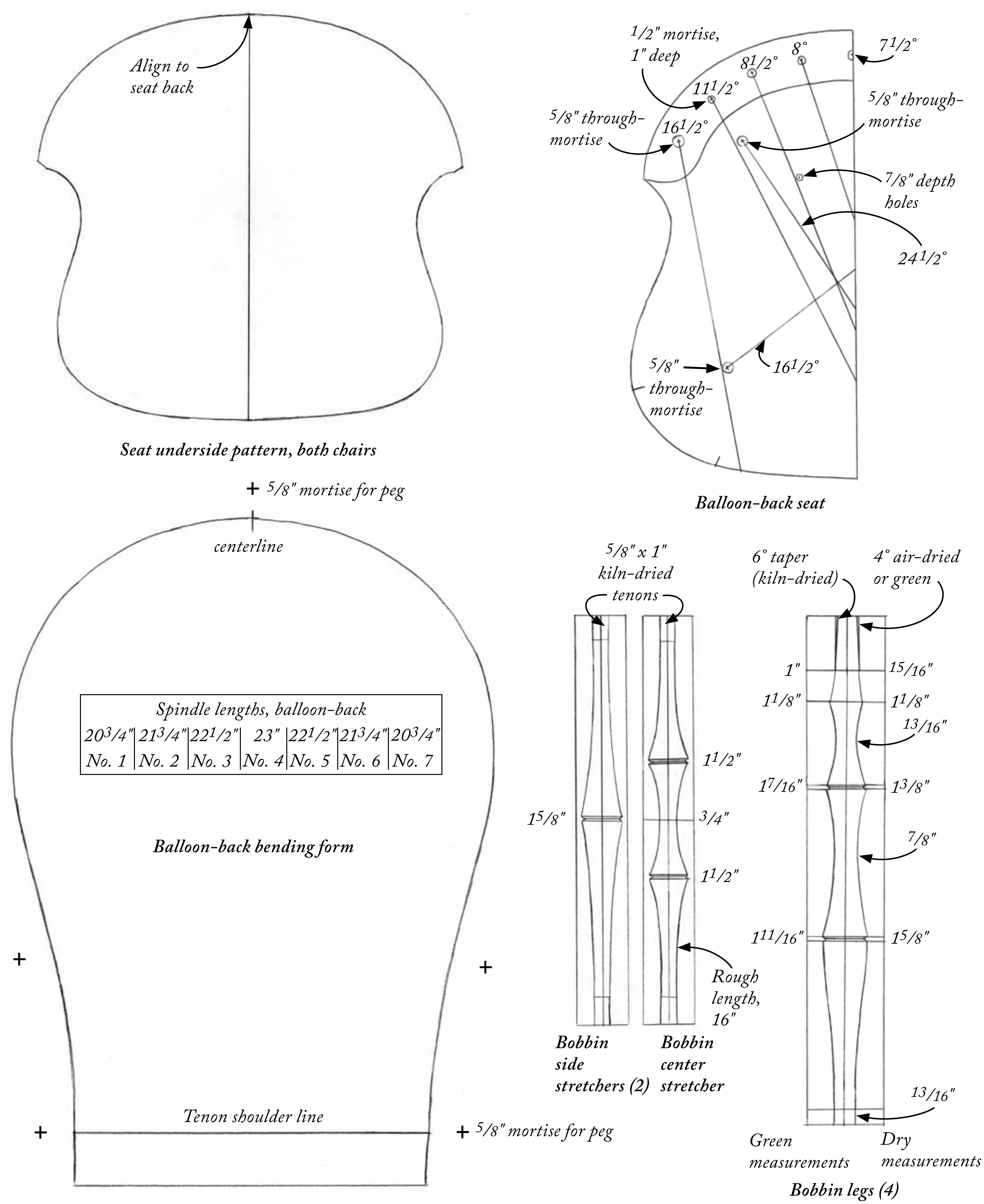
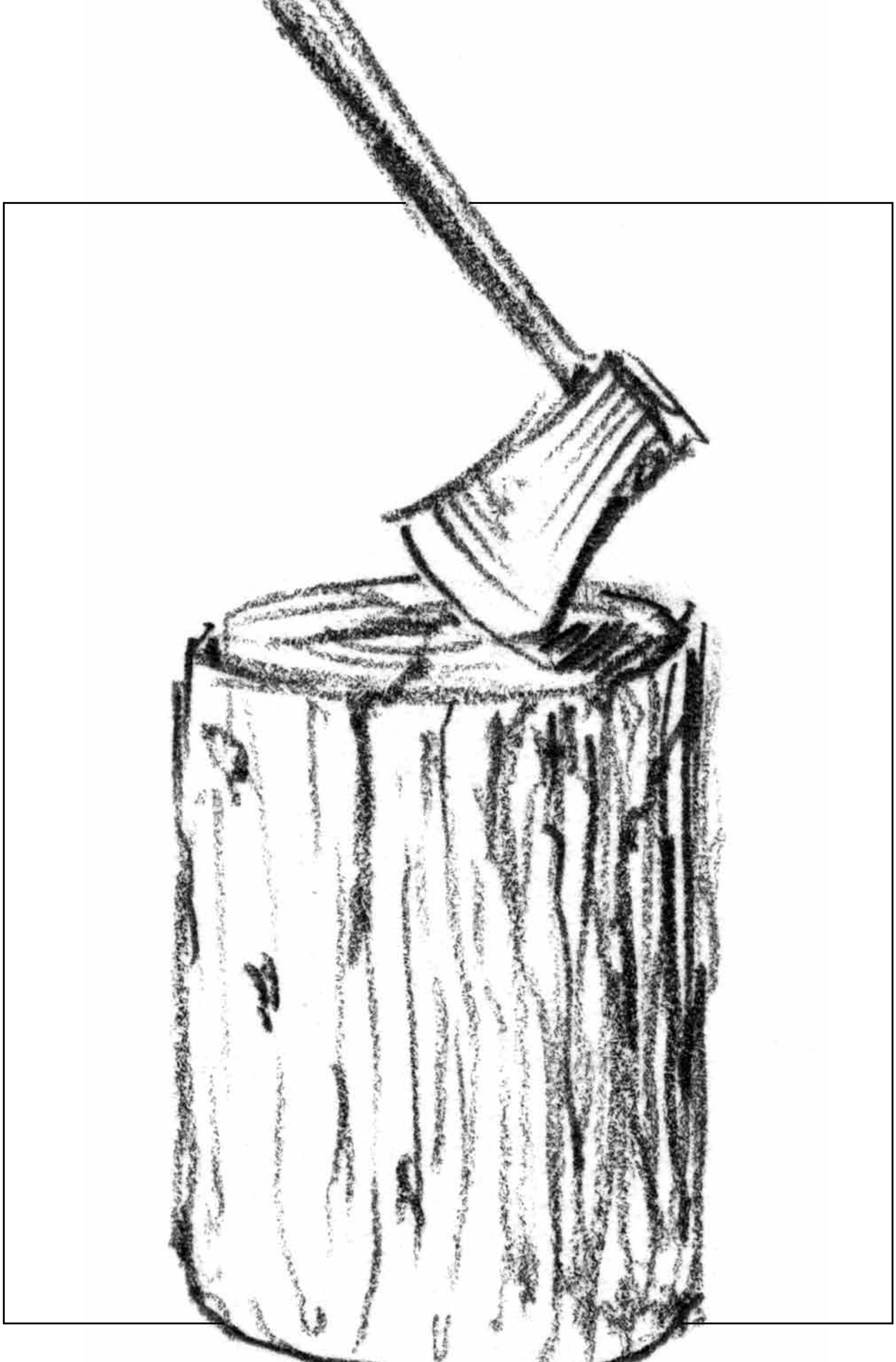



**FIG. 3.8** *Project plans for a balloon-back chair. Enlarge illustrations 540 percent for full size.*



# 4

# The Chairmaker's Workshop

I can remember the sounds and smells of my 7th-grade school's woodshop. Sadly, that was the only time I got to use the school's workshop. Years later, when I went to work for a cabinetmaker, it all came rushing back. A workshop is a great place to be. As I set out on my own, I discovered that there was much to learn about building a viable one.

Whenever I talk to craftsmen, the topic inevitably turns to workshops and tools. Amassing the tools and organizing a workshop is a process that every maker needs to figure out. Fitting your budget and interests can be daunting, especially when deciphering all of the guidance available online, in print and in advertisements. One simple guide is to focus on creating a shop that works for you, instead of you working for it. A major factor in my decision to specialize in chairs was the minimal amount of tooling and space required to produce them.

When I set out to make a living woodworking, I encountered the challenges of balancing my financial needs, production requirements and market demands. Regardless of whether you intend to run a business from your shop, you likely will encounter similar issues. Even if you are setting up a shop as a hobby, you will be confronted with the same decisions and factors. Woodworkers are incredibly adept at rationalizing a $2,000 tool to build a $200 coffee table.

The profit margins in woodworking can be slim once the landlord, tool manufacturers, electric company and lumberyard take their cuts. Most of the cabinet and furniture shops that I worked for in New York struggled with this, and I think that the problems are universal. While I worked with talented and motivated people, matching our abilities and facilities to the desires of a fickle market was the toughest skill to master. It's easy and exciting to think, "If I get this job, it will pay for that new tool that the job requires." Soon all those tools need a larger space, plus employees to keep them running and earning their keep. And before you know it, growing the shop is the only answer; the reason for starting the shop is long forgotten. I think that most of us get into woodworking for similar reasons: the joy of learning and making. But managing your shop to keep it functioning for you is as vital a skill as any that you will practice in it.

My shop is limited, by design, to keep me focused on making what I want to build and what folks want to buy. A chair shop can function with minimal tooling, which means that when I get paid for a chair, there isn't a long line of middlemen waiting to take their cut. It's an equation that everyone must work out for themselves, but a workshop tends to grow like a bureaucracy and should be managed and planned diligently.

## Light & Space

Space is the first major consideration when starting out. Of course, plenty of room for tools and materials is essential, but nature abhors a vacuum and if a massive space is available, things can get out of hand quickly. Not to mention the effort it takes to move around a large space. It might seem like a minor issue, but I used to walk many extra miles a day around the larger shops that I worked in. It might seem impossible to squeak by in a tiny space, but the annoyance of having to walk 40 feet to retrieve a forgotten tool is very real. I push my space for efficiency, asking more of little. Each tool must earn its place in my

**FIG. 4.1** *A chairmaker's shop is lean but productive.*

shop and usually if the shop seems too small, it just means that I need to clean up and put some tools away. Thinking ahead about traffic flow and shavings goes a long way toward making a shop function. You'll find out quickly if the shavings from the lathe are shooting onto your sharpening station.

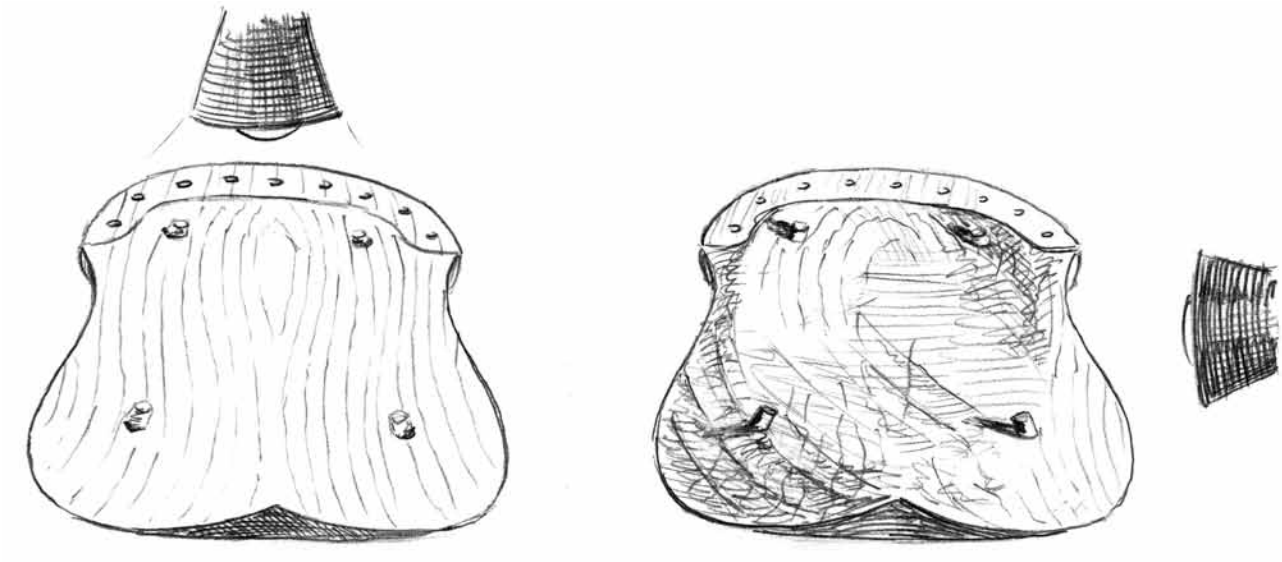
My shop is about 20' square, with a single-car garage attached. I keep my band saw and grinder in the garage to contain their dust and grime. The only large tool with a motor that lives in my shop is my lathe, which is a late 1950s Delta 36" model. I usually have two shavehorses, my primary workbench and a low workbench in the middle of the room. I also have a long row of benches that I keep all of my sharpening tools on.

When I built my shop at my house in upstate New York, I thought I had hit the jackpot where light was concerned. After spending four years in a dark basement, I had 10 windows and Southern exposure. But when examining chairs nearing the finishing stage, I kept finding small issues with the surfaces that I used to catch earlier. I was suffering from too much light, or perhaps more accurately, unfocused light. What I didn't realize was how much I'd learned about using light to my advantage in my dark lair.

When I worked in a light-starved environment, I staged my lighting for any task that I wanted to see clearly. To do this, I took a hint from my days in photo school and set up a raking light. A raking light is a light that shines across a surface and reveals the surface quality and shape. It highlights details better than a light shining flat on the surface.

The way that I like to work depends on my eyes guiding my hands, so clear visual information is vital to good results. Taking the time to set up a raking light makes all the difference. I have a large articulating desk lamp that I keep mounted on my workbench and another lamp at each of my shavehorses.

I use a 75-watt bulb in each, providing a nice raking light. Above the benches, I have track lighting with spotlights. I like being able to direct each light to a task or area that I am working. I don't have long fluorescent fixtures, but have used them in the past for basic fill lighting. I've found that fluorescent fixtures alone tend to flatten everything out and can make it tough to see edges and surface quality. When smoothing large surfaces, such as a settee seat, I position the light at one end and kneel down at the other so that I can sight across the surface. I repeat



*Diffuse light or light shining directly on a surface tends to flatten things out.*

*A raking light shining from the side highlights the surface quality and shape.*

**FIG. 4.2** ***Light shining directly down on a surface obscures the shape (left). Light shining across a surface accentuates the surface's shape.***

this from multiple directions to ensure I get the results I need. It's common for new chairmakers to assume that the paint will cover small problems, but the result is actually the opposite. The sheen of the paint and oil will reveal missed defects or unevenness, so it's important to find and fix them ahead of time. It can be helpful to shave or surface a piece in your shop then take it outside or to another bright space and inspect it to get an idea of how well your lighting serves your expectations. Light is simply another tool, and it's up to you to maximize it for the task at hand and the quality of the work you wish to achieve.

## Sharpening Station

Shop real estate is a valuable thing. Each tool should earn its place. But one area that I am always happy to expand is my sharpening station. Perhaps I am just weak-willed, but the notion that I would pull out my grinder and stones when I need them basically means that I would surrender to using dull tools. Having a permanent and comfortable sharpening area, away from the workbench, is essential.

I keep mine along the south wall of the shop for good lighting and near enough to my bench that I am always one step away from sharpening. Good habits form when they are easy. There are great books out there that cover sharpening from soup to nuts, so I'll simply share some of my personal tools, habits and techniques that I hope you'll find helpful. The details of my sharpening equipment is covered in the Hand Tools: Sharpening & Use chapter.

## Hand-tool Storage

I like to hang my tools on walls, magnets and in cabinets – as well as on shelves behind my workbench. I like to have things within reach, like in an airplane cockpit. This also aids in putting tools away. I keep my layout tools, planes, chisels, carving tools and seat-carving tools in this zone. I dream of having lovingly crafted tool cabinets and chests around, but I'm afraid that my shop time is delegated to chairmaking. As long as I have wall space, the cabinets won't be happening.

## The Shavehorse

The shavehorse is an essential piece of equipment if you wish to work efficiently with a drawknife. The benefits of the shavehorse are readily apparent after only a few minutes of using one. I have taught scores of people who have made chairs using a bench vise, and every one has been quick to convert to the shavehorse. It is a fast way to clamp and maneuver a workpiece while gaining the

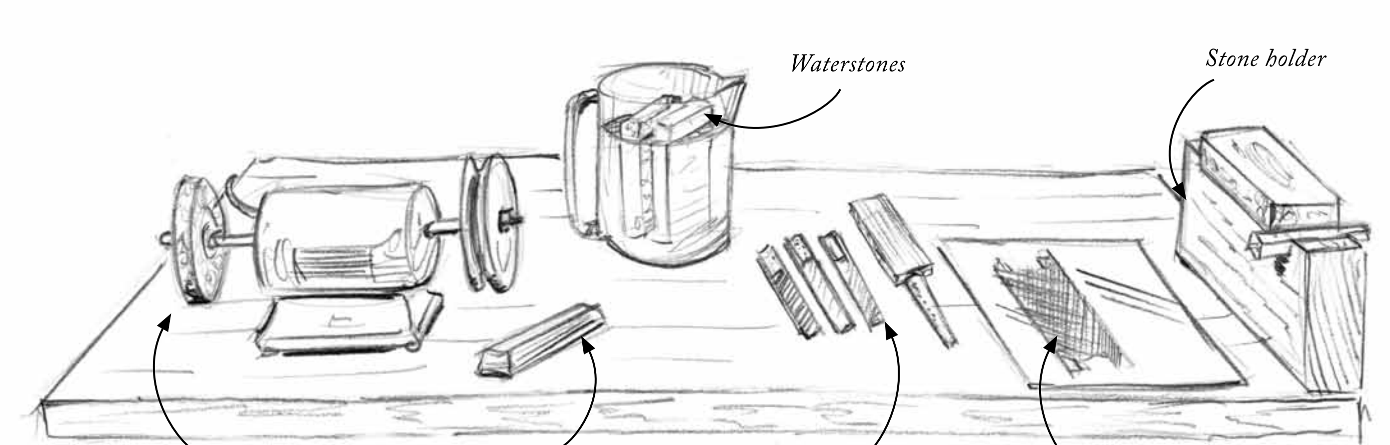



**FIG. 4.3** ***Tools in my honing and polishing station.***

maximum leverage and strength with the tool at hand. When working at the shavehorse, you naturally exert force on the pedal in direct relationship to the pulling force, so the effort to hold the piece tight is not wasted. And when you wish to shift the piece in the jaws, you simply release the pressure on the pedal, and the jaw swings open to allow instant repositioning. In the appendix The Shavehorse, I go further into the details of building and using the shavehorse.

## Hewing Stump

A stump for hewing can either be set over a sound structural floor joist or, if it's over a crawl space, simply pass it through the floor to solid earth.

The hatchet is a fast remedy for sizing parts when you begin with a series of depth blows then hew away the short-grain pieces remaining. My stump has a step cut in it to accommodate pieces of various lengths while remaining comfortable (thanks to Dave Sawyer for this simple solution). I remove the bark from the stump to deter pests. In my old shop, I took a cue from Jennie Alexander and set a stump flush to the floor that rests on the earth (see Fig. 4.4 at right). This works great as a solid base.

## The Workbench

The workbench is a vital tool for hand-tool use. A solid flat surface and a good vise go a long way toward making work flow, but you don't need a massive bench to make


**FIG. 4.4** ***I like to keep a stump handy for hewing away material from workpieces with a hatchet.***

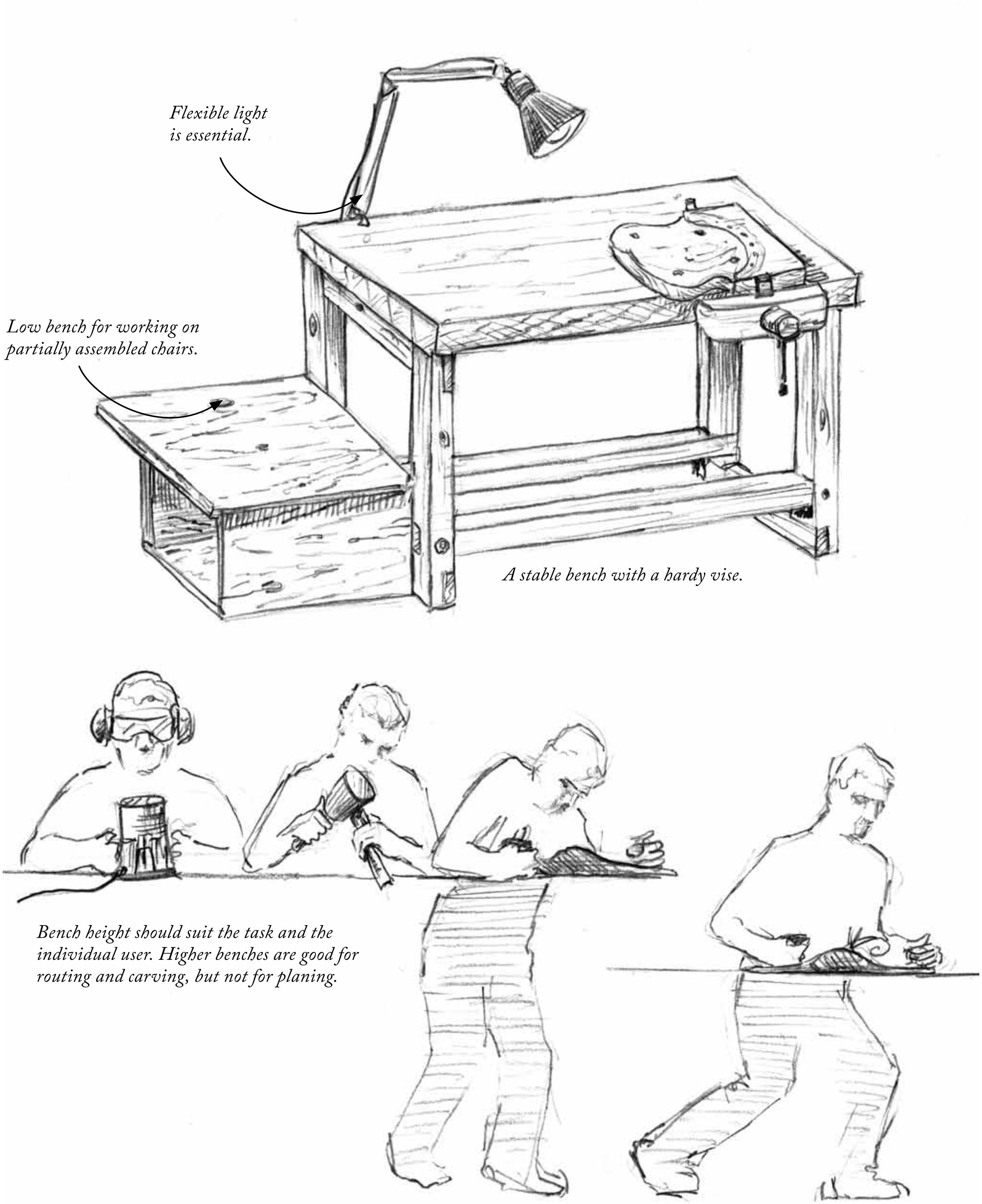



**FIG. 4.5** *A chairmaker's workbench.*

chairs. As a matter of fact, because of the need to work all around the bench, a smaller bench that is quick to get around might be the best.

My workbench is 27" x 46" and has a 2½"-thick top. It's plenty wide enough for a chair to sit upon – but not much more. It's actually an old industrial sewing machine table that I found on the street in New York City. I heaved it on top of my bike and walked it 21 blocks home.

You don't find a chunk of maple like that every day. I don't have a tool well, which usually just collects tools anyway and limits the ability to sit an assembled chair on top of the bench. I don't keep any tools below my bench.

My workbench sits on a relatively flat oak floor, and I've found that the non-slip material sold to keep rugs in place works fine to keep the bench from sliding around during heavy use. In my old shop, I simply bolted it to the plywood floor. But because I just laid the oak floor, I can't bring myself to screw into it (and the rug material works fine).

Alongside my bench, and bolted to it, is a plywood box that functions as a "low bench." I find this quite helpful for working on a chair that is legged up. I can scrape the seat and assemble the top at a comfortable height, and I can use the light mounted on my workbench as a raking light. I use a long strip of wood, cushioned by foam pipe insulation through the undercarriage, to help clamp the chair firmly to the low bench.

The front-mounted vise is vital to the way that I work. I have a quick-release vise mounted to the front right side of the benchtop. (I'm a lefty, so you might like yours on the other side.) Besides holding parts, I often use the vise's built-in bench dog in conjunction with a round bench dog on the benchtop to hold seats as I work on them.

My process for carving seats allows me to hold the seat this way. I can pinch portions of the seat that will be carved away later, so I don't need to worry about dinging the workpiece. No matter how you hold the seat, it is important that you can either move around it easily to cut from different directions or that you can move it quickly and easily to the different positions required for comfortable cutting.

Of course, there are commercial benches and antique ones that can fit the bill. One factor to watch carefully is the bench height in relation to you. Taller, modern

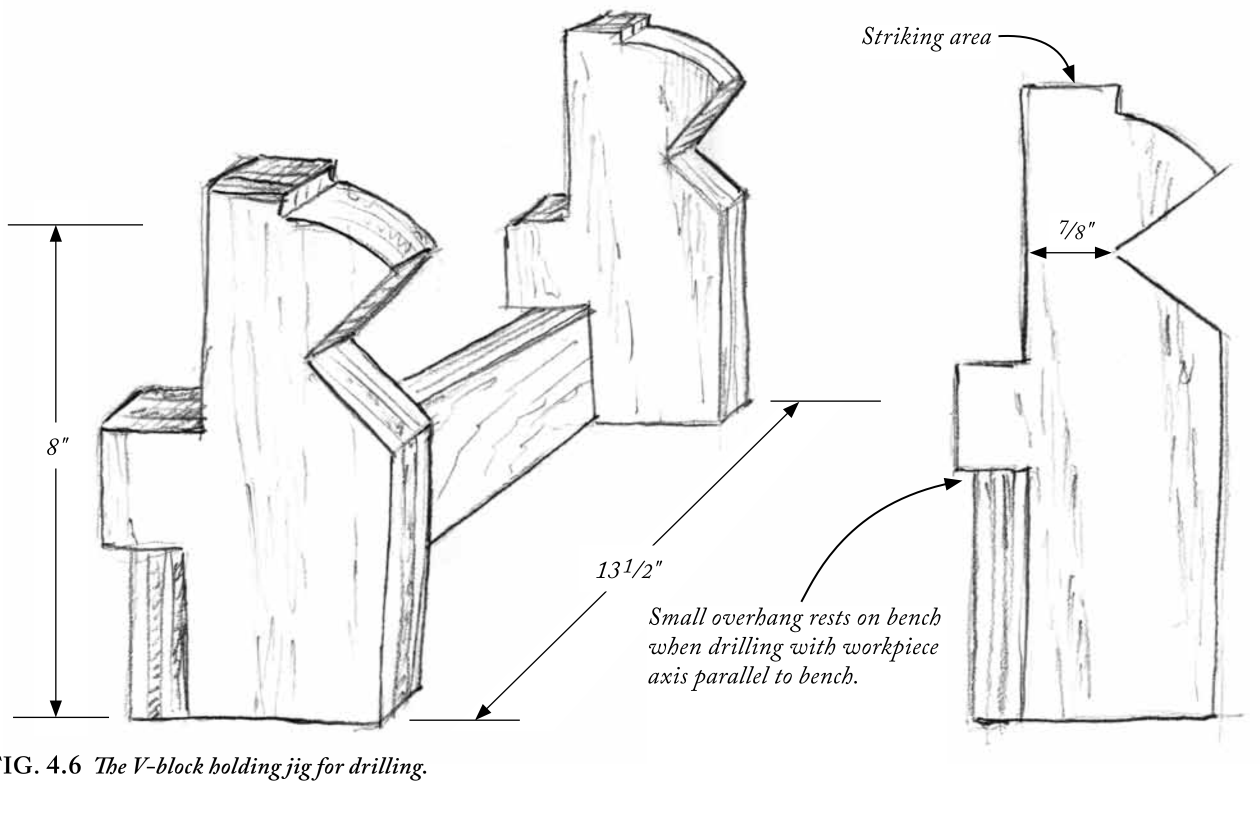



**FIG. 4.6** *The V-block holding jig for drilling.*

benches are suited for power tools, but when using handplanes, it's important that you can get your weight over the tool, which usually calls for a lower bench.

Sometimes, it can help to have a small booster platform that can be clamped to your benchtop for close-up work, such as carving.

Many folks find iron holdfasts that lodge in round holes to be a solid and easily moved way of holding seats for carving. I don't use them, but that has more to do with my process than their usefulness.

Another fixture is a V-block holding jig that I use when drilling legs and stretchers. The Vs hold the parts firmly and can be shifted to hold the part either parallel to the benchtop or at an angle, but more on that in the drilling section.

I also use a notched block of wood to help support pieces in tandem with my bench vise when I am edge jointing. It's a simple but indispensable tool. I admire benches that have this support built in.

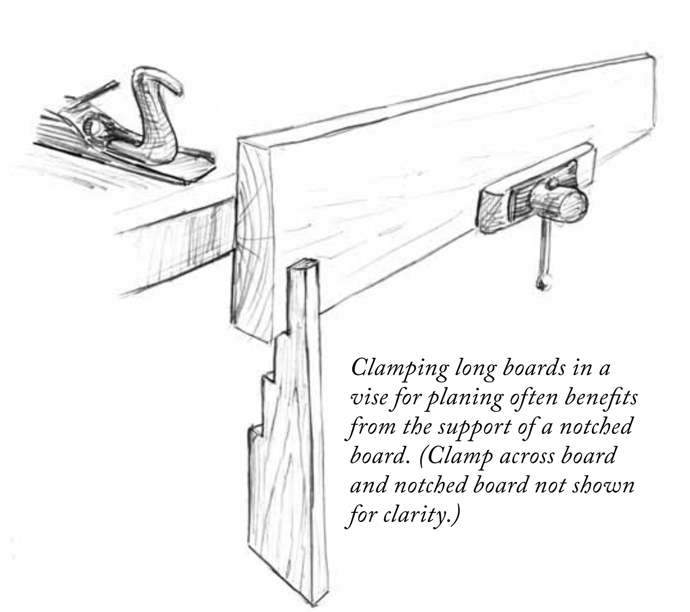



**FIG. 4.7** ***A bench slave can help hold boards for working on edge.***

## The Brake

A brake is simply a holding device. When splitting wood, it's helpful to get it off the ground. And it is absolutely necessary to have the work held solidly so you can use your froe and body weight to influence the splits. Simple

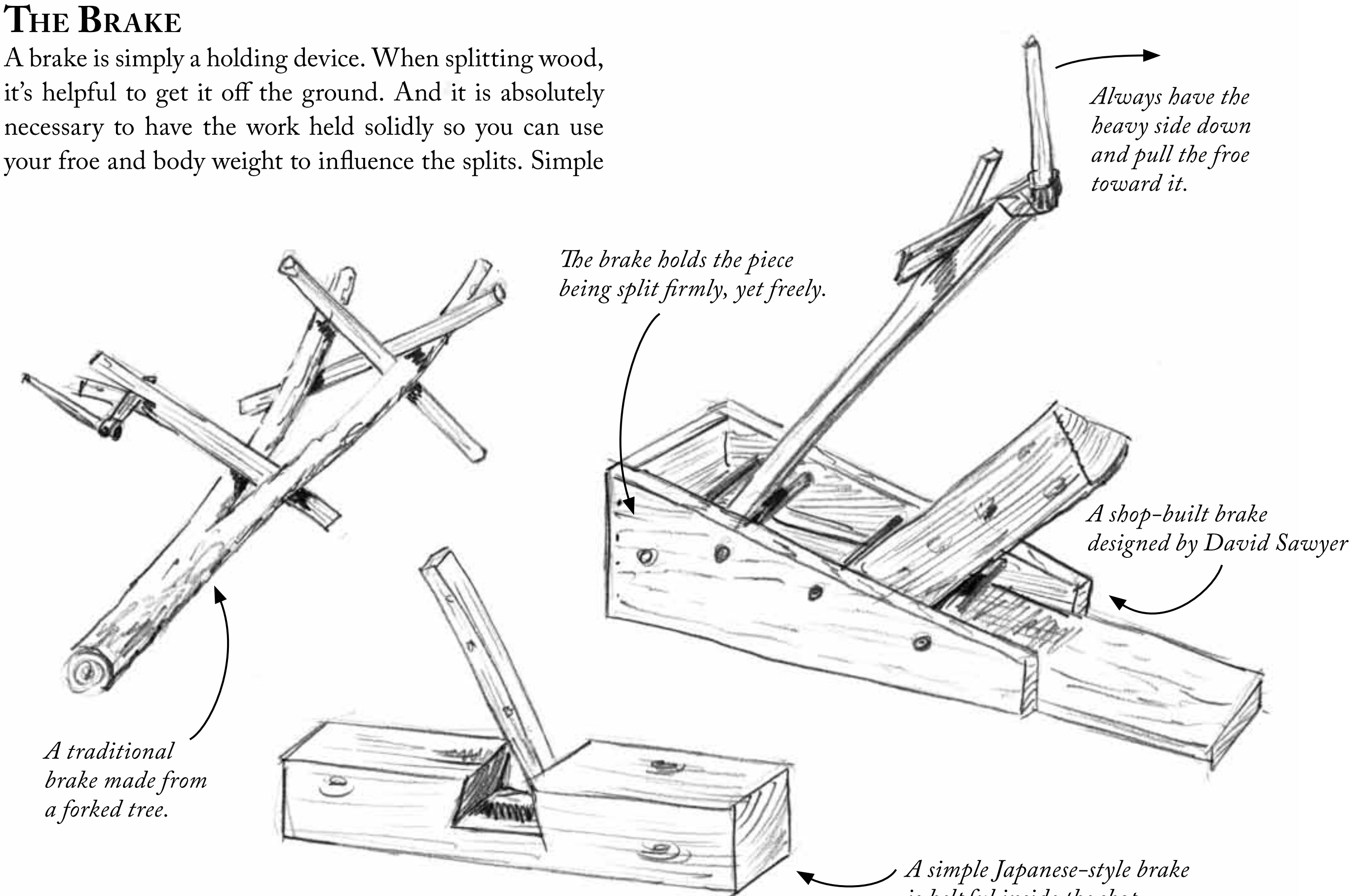



**FIG. 4.8** ***Different types of brakes.***

brakes can be made from the crotch of a tree and two supporting sticks, or a notch cut in a large beam (a Japanese style) or even your vise.

Outside of my shop, I keep a brake like the one pictured below that has a few different-sized openings. It allows me the portability and strength that I need to work with a variety of parts. (Once again, thanks to Dave Sawyer for the great concept.)

This brake holds the workpiece, regardless of size, at a height that is comfortable at which to apply the necessary leverage. If a piece is too large to fit into the gaps between the bars, it's likely you should be splitting it with wedges and sledges anyway. In recent years, I added the extra pedal and strap shown in An Introduction to Splitting Tools chapter, but they aren't necessary for the basic function and can be added later.

## Lathe

Historically, lathe work was often a separate craft and there is lots of evidence that many chairmakers purchased their turnings from specialized shops. When I set out to build chairs, I wanted to make my own parts, which meant spending lots of time learning to turn. You can make great chairs with just shaving tools, but using the lathe to make tenons and the drill for mortises is a great combination for fast and solid joints.

A quick note on terminology: Turning long pieces between lathe centers with the fibers in the wood running parallel to the tool rest is referred to as "spindle" turning. This can be confusing because I don't turn the spindles in the backs of my chairs, even though I could. So turning of the legs and stretchers is usually referred to as spindle turning, which I suppose sets it apart from bowl turning or other lathe projects.

The lathe is an ancient tool. The spring-pole, great-wheel and water-powered lathes have been spinning wood for thousands of years. My first lathe was a long bar clamp that I held in my workbench vise and a flywheel from an exercise bike that I found on the roadside.

It was crude, but I wanted to know what this turning business was about before investing in any machinery. At the time, my effort was cheap and tools were expensive. It wasn't long before I bought a lathe, but if you are interested and willing, a spring-pole lathe can turn out as fine a chair part as any motorized version.

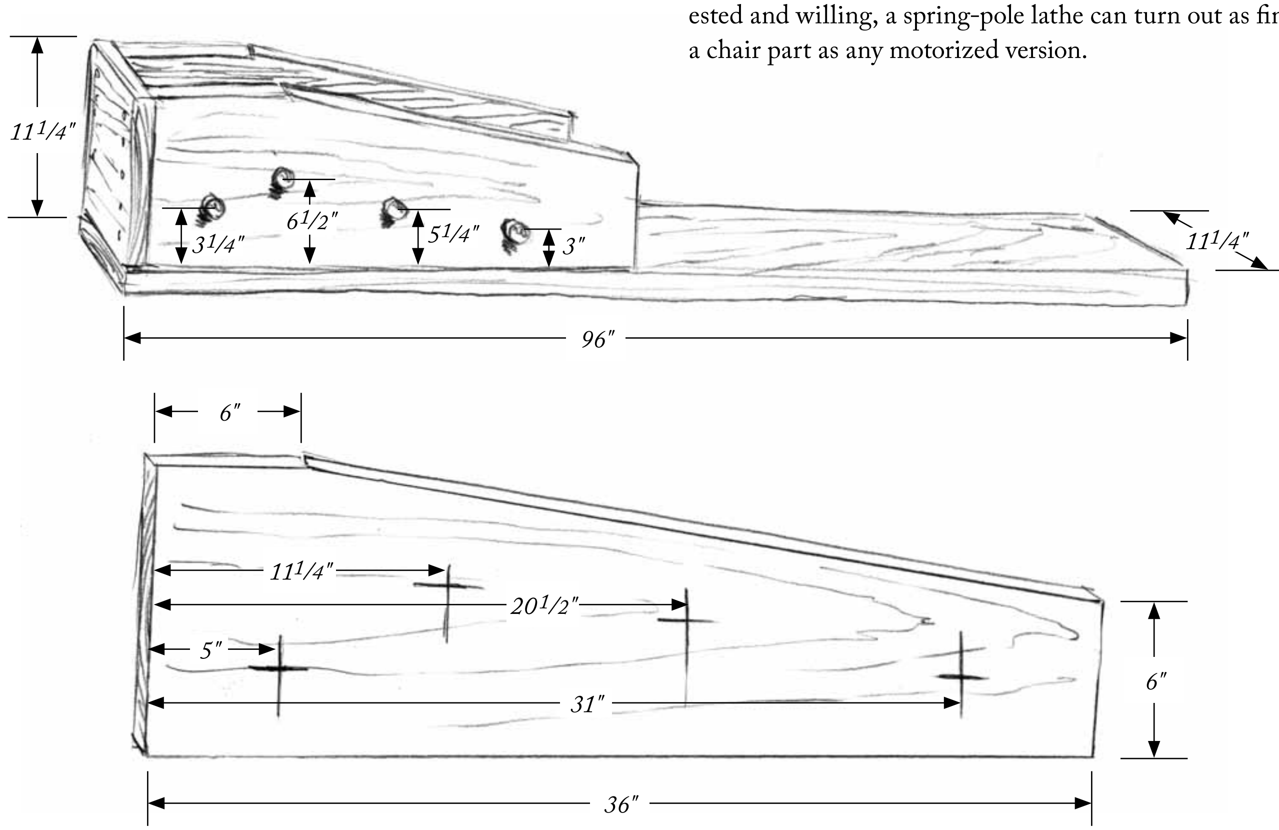



**FIG. 4.9** *Plan for my brake.*

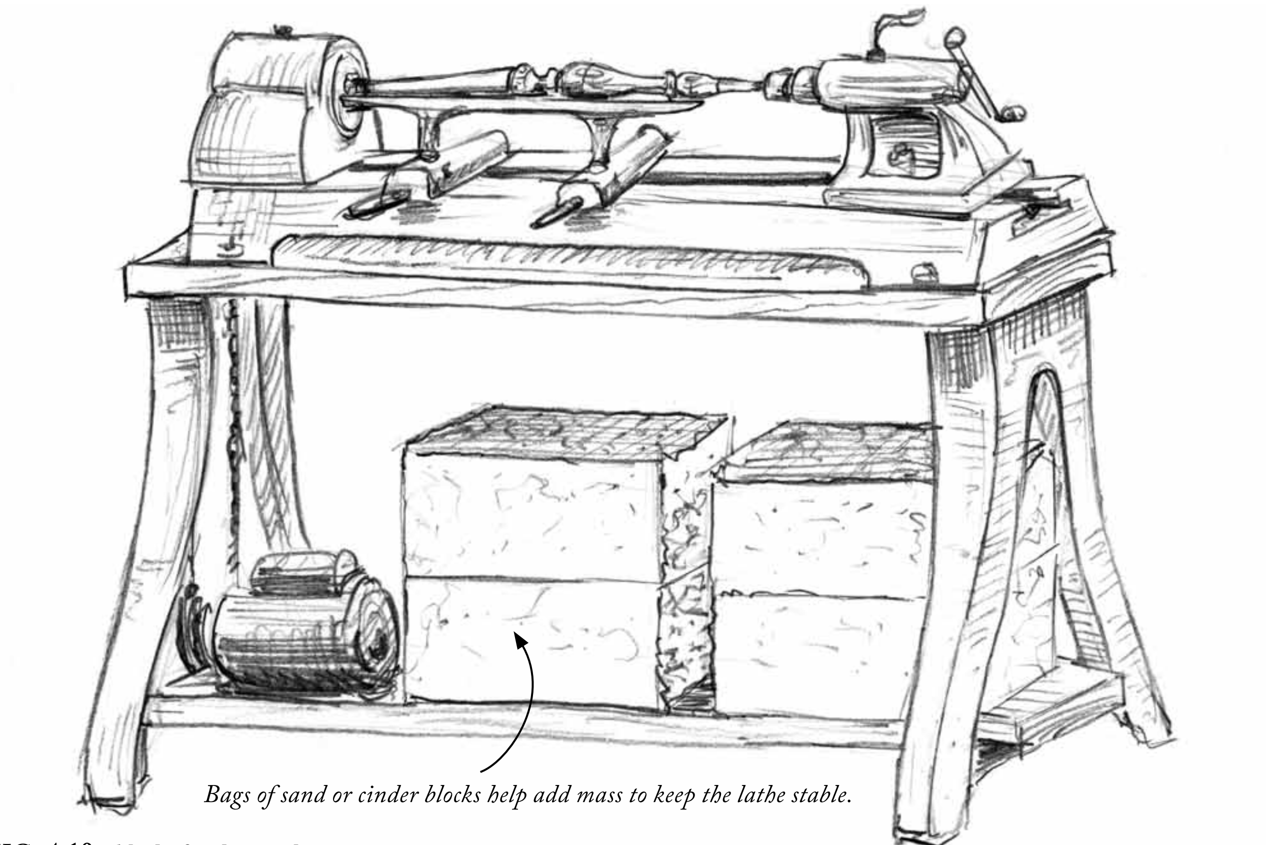


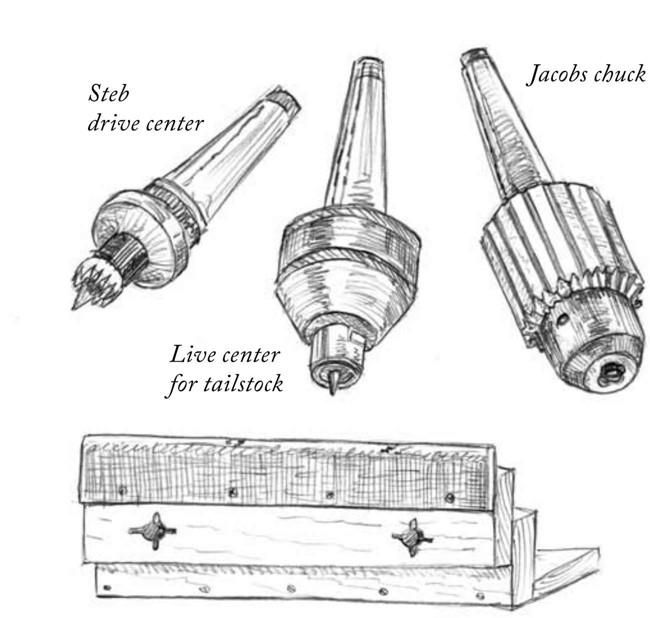

**FIG. 4.10** *A lathe for chairmaking.*

One lesson I took from my first lathe was that it doesn't take much to get a chunk of wood spinning so that you can cut it. Of course the quality of the lathe can make a difference. A good lathe has solid bearings and a smooth hum. The weight of the lathe is also a factor in the turning experience. The lighter the lathe, the more likely it is to produce vibration, especially on long, thin pieces.

That said, even lighter lathes will serve. I have turned the parts for all of my chairs on a 1959 Delta Rockwell lathe with a 24" tool rest. The longest piece that I can turn is 36", but most of my turnings are for legs, so a lathe that can handle 24" is fine. Before I bought the long tool rest, I made one out of mild steel and wood. My lathe has a stand with cast-iron legs and wood planks below for a shelf.

I keep cinder blocks below the lathe on the plank to add weight. I use a red anti-vibration link-belt to drive my lathe, which does a great job and can easily be custom-sized to fit any machine. If you are trying to reduce vibration, place a glass of water on the lathe bed and watch the ripples in the water change as you add weight. Bolting it to the floor and wall can also help. The need to stop the lathe to adjust belts for speed is cumbersome, and there have been times that I've considered upgrading to a heavier lathe, but my trusty ol' lathe certainly has kept me on my toes and taught me the value of sharp tools and light pressure. The amount of pressure that you put on the workpiece when cranking in the tailstock can also affect the tendency of the piece to vibrate. Too much pressure encourages thin pieces to deflect and vibrate. This can also overload the lathe's bearings and shorten their life.

There are a few essentials parts that fit into the head and tailstock. For years, I used a standard center in the headstock to drive the workpiece, but now I like to use a "Steb" center. This center has a circular part with little teeth that bite into the workpiece and a spring-loaded center pin. The spring-loaded pin helps me by holding the piece while I move it around to find the best location for the center. It can also help you learn to manage the pressure you use while turning. Tightening the centers




*Adjustable shop-made tool rest with mild steel.*

**FIG. 4.11** ***Some essential lathe accessories.***

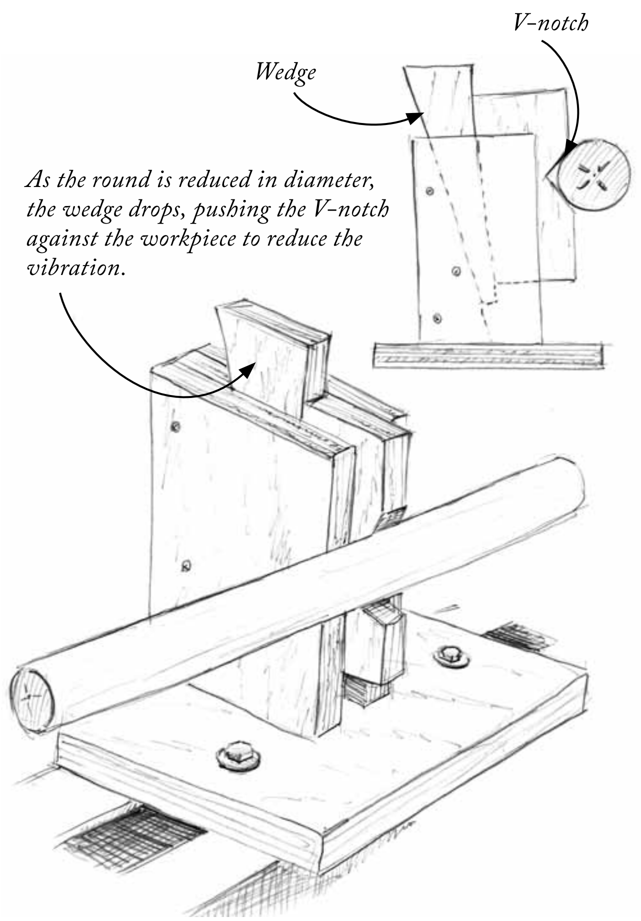



**FIG. 4.12** ***A shop-made steady rest.***

until the teeth barely bite into the workpiece will allow it to stop spinning if you use too much pressure or if you have a catch. It's a great way to practice when using the skew tool.

The other end of the lathe should have a live center with bearings that spin along with the workpiece. I've worked on lathes with "dead" centers that don't spin, and the friction between the workpiece and the metal can be a trouble spot that requires just the right amount of pressure and lubrication.

Another handy lathe accesory is a Jacobs chuck, which is basically a drill-press chuck that has a Morse taper that will fit in the lathe. I use this to hold drill bits and tenon cutters on occasion.

## Steady Rest

Vibration is usually a problem in the middle section of thin turnings, and not as much of a problem as you near the stable head or tailstock. If you are doing long, thin turnings, you might find a "steady rest" helpful, although sharp tools, a good order of operations and a little support from your hand can usually keep vibration to a minimum. The steady rest effectively cuts the length of the turning into two shorter sections, which can eradicate vibration. There are commercial steady rests available, but they are pricey and often get in the way of the turning. I prefer a homemade rest like the one shown at left. This rest opposes the pressure of the cutting tool, which is usually enough to keep vibration from beginning.

This rest can live harmlessly behind a turning until you need it and then, using gravity and a wedge, give support in the center of the turning. One great advantage of this appliance is that you can cut right in front of it, and the wedge will drop farther to keep the pressure from the steady rest constant. The contact point with the V-notch will leave a burnishing mark on the workpiece, or even a slight browning from the friction, so I keep it positioned on an area of the turning that can easily be cleaned up later with a pass of the skew.

As I have progressed as a turner and learned to keep my tools sharp and my cuts light, I've found that I rarely require the steady rest. When vibration does creep into my turning, I use the skew to create a new clean round and shave away the vibration-marred area from there.

The hand tools for turning are covered in the Turning Tools chapter.

## Band Saw

The band saw is not essential chairmaking equipment, but boy is it handy. My first band saw was a small Craftsman that was sold in the 1950s to the home workshop enthusiast. It was plenty of saw for my needs, and I only stepped up to my current 14" Delta with a riser block when I came across a good deal. The Craftsman is still functioning in the shop of a friend.

I use my band saw for cutting out the perimeter of the seat and occasionally for crosscutting parts. A bowsaw will also work for this. A band saw is only as good as its blade, tires, guides and friction blocks. There are lots of good resources out there for tuning a band saw, and tuning it is always time well spent. I usually abuse my saw a bit (crosscutting odd-shaped splits etc.) so I tend to keep a 1⁄2" blade on it. Narrow blades distort quickly. When I use the band saw, I always keep one hand on the table to guide the workpiece. This connection to the machine gives a great deal of stability as I make minor adjustments to the path of the blade.

These days, I've put my band saw outside of my shop space in the adjacent garage. I would rather be cold for the few minutes per chair that I use it than have the noise and dust (or dust collector) in my shop.

## Kiln

To folks unfamiliar with working green wood, my kiln must look absurd. It's like an oversized version of the Easy-Bake Oven that my sister made brownies in. I built a simple open box with plywood corners and lined the voids with 1"-thick reflective Celotex.

I have three lighting fixtures inside and, depending on the time of year, use various wattages to keep the temperature at 140°F at the top of the chamber (which is where I dry my legs' tenons). I've mounted a chicken incubator thermostat in the upper chamber to regulate the temperature.

The chamber is just large enough to fit my bending forms. At the top of the chamber are holes that I slip my leg tenons into to selectively dry them. The fifth hole ensures that the moisture-laden air has an exit when the other four are plugged with legs. When there are no legs in the top, I cover the openings to help contain the heat, once again leaving a small gap for egress of moisture. Fire safety is a great concern and should be considered in constructing a kiln. I have isolated the light fixtures from direct contact with the floor by mounting them on a steel crosspiece. The steel is the type used for framing walls. There is a screen and flashing barrier between the bulb chamber and the area for the wood to prevent chips or parts from getting too close to the bulbs. Common sense should guide you; look for any signs that reveal dangerous conditions.

Using the kiln is simple, especially if you are only running one batch of parts through it. At first, it is a good idea to limit the amount of air that can exit the kiln. This will create a high-humidity environment from the moisture that the wood is giving up. This helps ease the wood into losing moisture slowly without shocking the outer surface of the wood too much. Opening the door a couple of times a day to release the humid air and let in dry air is fine for the first day. Then, you can increase the opening for air to exit until you get a good flow of warm, moisture-laden air leaving. This is when the real change will begin. One easy mistake to make is to put green wood in with wood that you have already dried in the kiln. The dry wood will immediately begin to acclimate to the newly moist atmosphere by taking on the water. It is a better idea to remove the dry wood, place it in a dry place or a plastic bag, then return it to the kiln once the greener wood has lost moisture.

## The Steambox

There are many ways to make an effective steamer. My choices have been guided by cost, availability and flexibility. My box is simply made of 3⁄4" CDX plywood, set on an angle to drain, and a wallpaper steamer. The interior dimensions of my box are suited to steam a few pieces at a time. The interior measures 60" x 3" x 4", which is large enough for a continuous arm. When building a settee, I steam one half of the piece while the other half hangs out of the box. A rag stuffed around the piece plugs the opening. I bend the steamed half in the form and after a few days, I remove the piece from the form and steam the other side. Finally, I put the whole piece into the bending form. I suppose that I should just build a longer box, but I only make a settee about once a year.

Recently, I built a water-tight box around my steamer to catch any drips and funnel them toward a bucket. This box is screwed to the wall, which keeps my steamer handy but out of the way. My dog's food and water bowls fit nicely under the steamer now. More on the steambox in the Bending Wood chapter.

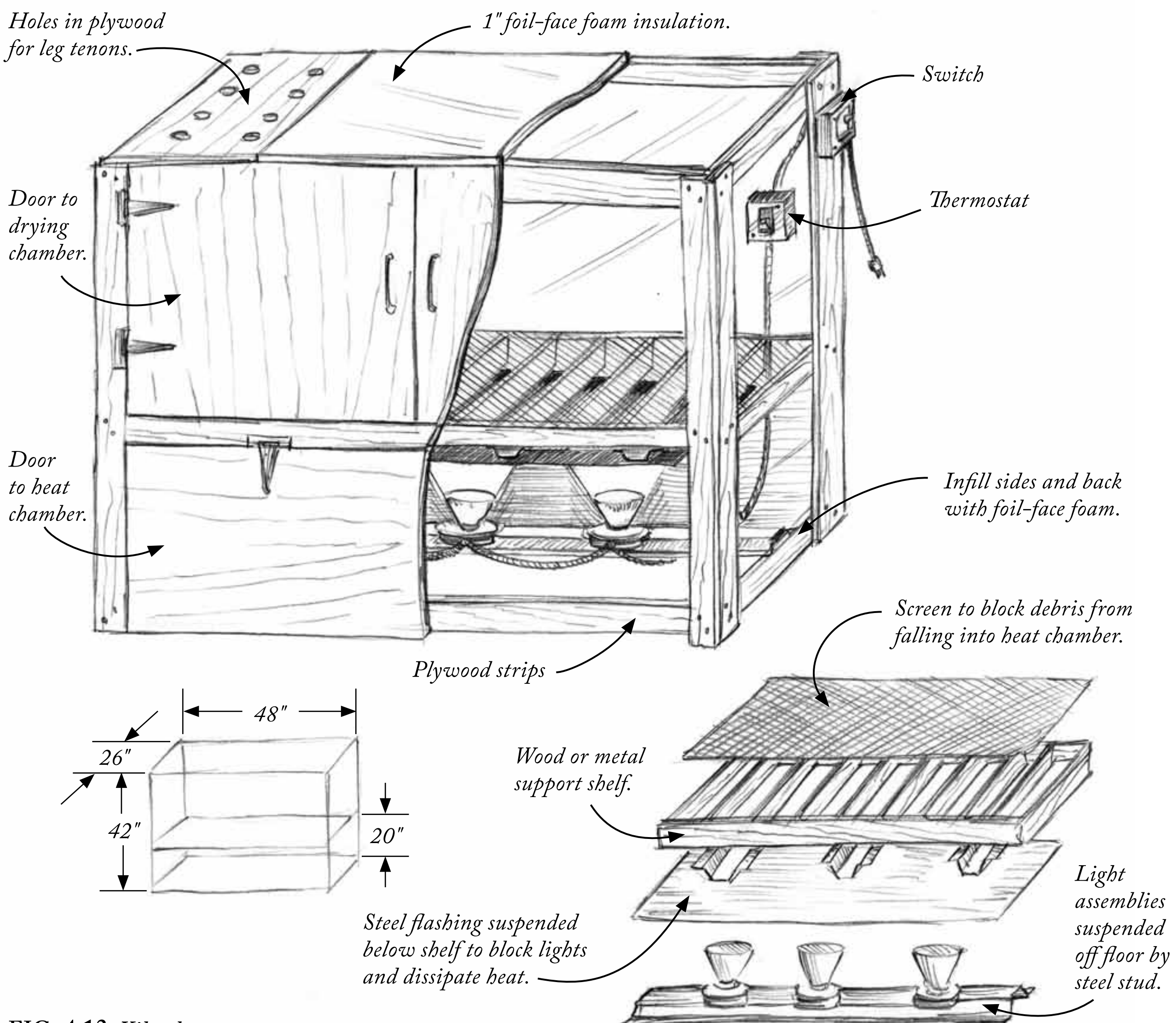


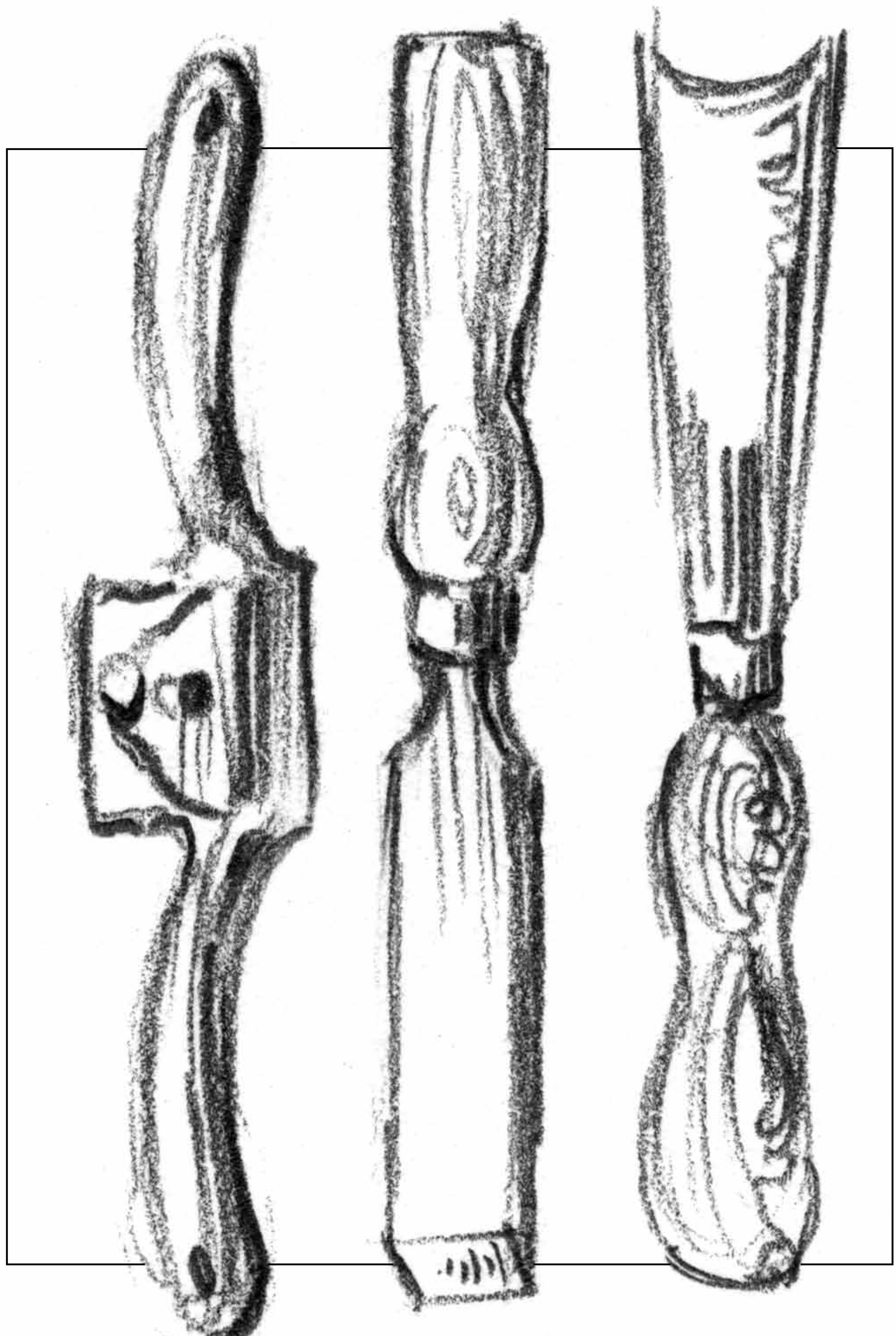

**FIG. 4.13** *Kiln plans.*

## Organization

I wish that I could claim to be highly organized, but alas, like most folks, the next task at hand often carries more interest than putting tools away. Clutter is dangerous and inhibits productivity. I try to remind myself that woodworking is merely a pleasant distraction from my real job, which is putting away tools and cleaning up.

For choosing where to store tools, I have a tip that works well for me. I put tools away in the first place that I would look for them when I think of them. This is different from where they "should" go. How many times have you put something in a smarter or safer place, just to forget where it is? It's like losing it on purpose! Just put it where you'd look for it and you'll always know where it is. Of course, if you start with a good plan and spend the time to house your tools in a smart, safe place to begin with, you will get the best of both worlds. A little training and your shop will function smoothly.

There is a special feeling when working in a shop that is well-tuned to your needs and processes. It easily becomes a favorite refuge. I always enjoy having visitors to my shop and seeing it through their eyes. It's as comfortable a place to hold a conversation as it is to shape wood, which I view as a worthy achievement.



# 5

# Hand Tools: Sharpening & Use

Learning about wood as a material for building furniture is half the battle, the other half is understanding how to use and maintain the tools that cut it. This chapter includes basic sharpening information as well as details on how the configuration of the tool and blade changes how it works. Specific details for tuning and using the tools are covered in the chapters where each tool used in the chairmaking process is introduced.

When I began working with hand tools, I looked through my stack of woodworking magazines and read that a handplane could take feathery shavings and leave a superior surface. This confirmed my desire to employ hand tools as an efficient and satisfying means to an end.

So I went to the hardware store, bought a plane, took it home and pushed it across a beautiful piece of cherry. Of course I mangled the surface. My inspiration was as damaged as the cherry. I thought the configuration of the plane would somehow magically bend the wood to its will, that by submitting to the wisdom of the past, my experience would automatically be transcendent. I had no understanding of the importance of the sharpness of the blade or the condition of the plane. I later learned that what they don't tell you on the box is that handplanes, or most hand tools for that matter, are sold as kits.

It is up to you to tune and sharpen the tools. Some expensive tools need little tuning, while cheaper ones might require hours of work and still not perform well.

Now that I work primarily with hand tools, I've found that much of what I do is actually metalworking. As Abraham Lincoln supposedly said, "Give me six hours to chop down a tree and I'll spend the first four sharpening the axe."

The basic idea is to get a sharp piece of metal to cut a chosen piece from a chunk of wood. It's impossible to separate the work that a tool is intended to do from the condition and shape of the edge that will do it. The wood basically sits there while I decide what shape of metal or metal housed in a jig (such as a handplane) will take the desired cut.

There is a lot of information out there about sharpening, in fact, likely too much. This is where the question turns from, "Where to start?" to, "Where to stop?" And, "When is the tool sharp?" Of course, the condition of the edge simply needs to meet the task at hand, but I have a simple test that I like to use to evaluate it. Any tool that will shave the end grain of a soft pine board and leave a smooth, waxy surface is sharp. Soft pine will tear out with anything remotely dull.

Why this test? By cutting the pine versus shaving hair etc., I can see the condition of the entire edge – not just that it has sharp areas, but that it is completely sharp. Dull spots or nicks show up on the cut surface as white streaks. This is essential because many of the finished surfaces of my work are straight from the blade with no sanding. Also, a sharp tool is a joy to use and, in many instances, is the only one that will work.

Often, just pulling a blade along the end grain will not give clean results, even though the blade is plenty sharp.

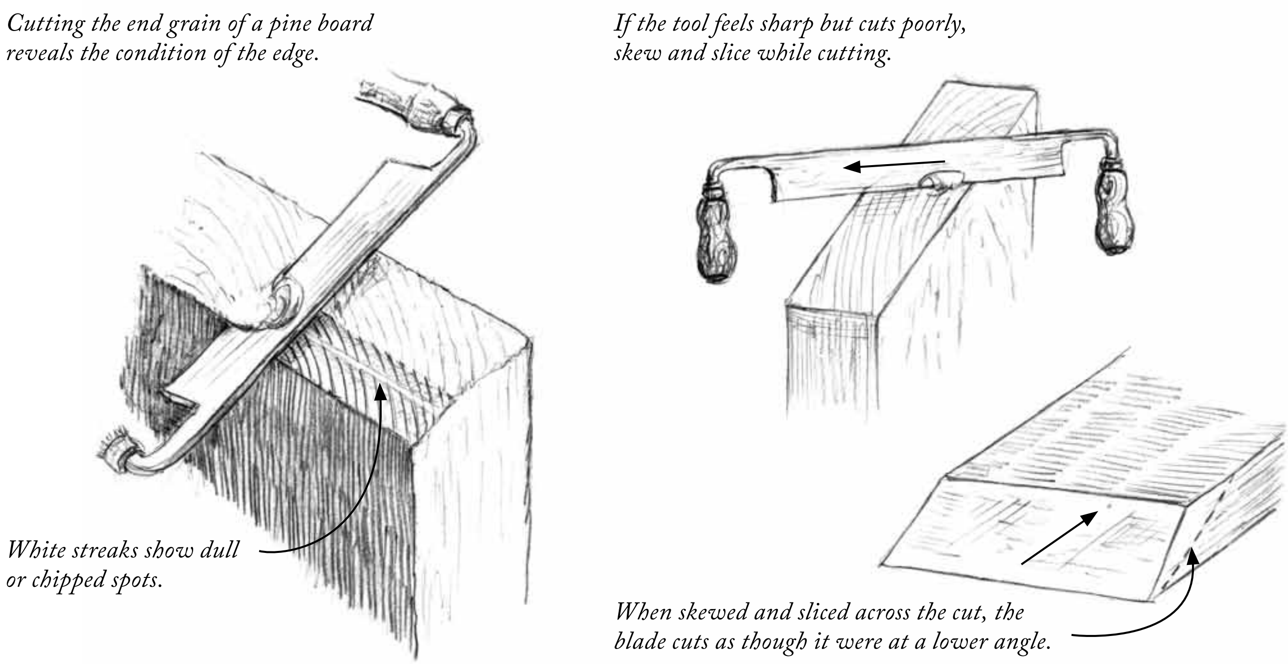



**FIG. 5.1** ***Cutting pine end grain gives a good view of the condition of the edge.***

This is because the angle at which the blade is sharpened is not low enough. A high cutting angle results in a rough surface. If you suspect this is the case, try skewing and slicing the blade while cutting, which effectively lowers the cutting angle of the bevel. You will immediately notice a change in the surface quality. If the blade is sharp enough to shave hair but it still doesn't give a clean cut on the pine, you might consider lowering the bevel angle. Somewhere around 27° inclusive seems to be a good angle for most tools, and gives a glassy-smooth end-grain cut when skewing and slicing.

## Sharpening Equipment

Even though I am frugal when purchasing most shop equipment, the one type of tool that I am most comfortable spending money on is sharpening equipment.

Some things to consider are: a quality set of waterstones, a piece of glass with sandpaper or drywall sanding screen (for keeping the stones flat), a grinder with aluminum-oxide wheels, a quality aftermarket tool rest for the grinder, and a piece of leather and honing compound for a strop. As for the grit of the stones, I like one coarse stone for rough shaping, such as a #1,000-grit stone, plus a #4,000 for polishing and an #8,000 for getting a mirror finish. There are combination stones that offer a less-expensive option. Usually, the coarser stone gets worn away first, and I buy a new coarse stone and keep using the finer half of the combo stone for fine polishing.

I recently purchased a diamond flattening plate to true my stones and found it to be very effective not only at doing the job, but at encouraging me to do it because I can flatten the stones when they are still in the holder. Its only drawback is the expense. No one enjoys flattening stones. But unless they are flat, they will undo the geometry you have diligently created. Before having the pricey diamond plate, I used a drywall sanding screen on a piece of plate glass. It worked great, and the grit washes out of the screen easily. I try to do my finer stones first so that I don't contaminate them with coarse grit. The only problem with this technique is that it adds a step that is out of the normal flow of sharpening, so it takes more discipline to keep up with it.

There are many types of abrasives that you can use for sharpening; the choice depends on your budget and interest. I have used oilstones, which I found cut too slowly, and sandpaper on glass, which can be effective but a hassle to change out the sheets. I prefer waterstones. They cut fast and the particles break down with use to become a finer grit. This allows the stone to polish to a finer scratch pattern than it's rated for.

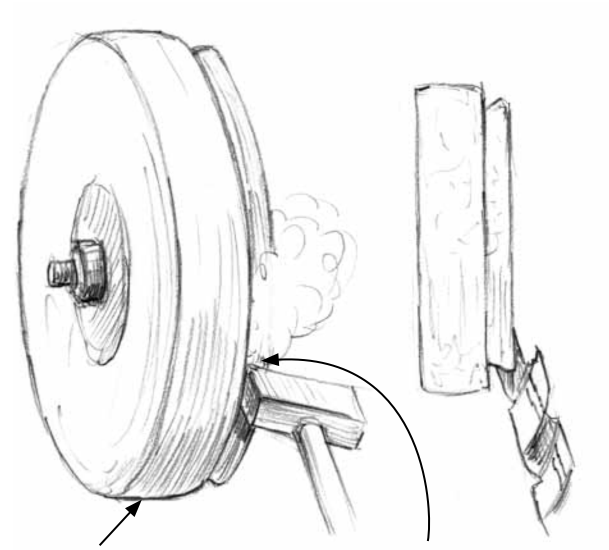
A couple of other tools that I find effective are a high-speed buffer with a fine Bear-Tex wheel, and a hard felt wheel. The Bear-Tex wheel is a rubberized abrasive wheel used for deburring and polishing metal in the machinist trade. Bear-Tex is like a cross between a buffer and a grinder. It will shoot sparks and remove enough metal to gently shape the tool, so care must be taken. It's great for turning a burr, which I then remove on the rouge-impregnated felt wheel. Of course, maintaining the edge geometry for a plane blade is nearly impossible with these tools, but for gouges and tools with a slight rounding, they work great. I use a green .05-micron compound on the felt wheel.

On my grinder, I use white aluminum-oxide wheels in two grits. An #80 grit for coarse shaping and #120 grit for fine grinding. There are possibly too many options for grinding machines, but the bottom line is they need to feel solid in use. Regardless of the machine you use, I recommend getting a cheap garage-sale chisel and eating it up at the grinder. Learning the pressure to use, the rate at which material is removed, and the heat that builds in the process can only be taught by experience, and using a valuable tool is simply a waste.

Next to my grinder, I keep a tub of water in which to dip my tools that become hot during grinding. During grinding, the steel should never get too hot to touch. If it does, it should be quenched. If a high-carbon steel tool starts turning blue, I dip it immediately to stop the softening effect of the excess heat. If this happens consistently, I use less pressure when grinding, and I dress my wheel more often. When grinding high-speed steel you should avoid quenching, which can cause microscopic stress cracks; but rest assured: anything below red hot will not damage the steel.

Keeping the wheels dressed is essential to cool and even grinding. I dress mine often with a flat diamond dresser, being careful not to breathe in the dust. This dresser removes the worn grit and embedded metal that rubs against the steel and creates the heat. I like to dress my wheels with a slight camber so I can always control the pressure and location of the grind.

I also dress a special profile into the right side of my wheels for grinding drill bits, but more on that later. Adding dust collection to your grinder and/or wearing a respirator (not a little dust mask) is a good idea. The particles that are freed as the wheel breaks down are very sharp and have no place in your lungs!



*A cambered surface is good for general sharpening.*

*Dressing a notch in the front of the wheel with a diamond dresser for sharpening drill bits.*

**FIG. 5.2** ***How I dress my grinding wheels.***

When I began sharpening tools, I spent a great deal of time at the stones. Over time, I've come to use the grinder to get the best grind and only a few strokes on the stones. When the grind is maintained, the area of metal to be honed is small and is polished quickly. The strop keeps the tools in shape, unless they can't be rounded, and then a quick return to my finest stone often does the job.

I have become a fan of diamond paste, which can be used on any clean base, such as freshly planed wood, a dowel or even a blank of wood in the lathe for power stropping. I also get great results with diamond paddles, hones and paste. With a proper sharpening setup, everything else falls in place. The easier sharpening is in your shop, the more likely you are to actually do it and enjoy the benefits of truly sharp tools.

For tools that require flat backs, I've taken to using a sanding wheel in my angle grinder to gently hollow out the back of the tool until I can easily hone the entire back flat. This replaces a lot of laborious rubbing and wasting of my stones.

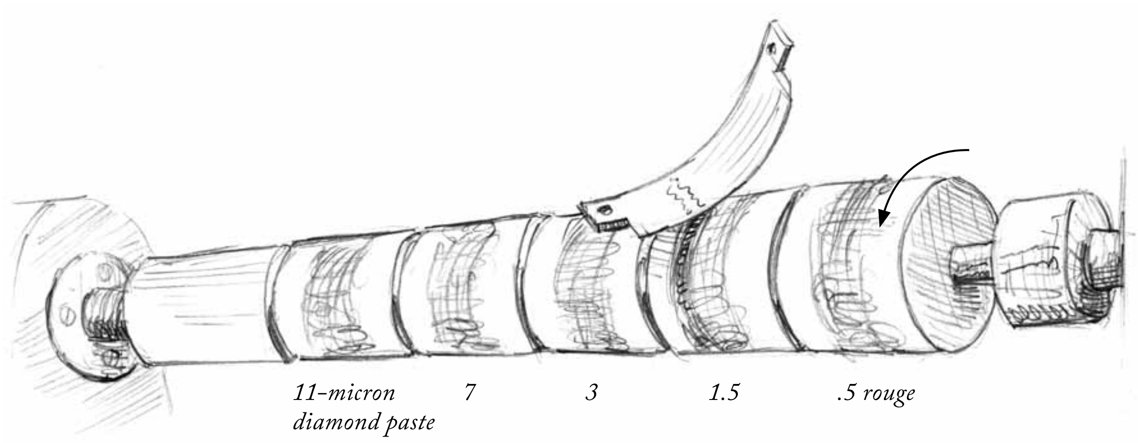



**FIG. 5.3** ***A lathe-powered sharpening setup.***

Lately, I've been using a spare lathe with a diamond-paste-charged piece of maple chucked in it to help maintain my curved tools. By separating sections and applying a sequence of grits down to .5 micron, I find that I can get a razor edge quickly and get back to work.

I run the lathe at about 1,000 rpm and am careful to make sure that the edge of the tool is always facing away from the rotation to avoid catching. If I am in a hurry and need a drawknife tuned beyond what a strop can do, I will run it against the wood and diamond paste on the lathe and the results are great. (Doing this repeatedly can round over the edge too much, so it's best to stick to more controlled methods for most drawknife maintenance.)

## The Steel

Modern technology offers us blades with astounding quality control. During the 18th and 19th centuries, the difficulty and expense of making high-carbon steel led makers to laminate a small portion of the prized steel to a larger piece of soft steel or iron. While the hardened edge could be high-quality steel, it's easy to romanticize the quality. I am guilty of this. I love buying drawknives with "warranted cast steel" stamped on them.

There is something about getting the best that was made at the time, and I have found many examples of old steel that rival or surpass many of my modern tools.

My expertise on the topic of steel isn't as deep as with some folks. What I think is important to understand is that beyond the quality control of the production of a piece of steel, its characteristics are always a compromise. Plain high-carbon steel is easy to sharpen to an incredibly sharp edge, but the edge wears more quickly than with some of the alloy steels available today. But for the longer-lasting edge of a steel such as A2 or high-speed steel (HSS), you must work harder (or with diamonds) to sharpen it, and it may never get quite as sharp. I gravitate toward simple high-carbon steel for the speed with which I can get a razor edge.

## Sharpening Basics

Sharpening is simple. An edge is the intersection of two surfaces. Polish one surface until a tiny burr forms on the opposite (polished) surface, then get the burr to fall off cleanly by polishing the opposite surface. Simple, right? Then why is it so elusive and mysterious?

First of all, besides correctly establishing and removing the burr, there is the geometry of the edge to consider.


**FIG. 5.4** ***Old steels are not necessarily better than quality modern steels.***

If I've followed the sharpening sequence correctly, the edge will be razor sharp, but there's still one question remaining: Does the edge have the right geometry to do the job?

The position at which the blade is held, the hardness of the wood, the quality of the steel and the type of work that it's performing will dictate the correct bevel angle. For example, I keep a low angle on my travisher's blade. Its blade is tempered to be more hard than tough, which could make its thin edge brittle, so I am careful using it around knots so the edge doesn't chip. While a hard edge sounds like a detriment, the low angle and hard edge work beautifully when carving the end grain at the back of the hollow in a seat.

This sort of evaluation must be made for each tool and application, although most often there is a range of angles that will succeed. The angle that the bevel is ground will be a compromise between being thin enough to take a shaving and being thick enough to cut without crumbling or chipping. Finding the best angle, especially with the variations in the steel of antique tools, can take time.

Second, there is task of maintaining the proper angle during honing. This sends many folks reaching for jigs to keep the angle of the blade constant on the stone. I started that way. And as a way to learn how sharp is sharp, it's a good solution. I've even devised a honing guide for my drawknives that I find useful. In time, I've limited my use of jigs, having learned that there are steps, such as hollow grinding, that make most honing tasks much simpler.

Sharpening is an abrasive process much like sanding. The metal is shaped with a rough grit (the roughest being the grinder) and then with successively finer grits until the two surfaces that make up the edge have a mirror finish and the edge where they meet has the smallest radius possible. When viewed under enough magnification, every edge is made up of tiny peaks and valleys; the goal is to diminish the variance between the two. Edges with dramatic peaks of sharpness might feel sharp and work for a few strokes, but those peaks tend to break off easily, leaving a prematurely dulled edge. The finer the edge is, the sharper it will stay.

For major reshaping or hollow grinding an edge, I use a grinder. I started with an old hand-cranked grinder that I picked up for $5 at a garage sale and ran every chunk of metal that I could find against it. This might sound silly, but working productively with a grinder takes a light touch that can only be gained with experience, and

*Under magnification, a sharp edge is as ragged as the scratches left by the last grit used to hone it.*

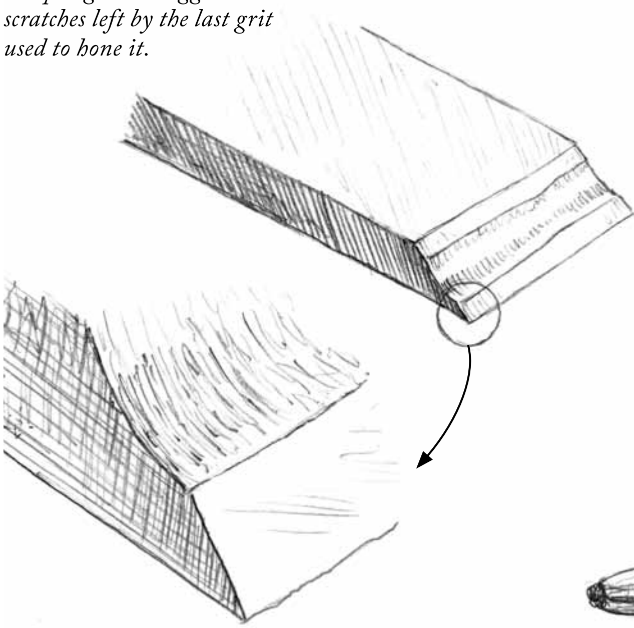


**FIG. 5.5** *Every edge has a series of scratches made by the sharpening media. The finer the scratches, the more durable the edge.*

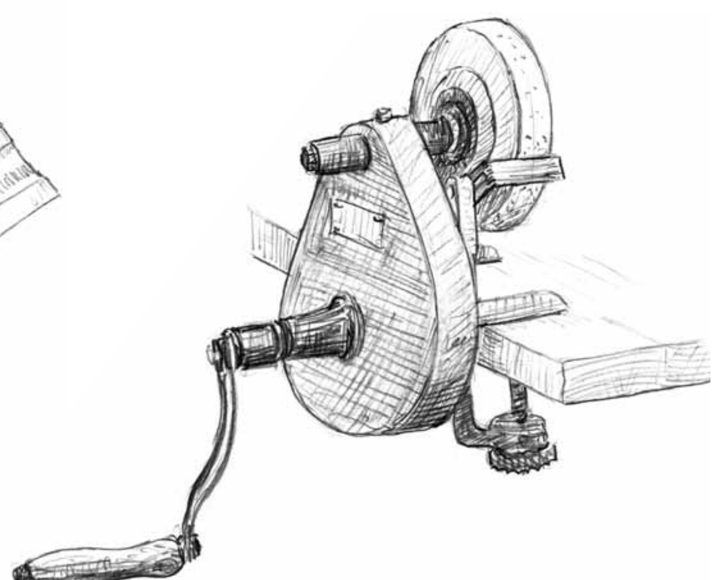


**FIG. 5.6** *A hand-cranked grinder.*

burning up expensive blades isn't the best way to go about it. Some folks get by without a grinder, but I think it's essential equipment.

Using my hand-cranked grinder taught me about the cutting action of the wheel and a gave me a feel for the heat it produces. Surprisingly, once you get accustomed to holding the tool in one hand and cranking with the other, the process can be quite fluid. It may be helpful to think of the grinder as being similar to a saw. Excess force isn't helpful. Like sawteeth that can only cut so much on each stroke, the grinder can only cut so fast. Any pressure beyond that causes the wheel to clog and the blade to overheat, risking losing its temper. (Yes, this is one of my favorite phrase origins.)

Now I use a grinder with a motor attached. I have both a slow-speed (1,750 rpm) and a high-speed grinder (3,600 rpm) The cool-running aluminum-oxide wheels that I use help prevent overheating the edge, which can cause the steel to lose its temper and soften. But I have also found the high-speed grinders tend to produce less drag on a tool as they grind, which increases my sensitivity during the cut. This can also help resist overheating, as long as the wheel is kept well-dressed and unclogged. I use a diamond dresser to expose fresh grit and true the surface of the wheel.

While you might be able to get a sharp edge without a grinder, it's often at the expense of the correct cutting geometry. When a flat bevel is pushed on stones for honing, the larger surface area in contact with the stone causes increased friction. This makes it more difficult to resist rounding the edge over, especially if you push and pull the tool on the stone. When transitioning from pushing to pulling, it's easy to tip the blade, slightly rolling the edge. Depending on which tool you are sharpening, this can be counterproductive and difficult to correct without a jig and lots of elbow grease. I try to spend my time working as little metal as possible.

What's so bad about rounding the bevel? A rounded bevel will rock on the stones and make contact on only a small portion of the blade. This makes consistently polishing the cutting edge difficult and usually exacerbates the rounding until the tool performs poorly, regardless of how sharp it is. The wasted strokes that don't contact the cutting edge and the degraded geometry make a task that most of us avoid even less efficient. My goal is that every swipe on the stones counts and is controllable.

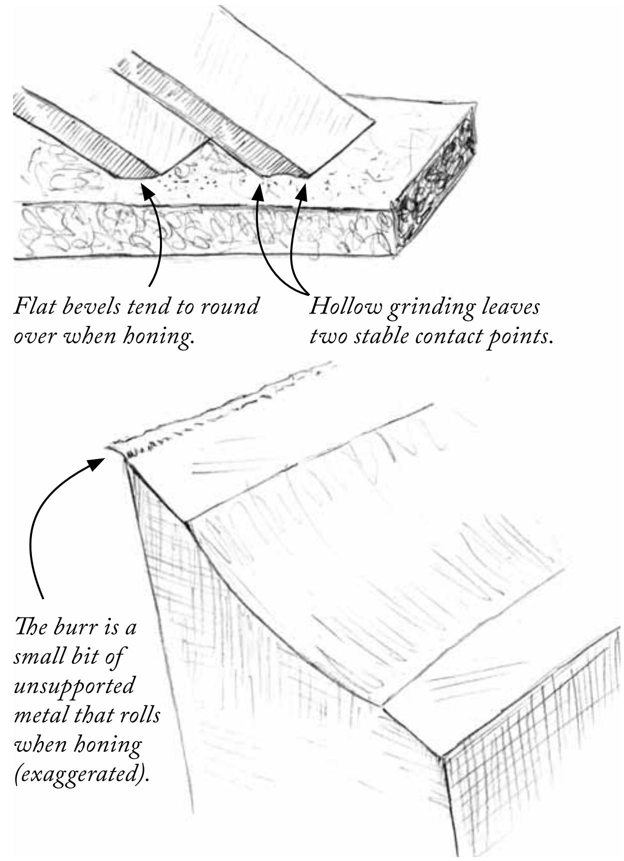



**FIG. 5.7** ***Hollow grinding makes it faster and easier to turn a burr when honing.***

The concave shape left by the round wheel grinding on the bevel of the blade gives me this control when I take the edge to the honing stones. The smaller surface area and stability of two contact points makes honing easier and faster. While some woodworkers swear that having larger flats on the bevel is advantageous, I prefer the hollow to be large for the easy and accurate sharpening that it encourages.

After establishing the shape of the edge with the grinder, I use the stones to polish the surfaces and remove the burr from the edge. I can't stress enough the importance of getting the burr to drop off the blade cleanly. Most problems that I see with folks sharpening is a lack of attention to the burr.

The burr is simply the tiny, unsupported bit of metal right at the edge of the tool that bends over as you abrade the surface. If you can't feel it with your fingertip, try drawing your fingernail off the edge to see if it catches. There is no benefit to having a large burr; it just means that you removed more metal than necessary, so I strive to detect the smallest burr that I can make.

As the surface gets polished to a higher sheen, the tiny bit of metal connecting the burr to the edge gets smaller and more brittle, until the burr falls off. Getting the burr to drop off cleanly is a large part of establishing a fine edge. If the burr seems to roll from the front to the back of the blade, never falling off, it's a sign that the steel is too soft. This could be due to improper heat treating or grinding. If the tool is new it could be a sign of surface decarburization that will go away once you grind deeper into the steel. Decarburization is caused by oxygen in the forge fire bonding to the carbon in the steel and stealing it away, leaving a layer that no longer has enough carbon to harden properly.

## The Sharpening Sequence

The easiest shape to learn to sharpen is a "flat" shaped bevel, such as on a chisel or a plane blade. This bevel has two perfectly flat surfaces that meet to form the edge. The type of cut that this edge can take, when not housed in a plane or a jig, is limited to chopping and paring. The flat geometry of the edge causes the tool to dig. When used in a plane or spokeshave, the blade will take a shaving related to how far the blade extends past the sole. Some tools, such as a travisher, are also sharpened with a flat cross-section, but they can take cuts of varying depth depending on how the tool is held. Learning to sharpen a thick blade is helpful because it more easily registers on the stone.

The basic sequence for sharpening most chairmaking tools is the same, with the exception of tools used "freehand," where an added step of buffing or stropping the edge creates a slight rounding. This shaping, sometimes called "dubbing," allows the tool to ride on the surface of the wood without digging.

But didn't I say that rounding the edge is not a good idea?

That's right – for most plane and chisel sharpening. Any rounding on these tools is a bad thing because it changes the cutting angle slightly and makes resharpening more difficult. But for tools such as drawknives, carving gouges and inshaves, a slight dubbing is essential to their performance. It is important to keep the dubbing to a minimum, and for most of the sharpening process, these

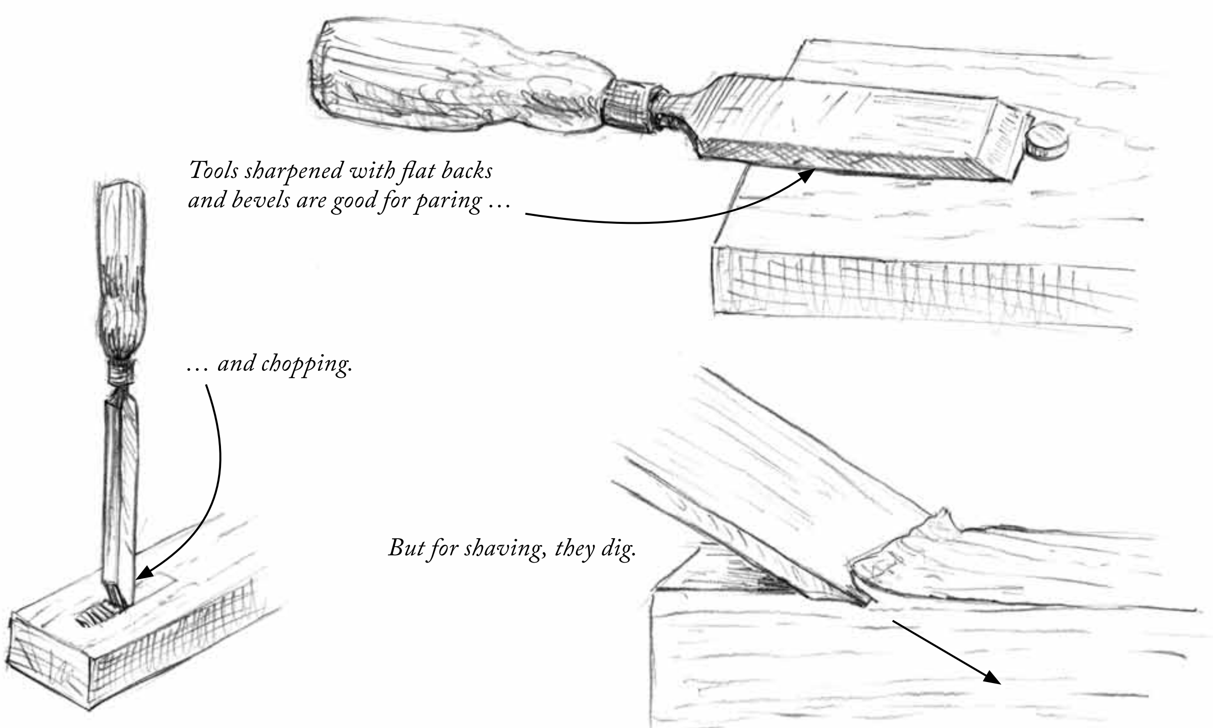



**FIG. 5.8** ***The advantages and disadvantages of flat cutting surfaces.***

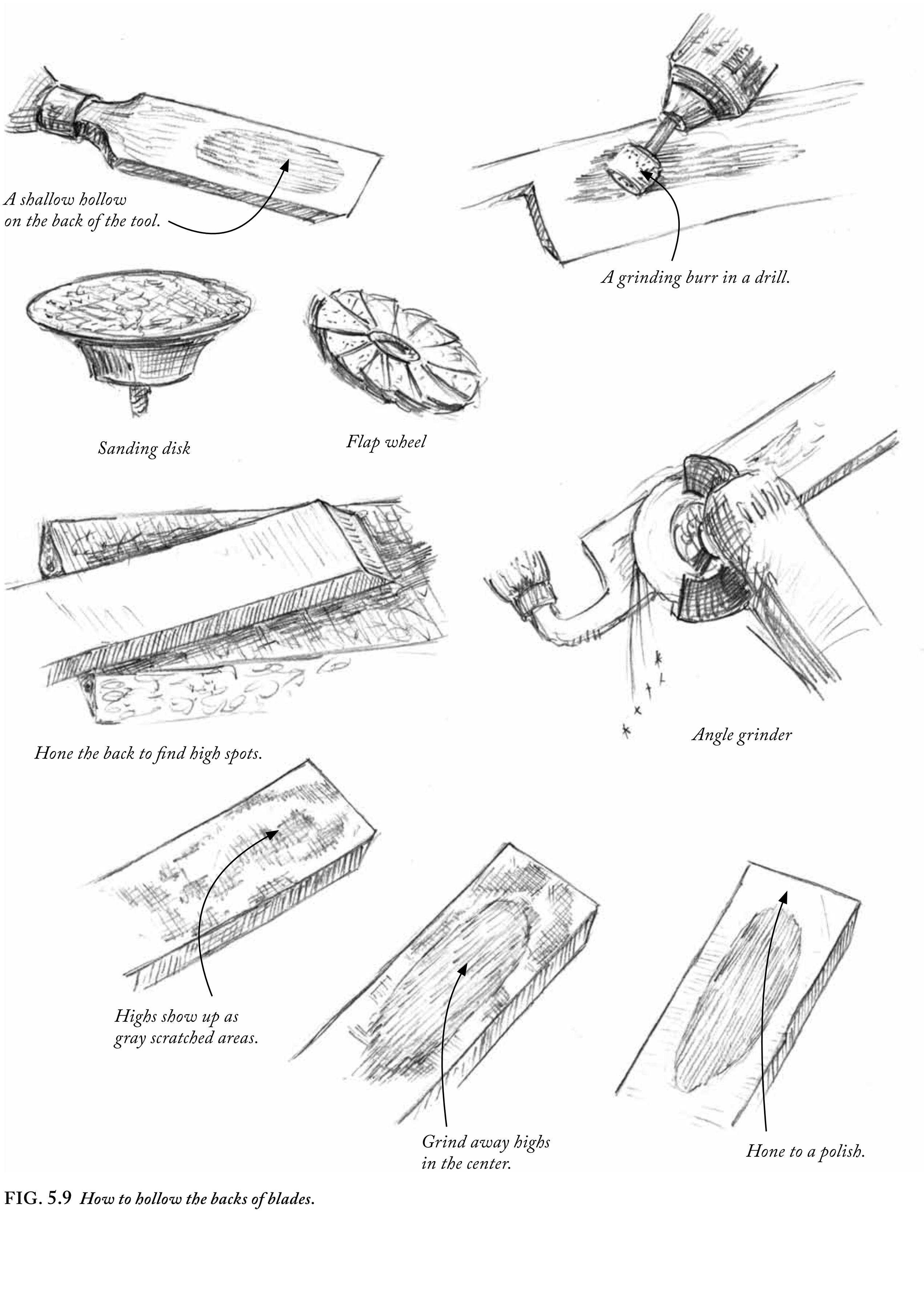



**FIG. 5.9** ***How to hollow the backs of blades.***

tools are dealt with exactly like the sequence shown below. I'll show the process for dubbing a blade after describing the sequence for sharpening non-dubbed tools.

## Flattening the Back

The first place that I start with any tool when I first get it is the back. A flat back will make honing much easier, but it's generally a broad surface and rarely flat. Here, I take my cue from Japanese toolmakers and I slightly hollow the backs of my blades. This means that I have less material to remove to get the surface flat and it allows me to remove high spots more aggressively. The back of the tool only needs to be flat for the first 1⁄8" or so behind the cutting edge – the rest doesn't do anything, so the material removed won't be missed. The depth of the hollow should be minimal so that repeated sharpenings of the back will increase the amount of flat steel near the edge at a rate that will coincide with the bevel as it recedes.

I've tried all sorts of way to hollow the backs of tools. First I tried the stationary grinder, which is too aggressive and hard to control. Then I used small grinding burrs in a drill, which are easier to control but much too slow. Finally, I found the sanding wheels that are used with angle grinders. These wheels are either a single sheet adhered to a plastic disc or layers of sandpaper-type abrasive that overlap in a circle. These allow great control, plus the speed and finish are fantastic. While an angle grinder might seem far out of step with "traditional" woodwork, I've found that it is actually the key to bringing my older tools up to speed. I no longer reject a tool because the back looks like it will be too much work to flatten, perhaps to my detriment!

The first step is to rub the back of the tool on my most aggressive diamond stone or sandpaper on glass. This gives a good picture of where the high spots are and how much material needs to be removed. Then I remove the high spots with the angle grinder, keeping about 1⁄4" back from the cutting edge. Then I return to the stones. I repeat this process until the flat reaches all the way to the edge. Then I polish it to a mirror finish on my finer stones. Lightly coating the working portion of the tool with oil (I like camellia oil) will help keep the edge from oxidizing during storage. Much of the wood that a blade cuts has caustic elements in it – wet wood is even worse.

Sadly, the edges of antique tools are usually quite rounded, so in most cases, I take a two-pronged approach. I start by flattening the back to a reasonable

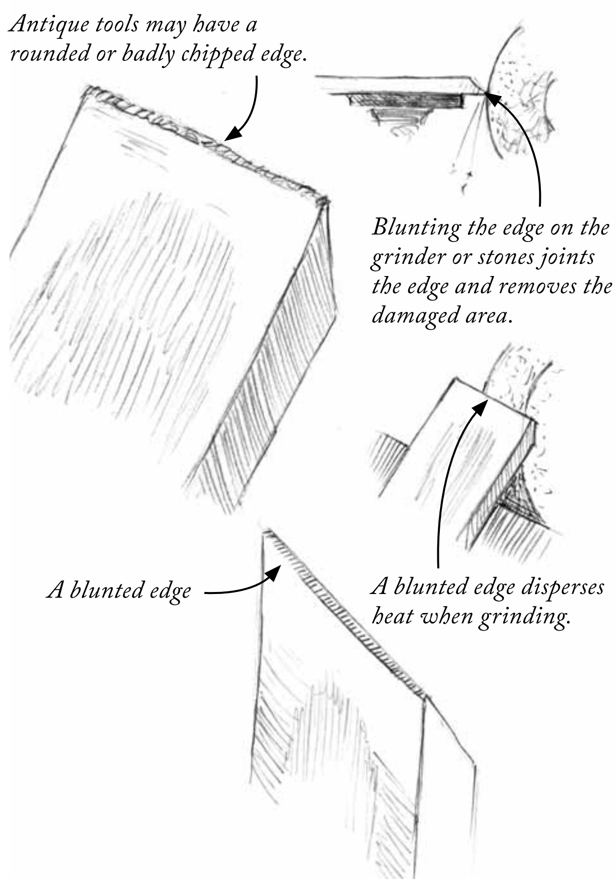



**FIG. 5.10** ***Blunting the edge to shape it and remove rounding.***

level (basically, when I get diminishing returns on my effort), then I blunt the edge on the grinder or stones to eliminate the rounded area. This might seem like a drastic measure, given that the end goal is to sharpen the edge, but once you become comfortable grinding, it proves to be a fast and effective way to rehabilitate a blade.

Blunting also gives you a chance to joint the edge, making it straight. Plus, the thicker edge disperses heat more easily, which reduces the risk of burning when you are reshaping the bevel on the grinder.

## Grinding the Bevel

The profile of your grinding wheel changes how you use the tool. Most wheels arrive with a flat surface and wheel dressers can be used to maintain that profile. However, I prefer a slight crown on my wheels, which helps me control the point of contact more easily when grinding freehand.

A slightly rounded wheel also suits the natural tendency of the wheel to go out of flat anyway. I always rest the wheel dresser on the tool rest when shaping the wheel to get a smooth, even surface. This is important. It helps the wheel run cool and reduces the amount of resistance and vibration that you feel. Dress the wheel whenever you see shiny black streaks on its surface, which is metal from the blade that has become embedded in the abrasive. Otherwise, you are just rubbing metal on metal, which not only hampers the cutting action, but increases the heat.

Balancing your wheels is an important part of using a grinder. Each wheel and spindle are going to be slightly eccentric, and aligning the wheel and spindle so that their wobbles cancel each other out is essential to smooth grinding. To balance them, mount the wheels and turn the machine on. If the wheels have a wobble, turn off the machine and loosen a nut on one of the wheels. Then, rotate that wheel one-eighth of a turn on the spindle while keeping the bushings in place. Retighten the nut and check it again with the machine running. If there is no "sweet spot" found with this method, try rotating one of the retaining washers and repeating the process. A little patience usually pays off with a true-spinning wheel. (There are also commercially available wheel balancers that I have no experience with.)


**FIG. 5.11** ***The blunted edge can guide your grinding and protect the edge from overheating.***

Grinding the bevel not only creates a helpful hollow grind, it gives you a chance to change the cutting angle. If the tool has already been honed and you wish to maintain the same angle, set the tool rest so that the grinding wheel contacts the bevel in its middle. If you want to make the bevel longer (thinner), contact the wheel at the rear of the bevel. If you wish to make the bevel shorter, contact the wheel at the front of the bevel.

If you do contact the bevel too close to the front, you risk having heat build up and ruining the temper because a thin edge heats faster than it can disperse the heat. In this case, consider blunting the edge slightly. I usually only blunt the edge when the blade is nicked or needs a major reshaping.

A blunted edge also makes it easy to see if you are grinding evenly along its length. The edge should be even. Regardless of whether the edge is blunted, I don't grind until a burr is turned; that risks overheating and mis-shaping the flat edge. Instead, I get close then use my waterstones to remove the last bit of material. Usually, the flats made by honing on the stones will also point out any uneveness in the grind, which I can quickly remedy by returning to the grinder.

When grinding, I hold my elbows tight to my body and move side to side, swaying from my knees to keep the motion and position of the bevel consistent.

The usual mistake when grinding is to apply too much pressure when abrading near the corners of the blade. This is because the amount of pressure appropriate for the blade in the middle is concentrated, but increased when you grind to the corners and only part of the blade is on the wheel. Focus on the working the middle of the blade, and the corners tend to take care of themselves.

One of the best pieces of advice on grinding that I've heard came from Greg Pennington: "Grind like you are trying to sharpen a feather." The grinder is a light-touch tool, regardless of how much metal you want to remove.

Once the grinding has reduced the blunted edge to about 1⁄64", I head to my coarse stone to begin honing. After the initial honing, I may return to the grinder to refine the grind.

## Honing

Honing requires dead-flat stones. Stone maintenance is a drag, but if your stones are dished, they will ruin all the good work that you've done flattening and grinding your tool. Remember, if your stones are abrading your steel, then your steel is wearing your stones, so try to use the surface evenly.

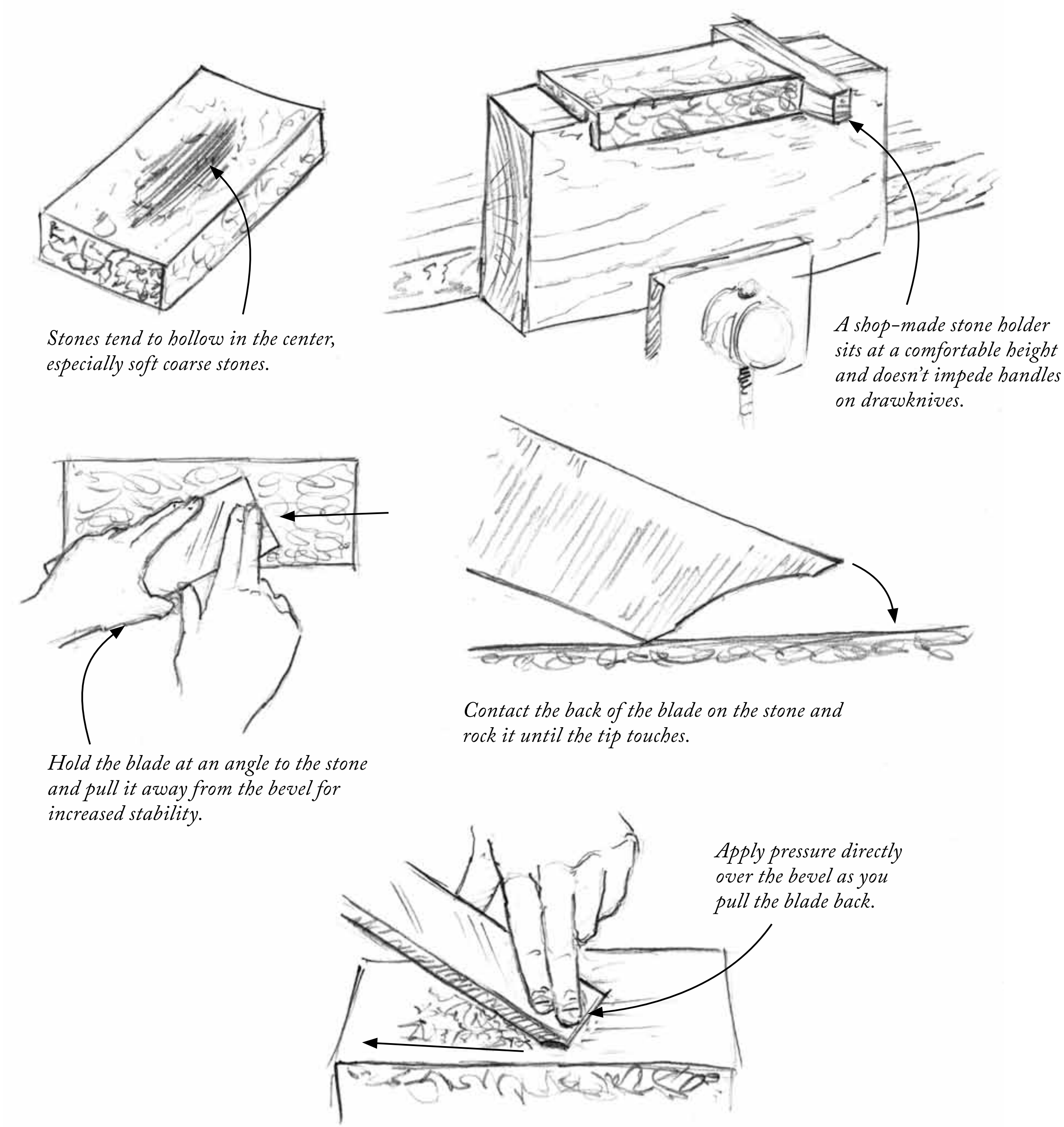



**FIG. 5.12** ***Good honing relies on holding the stone and the blade in a stable position.***

For years I used fine drywall sanding screen on a piece of plate glass to flatten my stones, although I have now switched to diamond flattening plates. I like the idea of bringing the flattening plate to the stone while the stone is in its holder. It makes more sense, and I am more likely to actually do it.

I always pull my blades away from the edge on my stones. This prevents the edge from digging in and snowplowing into the grit built up on the stone. Also, when pulling a tool, the tendency is to rock onto the back of its bevel, which doesn't damage the edge. I also skew the blade on the stone as I pull to increase stability and the amount of the stone being contacted.

I begin each stroke by placing the back of the bevel on the stone and tipping it forward until I feel it "click" onto the flat of the stone. I keep my hands over the bevel and support the rest of the tool with my little fingers; that way the tool is more likely to tip harmlessly back on the heel of the bevel if I lose control.

I take a few strokes on my waterstones to establish flats on the bevel. Viewing the shape of these flats I can better judge the uniformity of the grind as well as how much material I can safely grind without contacting the edge.

I go back and forth from the grinder to the stones until I feel the stones turn an even burr. Then I hone the bevel on the sequence of stones until the flats are mirror-polished. Finally, I hone the back of the tool on the finest stone to turn the burr toward the bevel. I go back and forth from bevel to back on the finest stone until the burr falls off on its own. Often I can see it lying on the stone like a piece of ultra-thin wire.

One more tip on waterstones is to let the slurry dry out. Slurry is the mix of grit, water and steel that forms on the surface of a waterstone. To make a stone cut aggressively, the slurry should be rinsed off to expose the fresh grit on the surface of the stone. But if you leave the slurry in place and continue honing until it dries, the grit in it will break down to a smaller particle size and polish the edge to a finer level. This is especially helpful when polishing on the finest stones. The slurry will form a paste then dry out to a shiny black gunk that will give a lovely surface. Before using the stone again, simply wash the slurry off with water to expose fresh grit. Some finer stones benefit from using a Japanese Nagura stone to pull up grit that will form the slurry.

## Sharpening with Dubbing

If the tool you are using is for paring or chopping, or it will be housed in a jig such as a plane, you are done. But if the tool is going to be used without a housing, there is one additional step.

Freehand shaving and carving tools require a dubbing of the edge that rides on the wood to allow the tool to enter and exit a cut without simply digging. Establishing this dubbing is easy because the natural tendency when sharpening is to round over the edge anyway. The difficult part is to maintain the dubbing so that it doesn't get out of hand and cause the tool to stop cutting properly.

Too little dubbing will result in a tool that "grabs." Too much dubbing will make the angle at which the edge will cut too high to take a controlled cut.

To initially dub the edge on a flat-sharpened tool, strop the part of the tool that rides on the workpiece on a piece of hard leather attached to a board. (For drawknives, see The Drawknife chapter to determine whether this is the bevel or back.)

Apply honing compound, also known as jewelers' rouge, to the strop. Horse-butt leather is excellent for this, but even freshly planed softwood will do the job. Keep the strop flat and protected from dust and dirt, just like you would a sharpening stone.

Because leather and softwood are softer than a stone, they deflect a bit as the tool is drawn along and round its edge.

Don't give into the temptation to tip the tool up as you strop because you will likely overdo the rounding. I know it seems impossible that a few strokes on a strop can do much, but remember how tiny the actual edge is and look at the blackened rouge. The black is the steel removed from that tiny edge.

I try to keep the rounding to a bare minimum and count on my regular maintenance of grinding the bevel and honing the back to remove most of it so that it never gets out of hand.

## Maintaining the Dubbed Edge

Once you have sharpened a tool and it is performing well, you need to keep it in tune. I often return to my finer stones to touch up the edge. I think of a musician who is onstage, tuning between songs so that the instrument always sounds right. Of course, after many light honings, you will want to return to the beginning of the process. I avoid using the coarsest stones on the flat backs of tools.

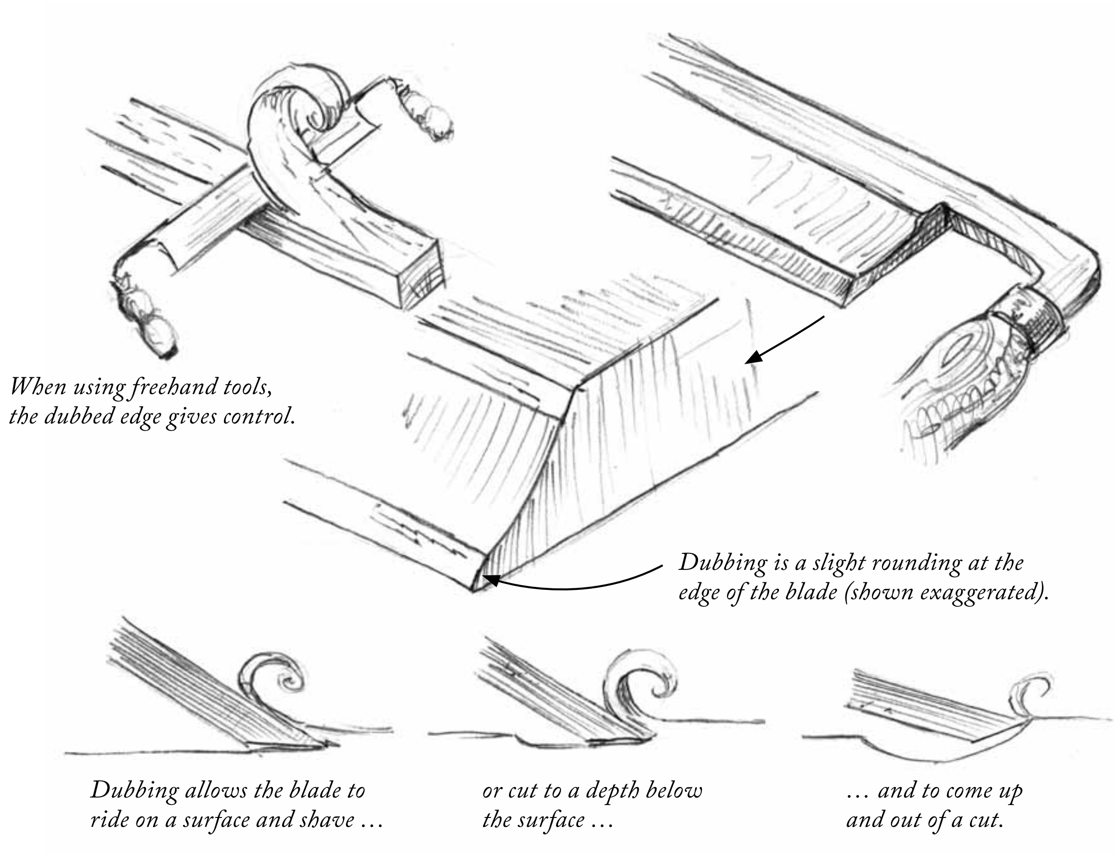



**FIG. 5.13** ***Why dubbing an edge is useful on freehand carving and shaving tools.***

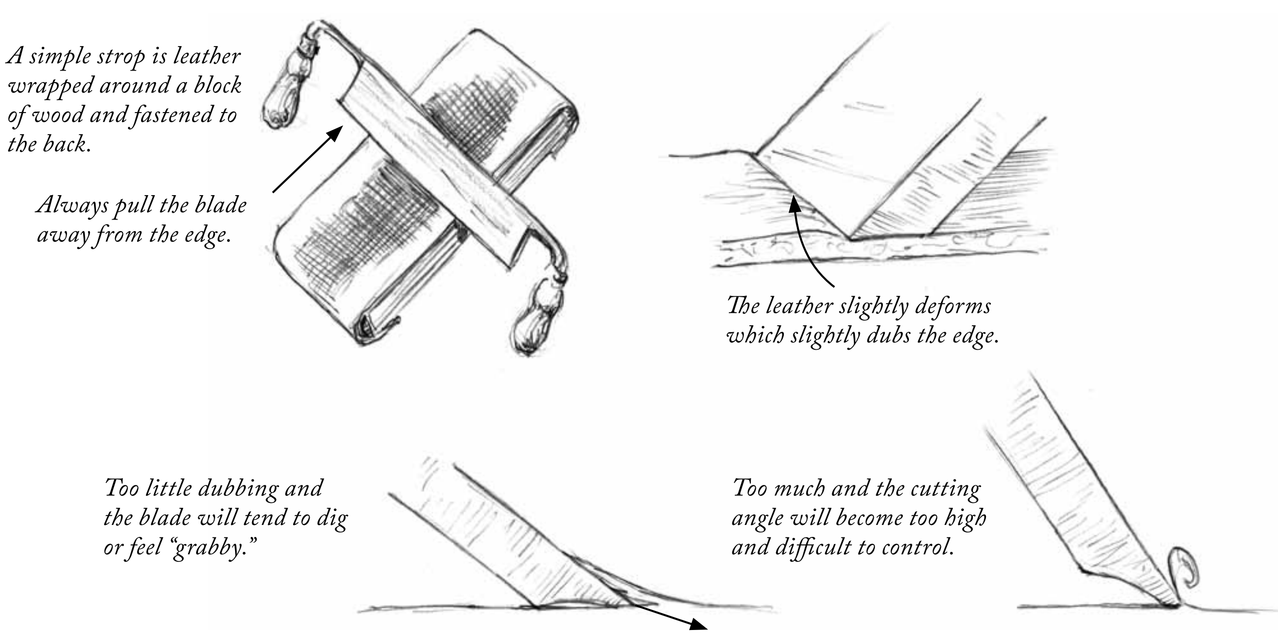



**FIG. 5.14** ***Stropping and the result of too little and too much dubbing.***

*On a tool with a dead flat-back and dubbed bevel, grinding will remove the rounding.*

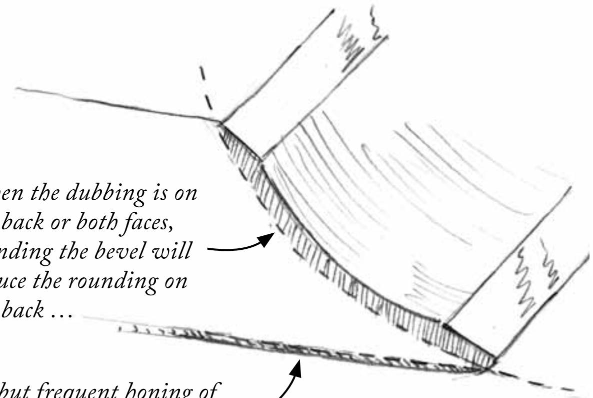



**FIG. 5.15** ***How grinding and honing can reduce or remove a dubbed edge.***

Even if I grind and hone the bevel on a coarse stone, I wait until I get to the #6,000- or #8,000-grit stone to turn the burr from the back; this saves time, metal and effort.

With my dubbed tools, I keep a leather strop nearby and touch up the edge periodically. If I have a freshly shaved piece of wood in front of me, I run my drawknife backward on it and use it as a strop. If the dubbing seems to be too much, or if the tool is too dull for simple stropping, grinding the bevel or stoning reduces or eliminates the rounding.

If the dubbing is on the back of a drawknife that is used with the bevel up, spending extra time flattening the back when you maintain the bevel should keep the dubbing in check. If not, grinding the bevel will also remove most of the dubbing from the back.

## Tool Configuration & Use

Once you have a grasp of sharpening, you should evaluate each tool that you plan to use. Just having a sharp edge isn't enough to get great results; you need to understand the way that the tool is used and is configured.

For this, I've found it helpful to separate the tools into two categories: those that cut freehand and those that are housed.

Why bother to group these tools into categories?

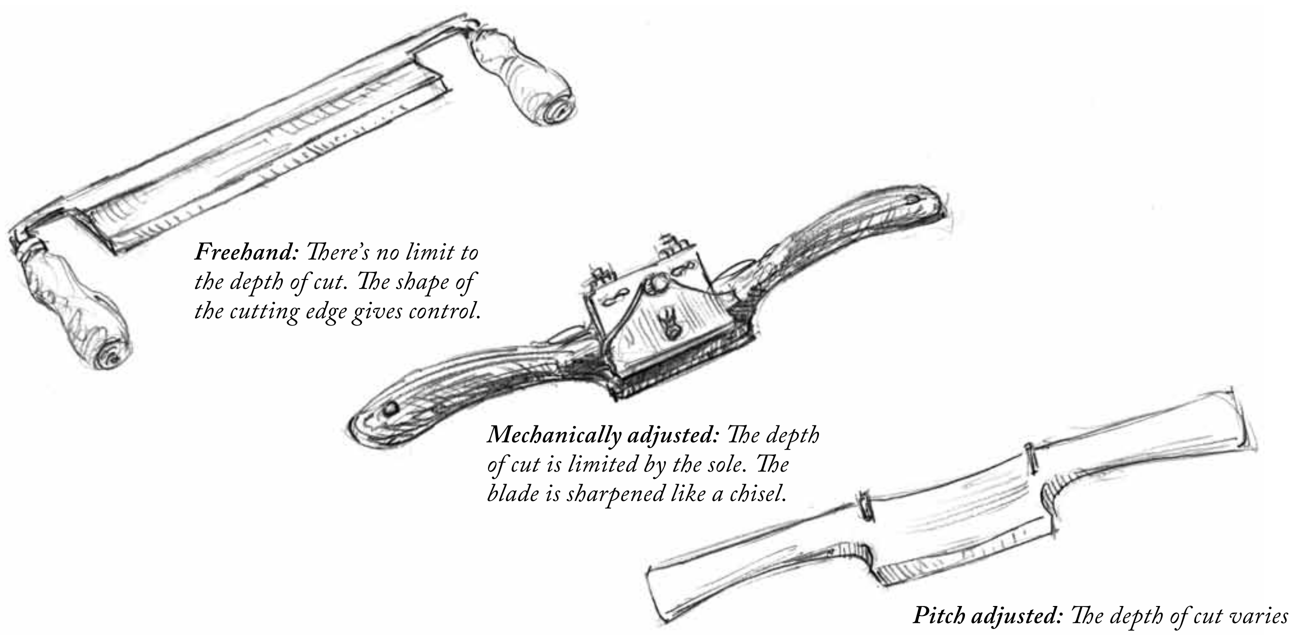



**FIG. 5.16** ***Housed and freehand tools.***

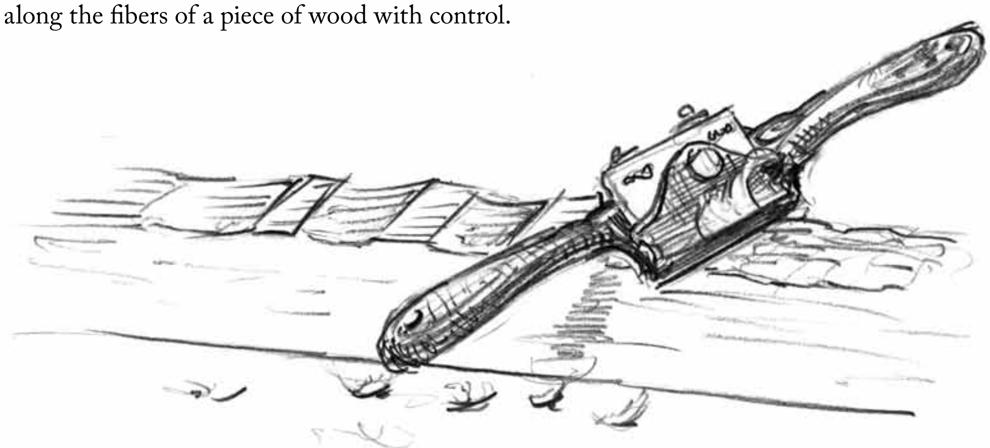
Each tool group has a special geometry that enables it to perform certain tasks. Understanding the way the geometry of each functions will help you choose and maintain the tool for the task at hand.

For instance, the dubbing of a drawknife (a freehand tool) allows it to follow the fibers of a piece of wood, which is essential when shaving parts for bending. The high angle and sole on a spokeshave (a housed tool) can fair and smooth surfaces after they are bent. To use the tools efficiently, it's important to recognize that they perform different and distinct jobs. Neither tool is a suitable replacement for the other.

The freehand tools use a slight rounding (dubbing) at the edge. Freehand tools are the most basic tools, usually just a handled piece of steel. They include drawknives, inshaves and carving gouges. Freehand tools, but especially the drawknife, excel at carving but can also be used to shave along the fibers of a piece of wood with control.

The housed tools use a blade mounted in a separate tool body to control the depth of cut and guide the cutter. These blades are sharpened without any rounding of the edge. Some housed tools use a blade that can be advanced and retracted to set a depth of cut and others rely on the way that the tool is held in use to adjust the depth of cut. The tools that use an adjustable blade include handplanes and metal spokeshaves.

These tools excel at leveling surfaces because the flat sole rides on the high spots and cuts them a consistent amount with each pass. They can also shave convex parts without flattening them. Spokeshaves like this work great when creating the tooled finished surface on curved parts, such as spindles and the sides of a seat.



*Housed tools excel at leveling uneven surfaces because the sole limits the depth of cuts while cutting the high spots.*

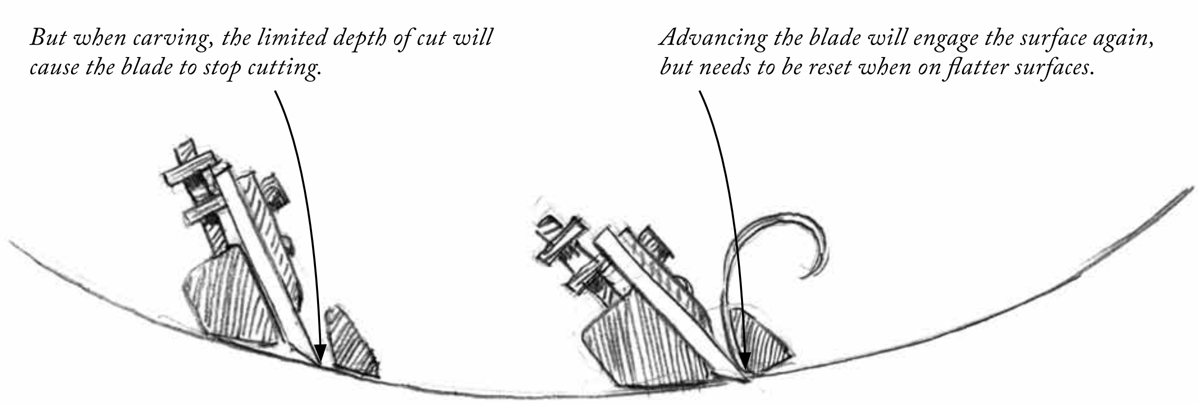



**FIG. 5.17** ***How housed tools cut.***

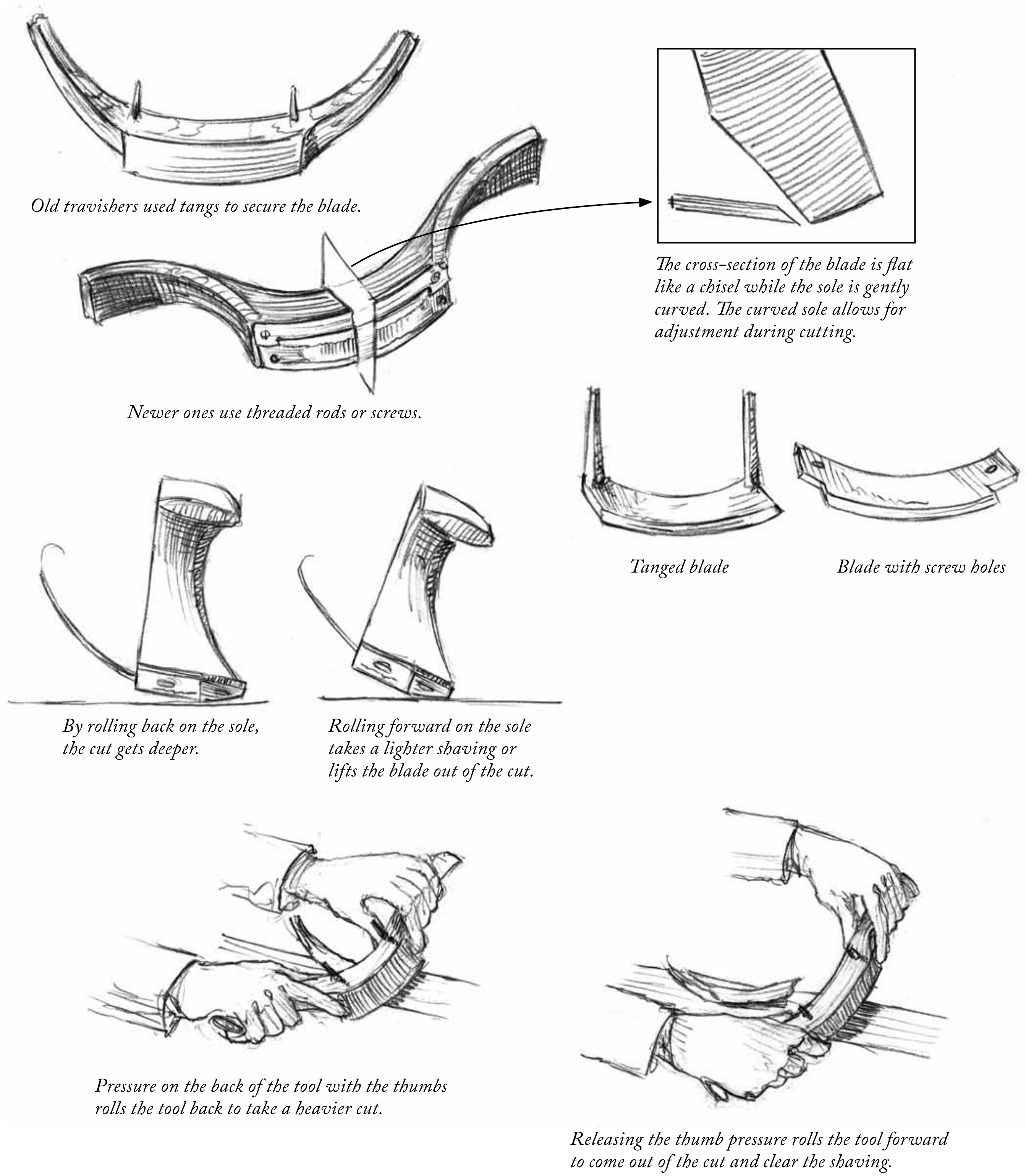



**FIG. 5.18** ***Some tools can be tilted to take a heavy or light cut.***

To compensate for the need to adjust these tools, some users extend one side of the blade more than the other, which allows them to adjust the depth of cut as well as starting a pass with a light cut.

Besides the housed tools with adjustable blades, there are a number of housed tools that have fixed blades, yet can take cuts of varying depths. They rely on the way the tool is held during use to set the depth of cut. These tools include the travisher and the wooden spokeshave. Like the housed tools, these tools have a blade sharpened with no dubbing and the blade is mounted in a body. However, a slight rounding of the sole ahead of the blade enables the tool to take a variety of depths of cuts, based on the position that the tool is held, much like the freehand tools.

These tools work well to carve and smooth shapes because their soles limit the depth of cut and guide the tool. Yet they can take deep or light cuts on the fly, just by changing how you hold the tool. This is helpful because you can use a single tool to hog off material then take a light finish cut without adjusting the blade.

Take a look at the sole of an antique wooden spokeshave and you will see a slight curve on the sole from front to back. The closer to the cutting edge that the sole contacts the workpiece, the deeper the cut. It is important to use these tools correctly, which can be counterintuitive.

There are specific instruction for using each tool where they are introduced in the process chapters.

The meeting of steel and wood is the heart of woodworking. Luckily, there are only a few concepts to master that make the work possible and, when done well, pleasurable. There is little that is unpredictable when you understand the wood and the tools, and as you become more aware your confidence will grow. A new chairmaker tends to sit amongst piles of tiny shavings, while an experienced maker takes bold strokes that leave chunks of wood on the floor. The speed and accuracy that we generally look for in power tools can easily be supplanted by a deeper understanding of the structure of the material and the tools that we command.

# 6

# Woods for Chairmaking

While working in cabinet shops in Manhattan, I found the connection between lumber and trees elusive. With all that concrete, New York is an environment more attuned to jackhammers than chain saws. I recall everyone in the shop gathering around to look with astonishment at the edge of a board that still had bark on it. Now when I think about building with wood, my first thoughts are rarely of boards.

It might seem daunting at first to locate a source for logs, choose the right specimens and get them back to the shop to split. I vividly recall wrestling with a gnarly red oak when I first started purchasing logs from my sawyer. Having no way to transport it in full, I split it at the log yard and got curious looks and snickers from the guys moving logs on huge loaders. Looking back, it might have been his watching me throw myself at that log for a couple of hours that endeared me to the sawyer.

During the next 10 years, he took time to understand my needs and went out of his way to help me meet them. I've found that many sawyers take pride in their offerings and enjoy knowing more about where the wood is going. That said, dealing with me was such an act of charity on my sawyer's part that he allowed me to pay him only once a year – the walk back to the office just wasn't worth it.

Not to say that this is always the case, but it's important to note what a slim margin these folks have in their volume-based business. Acknowledging the value of their time and the kindness of their attention is important. I don't advise trying to haggle; the value of the wood in each chair is minimal, regardless of the price. A quick note about the lingo: Most loggers will talk about prices using 1,000 board feet as the metric, so when you hear $350 a thousand, that translates to $.35 a board foot. The number of board feet is calculated using the diameter at the top end of the log and the length of the log using a log rule that has a table of numbers on the side to make the job fast. There are a couple of types of rules out there, but again, let the sawyer do his or her job if you hope to see a repeat of this effort.

It's also helpful to use terms that will help the sawyer or logger understand what you need, without dragging him too far into your world of froes and drawknives. I've found that asking for "veneer rejects" usually does the job. A veneer log is nearly perfect and prized for its geometric evenness, its lack of scarring and knots and its centered pith. After veneer buyers tour a log yard, there is generally a stack of logs that they rejected. Perhaps a bump or scar. But if the sawyer thought enough to show the log to a veneer buyer in the first place, it's a sign that whatever the issue might be, it is most likely small enough for a chairmaker to cut around or deal with. Even if the sawyer or logger doesn't deal with veneer buyers, he should understand what you mean.

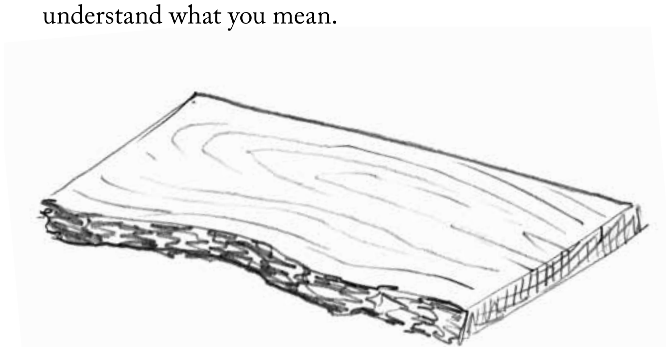


**FIG. 6.1** ***A board with the bark still on it is a reminder of the living tree.***

I don't buy the actual veneer logs for two reasons. One, they are pricey, and two, the sawyer generally uses that stock to keep the veneer buyers coming back. When the sawyer realizes that you will pay more for the reject log than if he'd relegated it to the saw log pile, he is more likely to work with you.

I haven't had much luck approaching tree services, however. While they have been interested in working with me, their stock is too erratic and their prices are high. In my experience, a sawyer or log yard will have more volume, better selection and more reasonable prices.

But finding your material is the epitome of "beggars can't be choosers." Wherever you can find the material, grab it. While I am going to feature my favored species for the different parts, they are by no means the only ones that can work. Invariably, folks ask me if a local species might work well for chairs. The answer is a definite maybe. There are just too many species and specimens to set any rules for success, as long as the tree meets the standard of quality, strength and working characteristics.

## How to Choose a Log

When you look at a pile of muddy logs it might be tough to know what is what. Beyond the species, there are a number of characteristics to look for in a log. These traits are usually a reflection of the life of the tree before it was cut. The best trees grow in the middle of a forest where they compete for light by shooting straight up to the canopy without expending energy by growing low branches. The protection of the surrounding trees also keeps the wind at bay. Trees that grow at the edge of the woods or in fields have no incentive to grow this way and tend to branch low and twist about – not to mention the likelihood of finding metal embedded from an old hammock bolt.

For the best return on your labor, only the straightest, clearest wood should come into the shop. I am quick to relegate inferior wood to the burn pile. Struggling with sub-par wood will quickly color your experience. The only wood in the tree suitable for chair parts is in the straight, limbless portion of the trunk, generally, the first 10'-14'. In some cases, a second cut above it may be suitable, but it might also harbor a few more surprises.

As a young tree struggles to reach the canopy, it will have some waviness to it. I call this the "reckless youth" stage, and just like with people, it's usually best to avoid it or forget it. Once the tree reaches the canopy, it begins to add on layers that build mass and smooth the early growth into a more even shape on the outside of the tree. When you split the tree, you'll see the transition from gnarly to smooth and note where the serviceable wood starts. Depending on how old the tree is when it's cut and the growing conditions that it experienced, it can get to the point where no blemishes are visible from the outside. I like to choose logs with a diameter at the top of 16"-24", rather than more massive trees. I have found that a violent "reckless youth" or other issues can be concealed beneath the larger mass. (Plus, larger logs are more difficult to split and transport.) Some species are more "honest" about their early years, such as red oak, whereas I've found white oak to be downright deceptive. Luckily, the medium-diameter trees that I prefer usually don't have the time to cover major flaws completely. Also, by choosing high-quality, smaller logs, I don't run into the troubles of long-term storage.

Besides obvious curves in the log, there are other details to look for. "Reaction wood" forms when the tree grows under stress, such as on a hillside. When you split this wood and release the tension, a lifetime of stress will express itself in warping and perhaps cracking. An off-center pith and uneven growth rings are signs of reaction wood and should be avoided.

I also avoid logs that have a considerable taper along their length. Of course, the top of any log will usually be smaller than the base, but a large flare makes the log tough to work because the layers get thicker at one end. This means that you can't follow the fibers and thickness the piece to a consistent measurement.

If the flare is just at the bottom and the rest of the log is more uniform, I simply cut off the bottom few feet and send it to the burn pile, rather than trying to split it.

One of the more insidious defects in a tree is a twist, and I say this because it isn't always apparent. While a knot or defect in a log can be cut out or worked around, twist will run the length of a log, and you'll fight it with each and every piece. To spot a twist in a log usually requires "sighting" down the length of one end, as though the log were a rifle barrel. It usually isn't any one line in the bark, but a general appearance of the pattern creeping around the tree.

A slight twist is expected, but note it as a possible deal-breaker. Learning to work twisted parts into usable chair parts is tricky. So given a choice, stay away from logs with a distinct twist.

A crack down the center of a log is normal, and it can

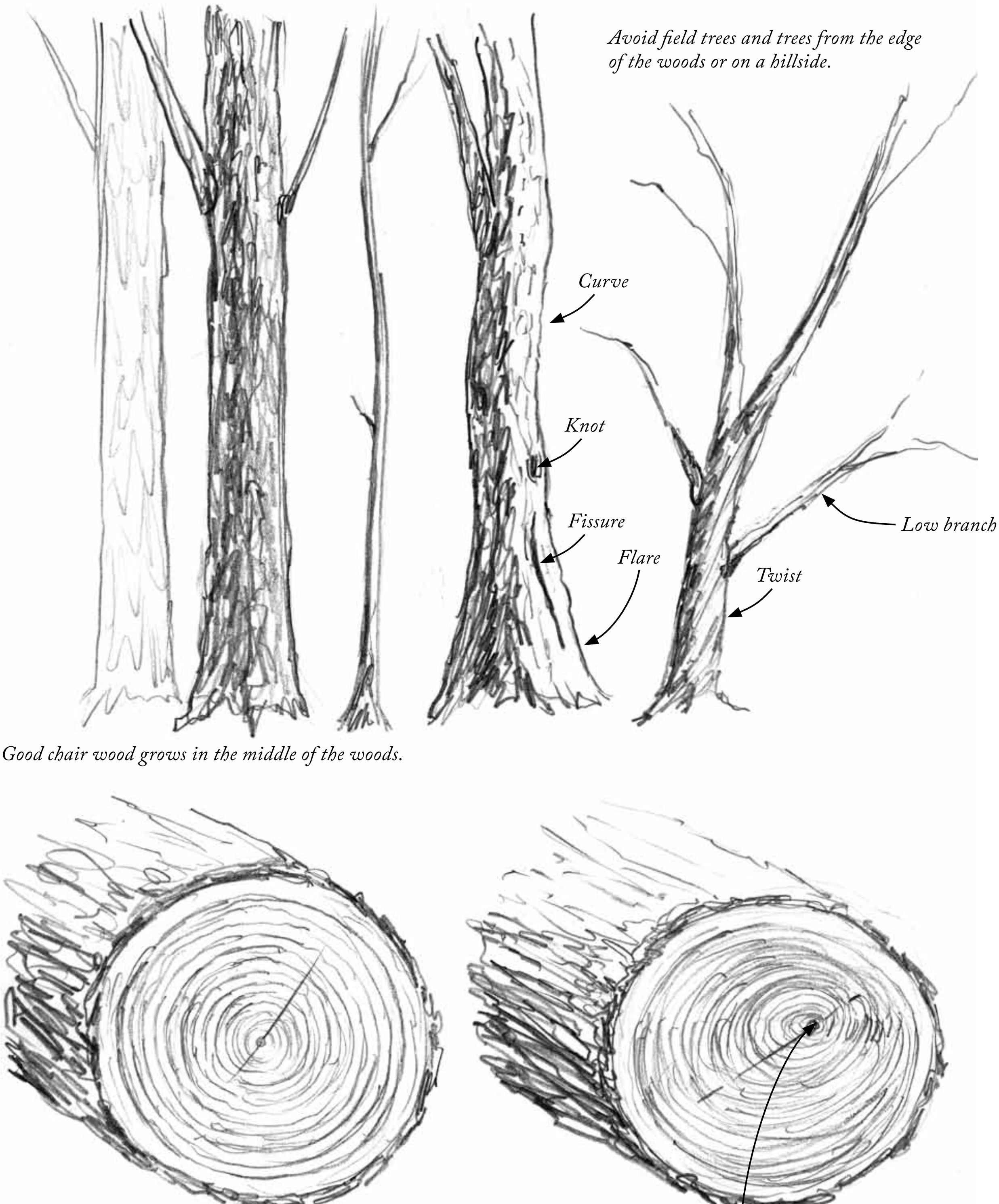
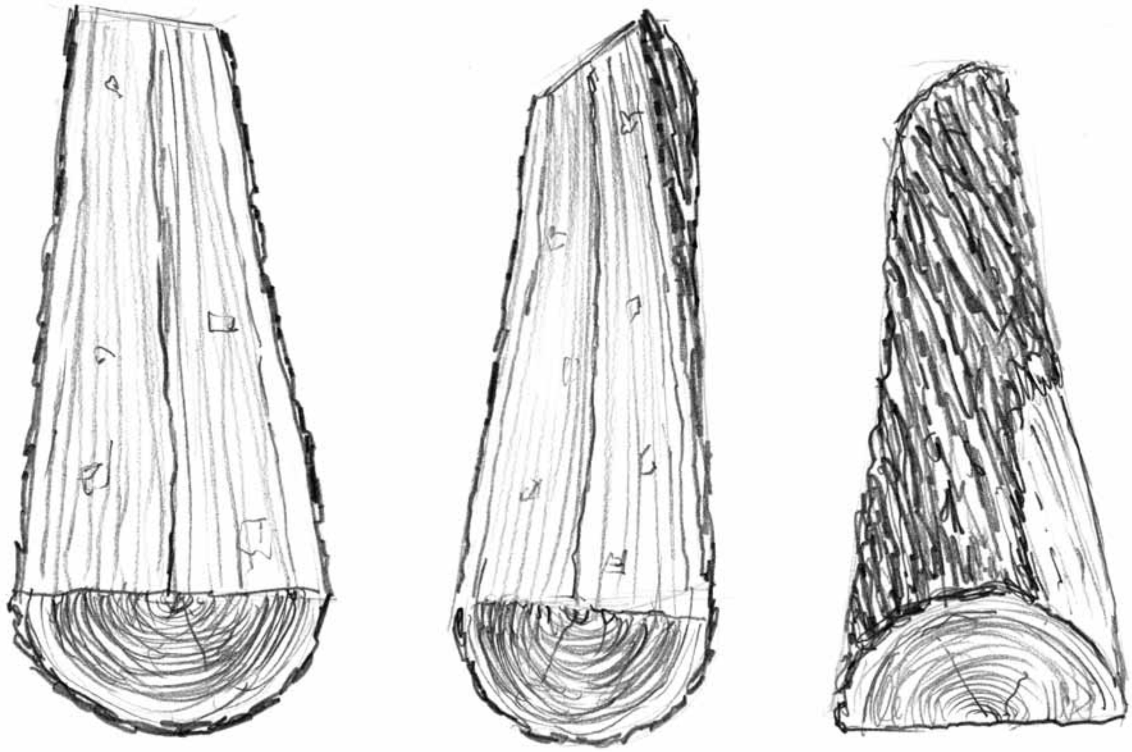



**FIG. 6.2** ***Characteristics of good (and bad) trees for chairs.***



*Most logs have a slight twist from end to end.*

*More obvious twists complicate splitting and shaving, and should be avoided.*

*A twist can be seen by sighting down the length of the tree and by peeling bark to see the fibers.*

**FIG. 6.3** *How to spot defects in logs.*

sometimes help you spot a twist. If the crack is vertical on one end of the log and horizontal on the other, be wary and inspect the bark further. When the bark is removed, you will see the twist in the fibers when sighting from the end.

Hopefully, the folks you are working with will allow you to roll the log before committing to purchasing it. Often, you will spot problems that you can't see from just one side or when the log is stacked.

## Moving Logs

I learned the hard way that hauling logs is a great way to beat up a truck bed. Now I use a trailer, which is a surprisingly cheap extension of my truck that I have no guilt about abusing. When I go to the log yard, I bring a few essentials: a tape measure, a chart for calculating board feet from a log's diameter (always measured at the top) and length, a log peavy for rolling the log, two notched beams for supporting the log in the trailer, a chain for loading the log and ratcheting straps for securing it while in transit.

The heavy-equipment operators at the log yard are used to dropping logs from the loaders and sometimes they seem to revel in testing the strength of your trailer. To avoid a busted trailer, I always grab my chain while they bring the log over and ask them to use it to lower the log gently onto the trailer.

I put the chain down on the ground so that they can set the log on it. Then I wrap the chain around the log and attach it to the the forks on the loader. There is usually a glimmer of pride showing as the operators lift and lower the log with finesse. Be sure not to be anywhere near the log when it is airborne. If the chain isn't at a good balance point, put some boards on the ground and motion to the driver to set the log down so you can adjust it.

Getting the log off the trailer safely is another matter. There are a few options, some more dramatic than others. You can back up to a standing tree, chain the log to it and

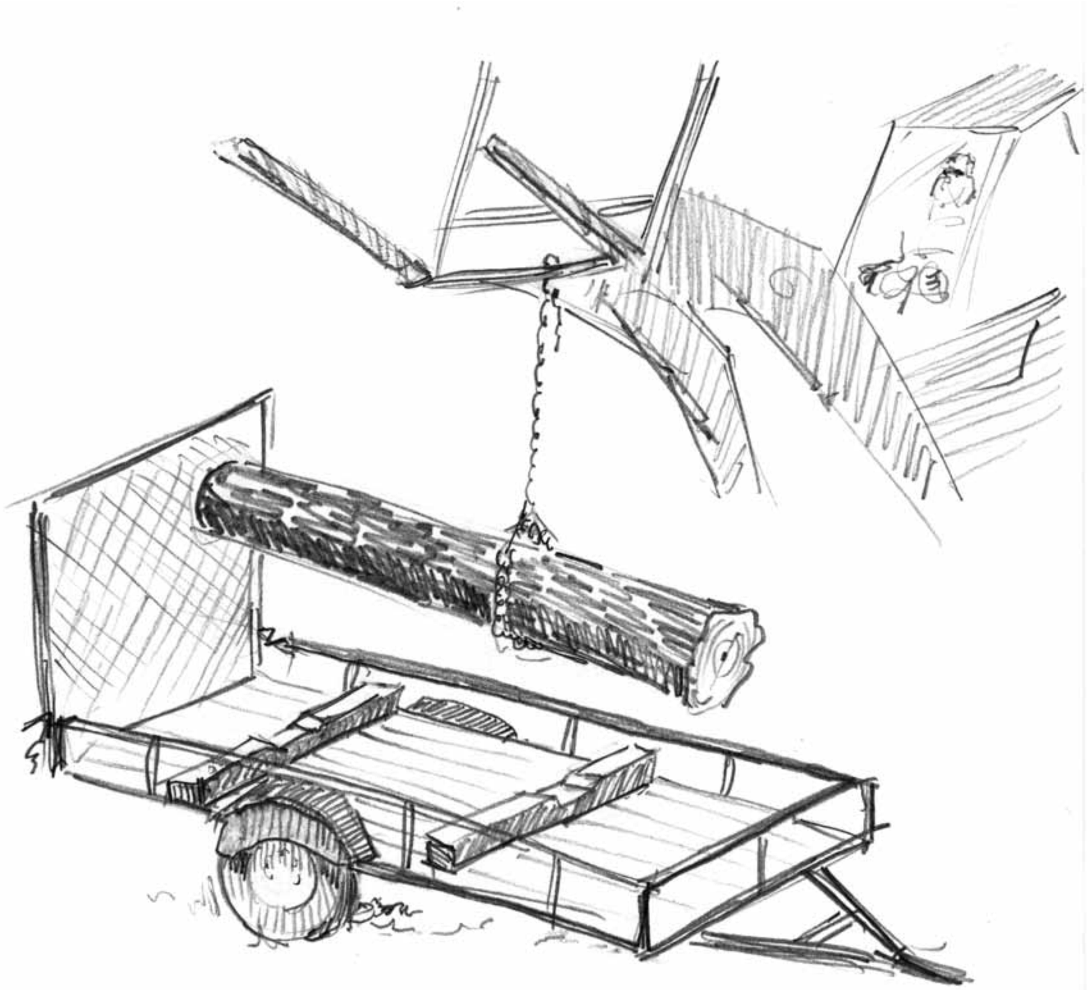


**FIG. 6.4** *Lowering the log with a chain will be kinder to your trailer.*

drive away, or even split it on the trailer and heave off the parts. I've become quite adept at rolling logs off the side of the trailer with a log peavy, but this takes some practice and my trailer shows the dents to prove it.

Whatever method you choose, don't risk safety for quick results. Or, if you have a willing logger, get the thing delivered and dropped. It's money well spent.

## Species, Uses & Particulars

Following are some details about the species that are ideal for the different parts of the chair and how to select woods for chairmaking.

### SEATS

The seat is the one part that must be fully dry before you can build a chair. I saw and dry all my seat stock, but you can also purchase dried planks for the purpose. For wood to be suitable for seats, it should be easy to carve and softer than the parts that will join it. The "softness" allows the other parts to be tightly socketed. Imagine pushing a tenon into a hole bored into cork versus a hole bored in steel; the cork is more forgiving.

Softer woods tend to grow faster and dry more easily without defects, which also makes them attractive for seats. Time, cost and availability will probably play a large role in your choice, but there are other considerations. Besides which species you choose, the next question is usually how it was dried.

While this may seem like a benign issue, given that we usually accept kiln- and air-dried wood as long as it is suitably dry, it can be a factor in the success of the material. I've seen trouble arise with pine that I attribute to the way it was dried. When improperly kiln-dried or incompletely air-dried, there is a variation in the tension between the surface of the board and the interior.

When this wood is carved, it tends to warp. This is not usually a deal killer, but the carving also leaves small areas of tense wood on the spindle deck that fight large areas of uncarved wood on the bottom of the seat. I have seen seat stock that splits on the slightest tapping in of a tenon, and I think improper drying might be part of the problem.

Of course, the best solution is to take charge of the pine as soon as it is sawn and slowly dry it yourself, but I realize this is not always an option.

Traditionally, chestnut, elm, Eastern white pine and poplar were the usual choices for seat stock. Sadly, we no longer have ready access to chestnut due to the blight in the beginning of last century, but pine and poplar still abound. I generally use pine for my traditional chairs,

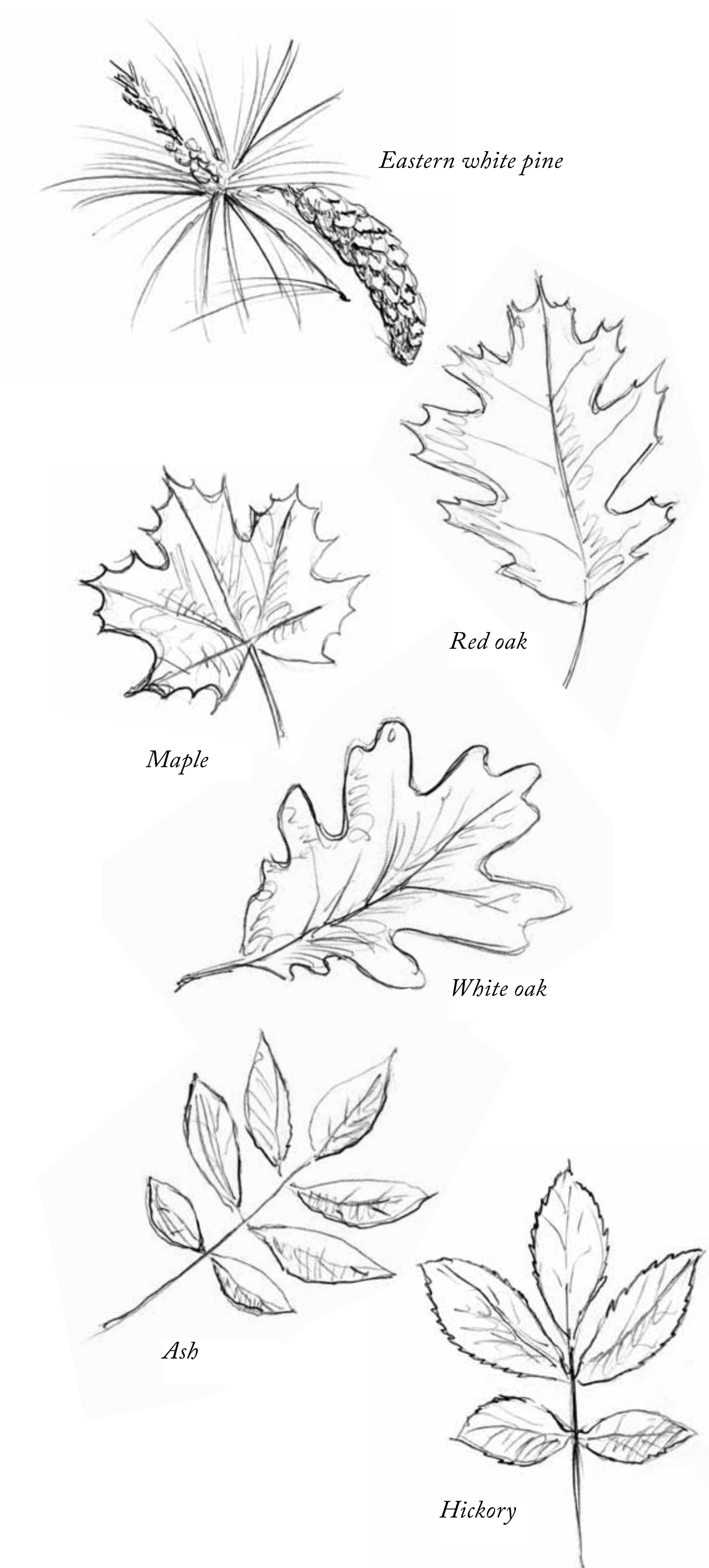



**FIG. 6.5** ***Leaves of trees common in chairmaking.***

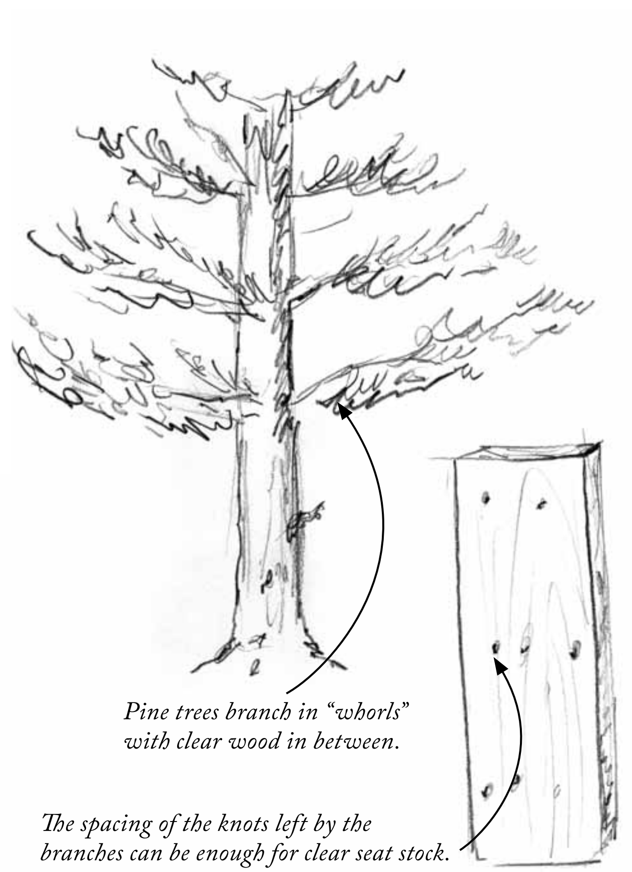
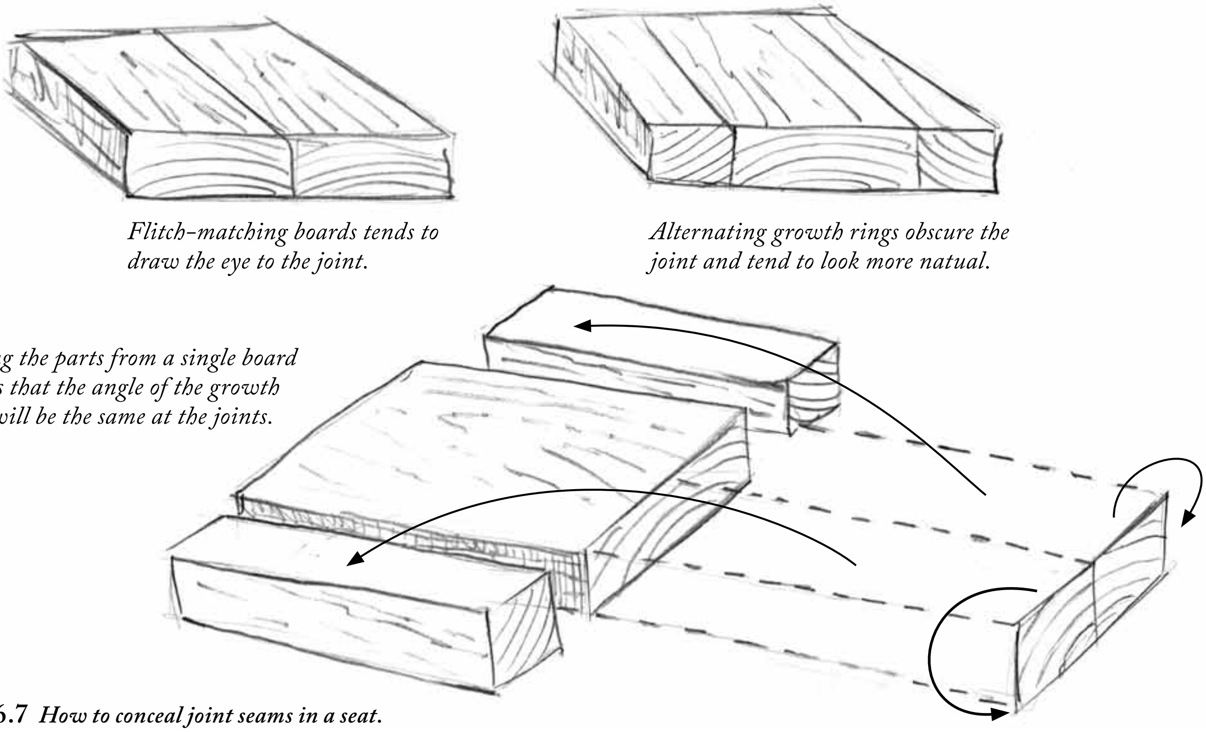



**FIG. 6.6** ***Avoid knots in pine with strategic cutting.***



*Flitch-matching boards tends to draw the eye to the joint.*

*Alternating growth rings obscure the joint and tend to look more natual.*

*Cutting the parts from a single board ensures that the angle of the growth rings will be the same at the joints.*

**FIG. 6.7** ***How to conceal joint seams in a seat.***

unless they are for public seating. Then I use poplar because it is a bit more resistant to dents and scratches. Pine has a wonderful texture and grain pattern that readily shows through the paint, and there are moments while carving it that you feel you have superhuman strength. On the downside, you have to take care when finishing pine to make sure there isn't a problem with adhesion because of the pitch in it. If you pick up a piece of dried white pine and it feels unexpectedly heavy, it might be dense with pitch. The pitch will make carving it a bit tougher and add weight to the chair, but otherwise it's generally harmless. Pitch can be recognized as little dark spots or streaks that look almost like honey. A quick pass with a heat gun will melt and reveal the pitch.

Poplar is fine to carve, especially if it is the greenish heartwood (which turns brown with exposure to the air), but the white sapwood is tough stuff and no pleasure to carve. Elm is often used in European Windsors, and it has such a resistance to splitting that you can eliminate the stretchers in the undercarriage. In recent years, I've carved seats out of walnut and butternut (a.k.a. white walnut). These species carve well and hold crisp details, but I don't paint them.

There are plenty of other woods out there that might fit the bill and I recommend using what is available. I've heard of catalpa and buckeye making nice seats.

I avoid using knots in my seats when possible, mainly because they are destructive to the edges of my tools. Luckily, pine branches grow in clusters called whorls and there is usually enough clear wood between them that knots are easily avoided.

I'm often asked about using cherry and other dense woods for seats. Yes, you can do it, but it takes more effort, and you will either need to be more patient or consider some power assistance to remove the bulk of the material.

Seat stock is used after it is air-dried, but to save money I buy my stock freshly cut and sawn. Of course, if you have access to stock that is already dry, it might be worth a little upcharge, if for no other reason than not having to wait a year to get carving.

I usually purchase my green seat stock in 2 1⁄8"-thick planks from a sawyer and stack it stickered outside through a spring and summer. Keep the stack sheltered from direct sunlight, or the outermost boards will check. After that, I bring it into an unheated shed for about six months and then into my shop space for another few

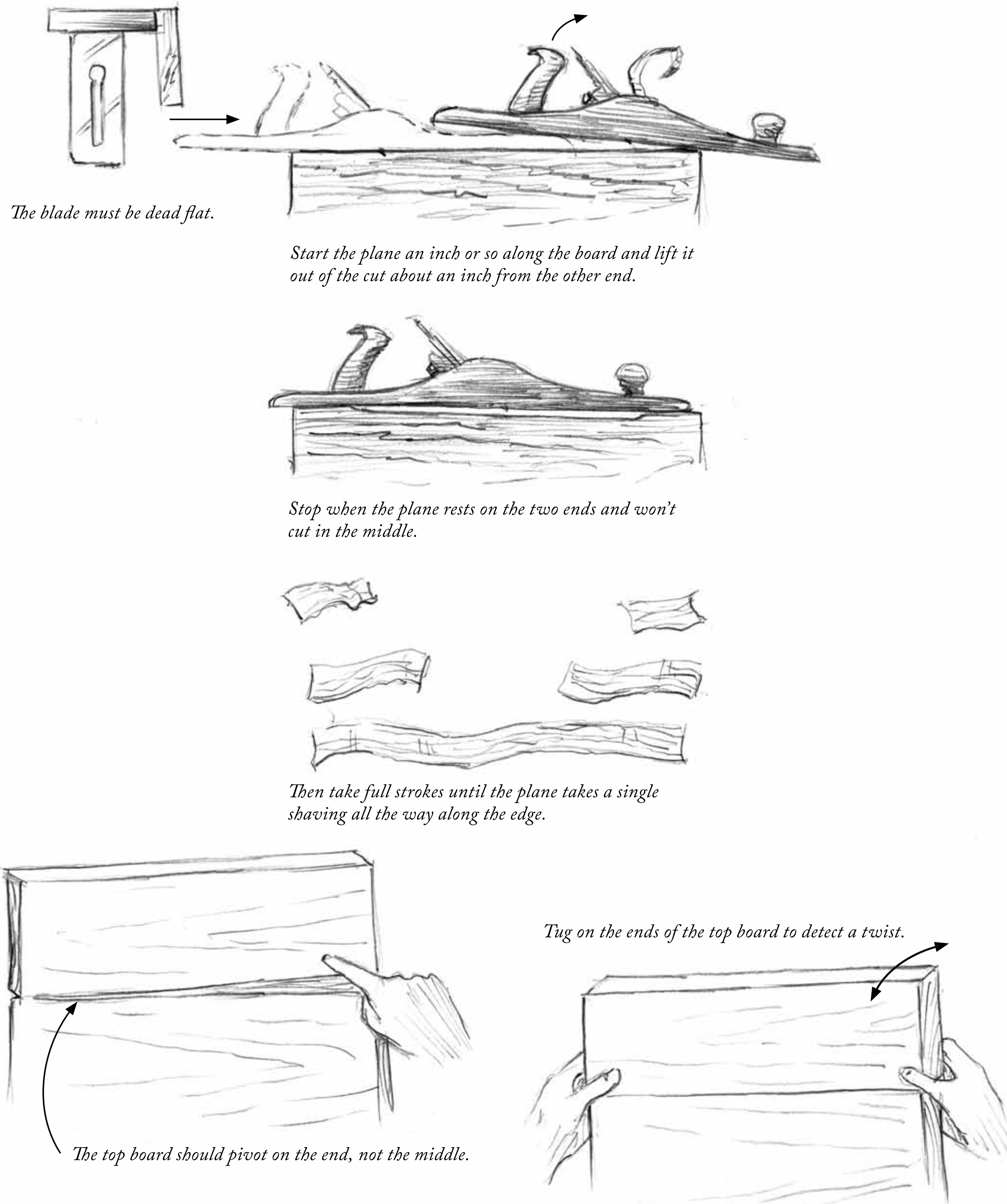



**FIG. 6.8** ***How to joint boards before gluing up a seat.***

months to come to equilibrium. Once again, patience is a virtue and a little experience helps you avoid trouble. I have used a moisture meter to check the moisture content, but usually simply erring on the side of patience and noting the weight of the board is enough to judge the progress. Once the board stops losing weight while in the shop, it is ready to use.

If I have access to wide stock for one-piece seats, I use it. I am, however, just as happy to glue up two or three pieces. I have a technique that helps obscure the joints. I don't mind if viewers can find the joints, but I take a special joy when they have to look for them.

The boards that I prefer for gluing up a seat are a little wider than half of the seat width and are flat-sawn. That way, I can saw the pieces the length of the seat then split one of them to glue onto the edge of the other piece to make up the full-width.

By alternating the bark side, I avoid the eye-catching effect of bookmatching. While bookmatching might be a pleasant visual to use in flat work, I find it distracting on carved seats because it quickly draws attention to where the boards are joined.

If the face of the board is sawn at an extreme angle to the fibers, then alternating pieces like this might cause some trouble when carving because the direction of the cut will change in the flatter areas. If that's the case, then I compromise to find the least troubling solution for carving. I also try to avoid having the glue lines run through any of the chair's joints if I can help it.

I prepare all of my joints for glue-ups with a No. 7 jointer plane. Besides needing a flat sole, it is absolutely essential that the cutting edge of the blade be dead flat – sharpened straight across. Any camber will make it very difficult to get flat joints.

I begin my jointing process by taking a few passes to flatten the edge and assess its condition. Then I set the plane to take a light cut and take a number of passes that cut only in the center portion of the edge. Once the plane rides on the two high spots on the ends without the blade cutting in the middle, I switch to full-length passes. It is vital to have the pressure on the front of the plane in the beginning of each pass, over the center of the plane in the middle of the pass and at the back of the plane at the end of the pass.

Each pass reduces the high spots at the ends of the board until finally the plane takes a full-length shaving. This is where I stop planing. Any additional cuts will likely round the board's edge by taking more at the beginning and end.

Once I have done this to both edges to be glued, I set one edge onto the other to check the joint. I try to rock the top board to check it for twist, and I push it with my finger to check to see if it spins on a high spot. A twist or high spot sends me back to the step where I create the hollow in the middle of the edge. If I am sure that the edge is substantially twisted, I will take a few passes over the high spots before hollowing out the middle.

It can be tough to figure out which board has problems or if it is both, but the process of rejointing the sides is quick and by far more efficient than fussing around. This is one of those places where relying on the process gives the best results.

I don't try to "spring" the joint, a technique where you consciously leave a small gap in the middle of the boards that closes up under clamping pressure and ensures that the ends stay tight. Instead, I aim to get the joint dead flat and carefully check to make sure that there is no gap at the ends when they are put together without pressure.

To flatten the faces of the seat board, I begin with a scrub plane on the face of the seat that is warped convex. I create a flat down the center using crisscross strokes and take cuts like this until the flat area spreads to the edges. Then I refine the surface with my jointer plane and winding sticks. Using a marking gauge, I then mark the final thickness of the board, usually 1¾" to 1$\frac{13}{16}$", and use the scrub plane to flatten the other side while approaching within $\frac{1}{16}$" of the line. I use the jointer plane to shave right to the line.

### SPINDLES & BENDS

When it comes to spindles and bent parts, the ring-porous hardwoods are king. "Ring porous" refers to the variation between the large pores that grow early in the season (early wood) and the dense tough wood that grows later in the season (late wood). The obvious variation between the early and late growth accounts for the distinct grain patterns that show when ring-porous woods are sawn into boards. While cabinetmakers prize slow-growth wood for its showy patterns, I search out fast-growth trees that have a higher percentage of dense late wood for the added strength. While I will detail the bark, leaves and some of the identifying characteristics, the best technique is to use a summer tree-finder to identify trees by the leaves or, even better, a winter tree-finder to identify species by the buds. My personal favorites are white oak and hickory. They have wonderful working characteristics and are stronger than necessary. As a matter of fact, the only reason that I prefer white oak to hickory is that hickory is too strong and tends to stiffen some chair designs beyond what I consider desirable. But when it comes to chairs such as the comb-back, where there is no support above the arm rail except for the spindles, I love to use hickory.

White oak is known as "white" due to its whitish bark; the wood itself is actually brown with a greenish hue. It has a strong resistance to drying and decay, so the heartwood can store for long periods while remaining green. The hollow pores in white oak are blocked by tyloses, small inclusions that act as plugs, which is why white oak can be used for barrels without excessive evaporation through the pores. Red oak, which lacks tyloses, has excessive moisture loss through the end grain, which also explains why it is easier to dry red oak evenly and without problems.

Splitting white oak can be a challenge due to the "webbing" of fibers that usually connects the two halves being split. Careful hatchet work can free up the split. I think of this webbing as a good sign, because any log that hesitates to split will most likely bend well.

Hickory comes in many species: shagbark, pignut, mockernut, etc. It's in the pecan family. Hickory doesn't have great decay resistance. Even worse, it checks easily. This is because of the density and difference in the shrinkage in the tangential plane versus the radial plane. This shrinkage should also be minded when sizing green parts. If you were to shape a crest for a comb-back from fresh hickory and make the "ears" nice and round, they will look quite squat after drying (ask me how I know).

I've started to use hickory for my wide, flat spindles because I can make them remarkably thin and flexible without their breaking. They defy expectations of how comfortable a wood chair can be. The sapwood is usually wide in hickory and nearly white in color. If the chair is going to be unpainted, I tend to use the white sapwood, but for painted work, I use the heart and sapwood interchangeably.

As for bending, a good hickory tree can be nearly tied in knots, while a bad one won't budge. I try to stick with the shagbark, but hickory is so cheap that when a good one comes my way, I snag it, figuring its high btu rating makes it worth the price in firewood alone.

Hickory is also my favorite for handles, mauls and firewood carriers.

Red oak is widely available, so it's easier to find a tree with fewer defects than any of my other choices (besides ash). It also splits more easily. Northern red oak in the area that I live in Massachusetts is lovely stuff; it shaves well and bends fine. I used to have trouble with the red oak that I got in New York. It was "brash," with shavings that seemed sort of brittle, and it didn't bend consistently. The difference in regions, and even tree to tree, can be significant. I use the better red oak and like it, but for parts such as the comb-back spindles that I mentioned, I would steer away from it, because it is just a bit weak.

Red oak dries without complaint because of its large, open pores that run through it like straws. Visually, it is clear to see what is going on with the fibers. I recommend

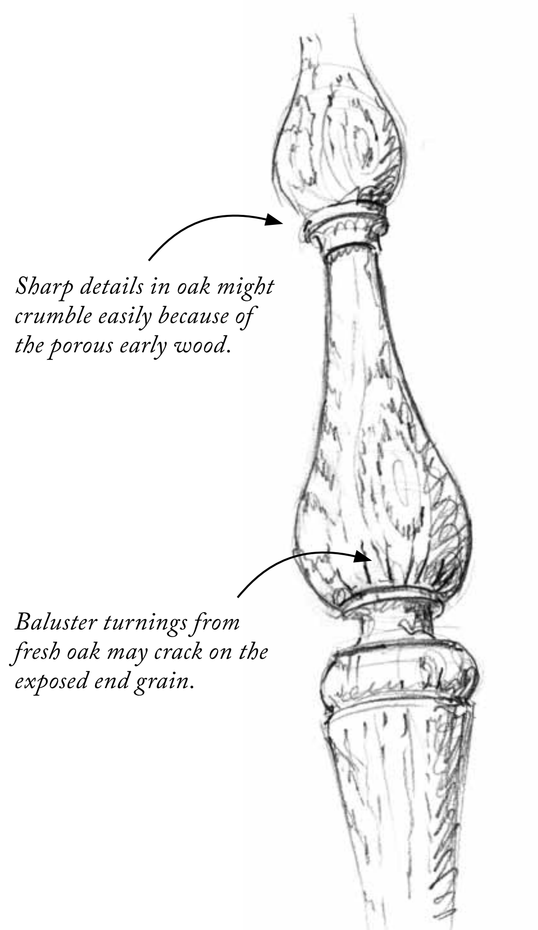



**FIG. 6.9** ***Species selection for turnings is critical.***

red oak for new green woodworkers because of its good behavior when splitting and shaving.

Ash is another suitable wood for these parts, but I haven't used it much. I don't care for the way that the surface tends to peck out when shaving, especially on the radial plane. But for strength, straightness, ease of splitting and abundance, it's a winner. If I had a supply of it easily available, I'm sure I could learn to love it.

I do on occasion use walnut for these parts. Walnut is considered "semi ring-porous," but it won't split like the others. So I get air-dried walnut, chosen carefully for its straight grain, and saw it along the fiber line. It doesn't have the strength of the other woods, but it does bend well. I usually use flat, wide spindles when making a chair from walnut, and these days, I like the contrast between hickory spindles in a walnut chair.

**WOOD FOR TURNINGS**

Selecting wood for turnings based on strength is of the utmost importance to the survival of the chair. The legs and stretchers of the undercarriage and the arm posts above the seat absorb most of the stress during use. Once again, the species of wood for these parts is chosen for its strength, but also for its ease of turning and ability to hold crisp detail. Hard maple is a perfect candidate for this job. Its fine grain and immense strength allow for visual delicacy and high durability. Other suitable turning woods, such as birch, cherry and soft maple, require that the diameter of the thinner parts of the pieces be increased. I also like to use oak for my bamboo and bobbin-style turnings, but I avoid it for turnings with sharp details where the porous early wood would crumble. Green ring-porous woods such as white oak and hickory also tend to check where exposed end grain allows for rapid moisture loss, such as at the bottom of the major swelling in a baluster.

Of course, to get the most strength out of the wood, the shape of the piece must be aligned along the fibers. This is another place where hard maple excels. Unlike the oak-splitting process, where the parts are split long and thin enough to become flexible, and therefore easily bent, the maple is split in large pieces; beyond choosing the location to drive the wedges or froe, there is little ability to guide the split. But maple is generally well behaved and cleaves cleanly.

If the fiber line of the workpiece isn't parallel to the axis of the lathe, you'll find that one side of the turning is always cutting "uphill" because, unlike when working on a flat board, you can't cut each side in opposite directions.

More details on splitting, turning and drying wood for turning is in the chapter Splitting Parts from the Log and turning chapters.

It would be tough to overstate the importance of matching the characteristics and quality of the wood to the tools and techniques used to work them. The hunt for a good log is a worthy pursuit, and the rewards of working with straight, clear material will change the way that you look at wood. Those sawn boards with the fantastic cathedrals and swirling patterns tell a distinct story of their life in the woods and on the saw. While the story might have a happy ending in a tabletop, it's not one that ends well in a chair.

*Turnings that are out of line with the fibers cause problems.*

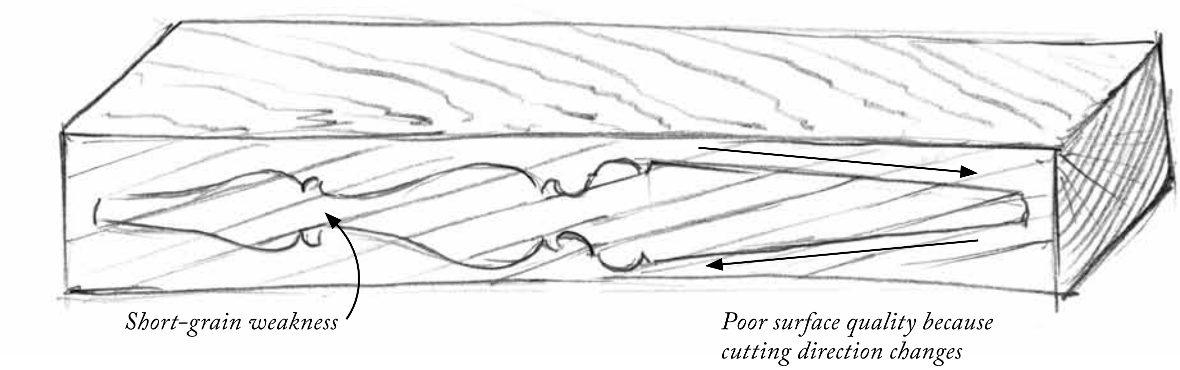
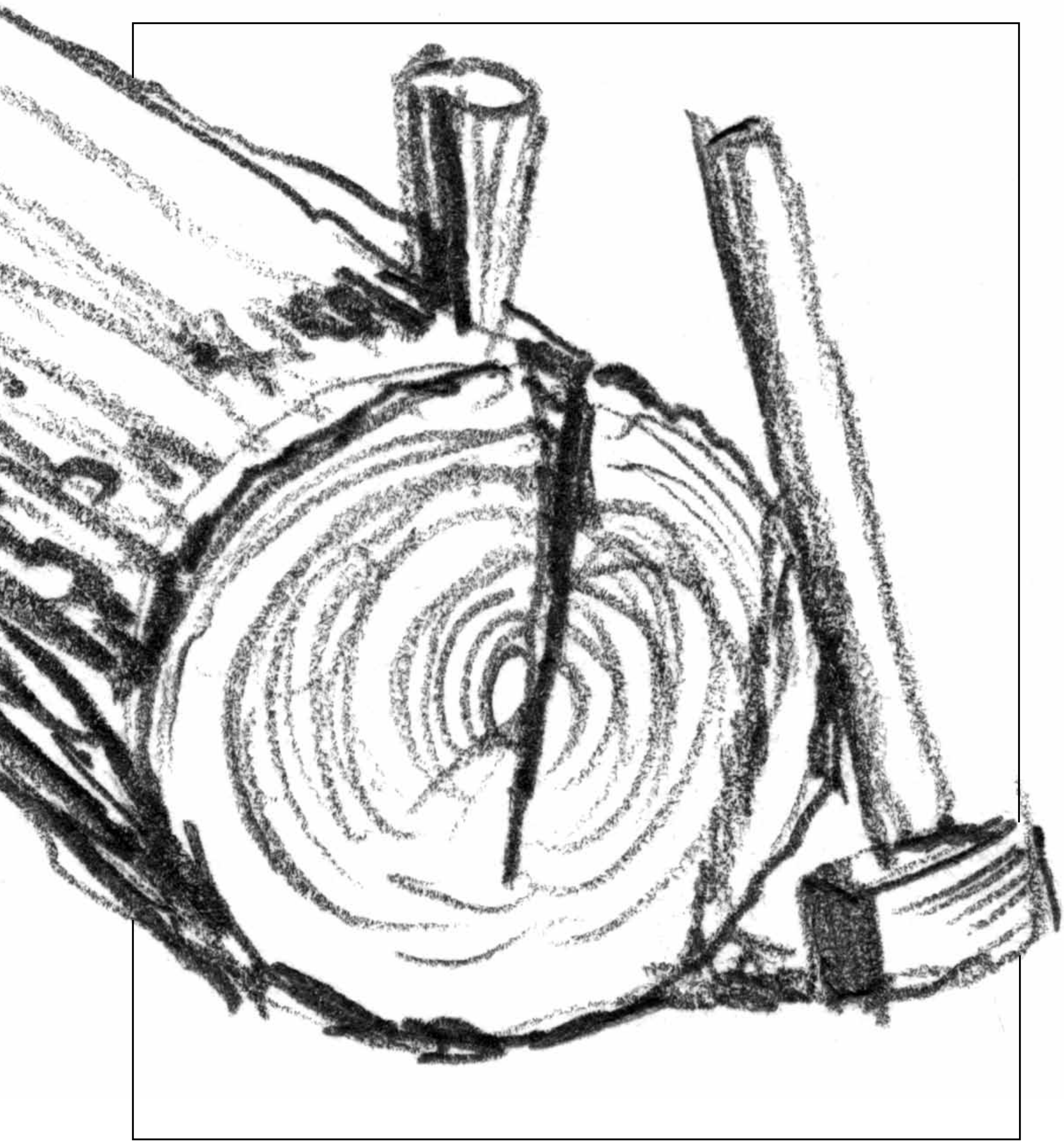



**FIG. 6.10** ***Why it's best to have your turnings follow the fiber line.***



# 7

# An Introduction to Splitting Tools

I can easily recall how mysterious it was to start a project from a log. After years of plywood and store-bought lumber, learning to see furniture parts in the huge bark-covered mass in my yard was a stretch. Although splitting logs for furniture parts might be out of step with your experience, the simplicity of the job is quick to quell any concerns.

A funny thing usually happens when you put a sledgehammer in someone's hands; they swing it like they are trying to win a stuffed animal. When confronting a log, it's a natural reaction, but it's not the best technique for you or the log. While some of the major splits require a good deal of power, getting a tree to give up chair parts is a different sort of work, more about good judgment and finesse than you might expect.

Each blow is meant to send a stress down the length of the log, and a surprising amount of force comes from even a series of light blows. Plus, a series of lighter blows gives the fibers time to separate without running out by minimizing the amount that the two parts deflect. Splitting out parts is more like peeling a banana; you are simply exploiting the weak layer that exists between the strong fibers. Patience wins out over brawn in the long run. After each blow, be quiet and listen as the log groans and yields to the stress. Pausing while the log reacts will also give you a chance to catch your breath.

When you are ready to split the log, it's best to note how much of it you plan to use and to leave the rest in the largest possible pieces to slow the drying process. While it takes more effort, it might be worthwhile to split the log into halves, or even quarters, before crosscutting. More often than not, the log will have some surprises inside, and opening it up first reveals the best options for avoiding defects. If the log has a large swelling at its base, cut it off because it will be a bear to split, plus the fibers are likely to be wavy and full of curves. When moving the log around, swinging the sledge or pounding wedges, safety should be your primary concern. The forces at play when splitting a log cannot be exactly calculated, and any error in estimation can play out on your body.

Splitting tools might seem like rough tools, but to perform properly and safely, they need to be in good shape and properly tuned. Wedges should be ground to a clean bevel, and all of the mushroomed metal on the top of most wedges should be ground to a chamfer. I don't think that I'll ever tire of buying wedges. For a woodworking tool enthusiast, they are about as cheap a garage-sale item as you can seek.

Of course, eye and ear protection are a must. Even a properly tuned wedge can let loose shrapnel on occasion, and the ring of metal on metal for long periods will damage your hearing. The handles of sledgehammers, froes and axes should be tight, so avoid leaving them out in the rain and weather.

A favorite tool of mine is the log peavey, which allows you to roll and move logs with ease. If you don't own one already, you will after straining yourself.

While many of these tools can be found at garage sales, the froe is a rare find, and a good froe is even more

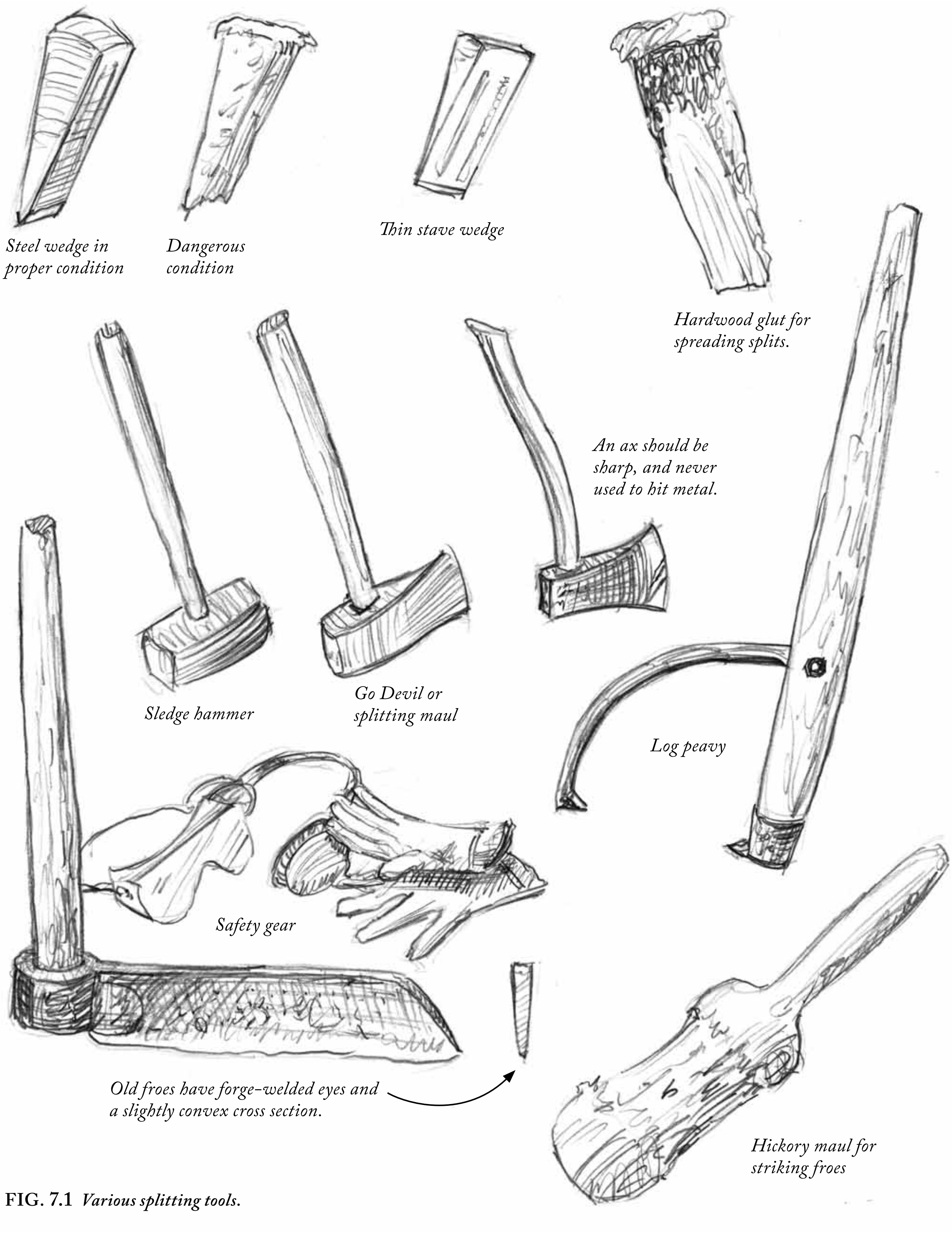



**FIG. 7.1** ***Various splitting tools.***

so. The froe is more than just a bar of steel and a ring where the handle fits. A proper froe is shaped and sized to allow finesse. The blade, which is not sharp, should be slightly convex. This shape allows the tool to lever incrementally as the split opens. Blades that are flat and have a bevel edge at the bottom have only one speed. Many modern froes have straight cross sections and a short bevel at the bottom. It may be worth using an angle grinder to alter these to a slimmer, convex profile.

Froes are always struck with a wooden mallet or maul. Never strike a froe with a metal tool – that will deform the metal on the backside.

I prefer old forge-welded froes. You need only one, but owning different sizes is handy for a variety of jobs. When I use the froe, I try to "sneak" it into the wood without the split running too far into the workpiece. A froe with a thinner profile helps with this.

## Approaching the Log

Most logs have some small or large cracks along the end grain. This is to be expected and is the best place to start the splitting process, because the log will continue to split along this fissure anyway. I always start splitting on the smaller, top end of the tree, where it will split more predictably. Any small error in locating the middle of the large end is likely to play out in more substantial unevenness when the split reaches the other end. This goes for smaller splits as well.

After scoring a 1⁄4"-deep line on the end grain along the split with the wedges, set the wedge into the end grain near the top of the round. Sometimes the wedge will bounce out of the split, which is where slimmer "stave" wedges come in handy. It is usually bad practice to strike an axe or hatchet with a sledge, but I keep an old solid-steel hatchet around to help get splits started in troublesome logs. In time, the sledge will deform the back of the hatchet, but it is helpful enough that I don't mind. If you don't have a slimmer wedge, starting a wedge on the corner of the log can be helpful, but be aware that because there is not much material on either side of the wedge, the crack could run out horizontally. So don't pound too aggressively, and insert other wedges along the fissure as soon as you can.

Once the wedge is set and the split starts to open, set another wedge in the split on the end of the log and drive it in, leaving 1" of the wedge exposed. The split should now run somewhat down the length of the log. Put a wedge in the split running down the bark of the log and, once again, drive it in and leave 1" exposed. That exposed 1" allows you to tap the wedge on its side to remove it. A slower approach usually gives the log time to "unzip" along its fibers. When I set the next wedge in the fissure, I am careful to keep it back from the farthest extent of the crack. Often, what appears to be the end of the crack is just a small detour that the surface material has taken. It's worth staying back where the path is clear.

I leapfrog the wedges down the length of the log until I reach the other end. Never put your hand in the fissure; it can close unexpectedly and crush your hand. I like to have wooden wedges, called "gluts," on hand for this process to keep the fissure open.

So you've made a crack down the whole length of the log and it is still holding tight. What next?

Depending on the species, the log might still have a lot of wood holding it together from the opposite side. I pound in hardwood wedges to free my steel ones, leaving the wooden ones in place. Then I take my peavy, roll the log and repeat the wedge-driving from the other side of the crack. This may not separate the two halves either. But take heart: A log that is tough to split is often a good sign that it will bend well.

Once the second side is split open, I take a hatchet and cut the "webbing" that connects the two halves, being careful to stay clear of wedges. If I can't reach in far enough with my hatchet, I drive a steel wedge alongside a wooden one to spread the halves. Usually this will get the job done. Avoid the temptation to pull the log apart with your hands, or it likely will have that effect on you. Yes, I mean that the log will pull you apart. Remember, you are just muscle, bone and tendon competing with a huge mass of wood under extreme tension. Just keep finding and cutting the webbing and get ready to get your feet out of the way when the halves break free and roll to the side.

I usually roll one half of the log face-down on some small sticks in a shady spot for later use, then split the other half for parts. I usually split the log into quarters before doing any crosscutting. It's disappointing to cut a piece to length and discover a fatal defect that you couldn't see.

You should expect the first split on a round log to be tough, but the subsequent splits are much easier because the circular tension of the log is gone.

When I process a log into parts, I keep my pieces off the ground and free of dirt or rocks, which will ruin the

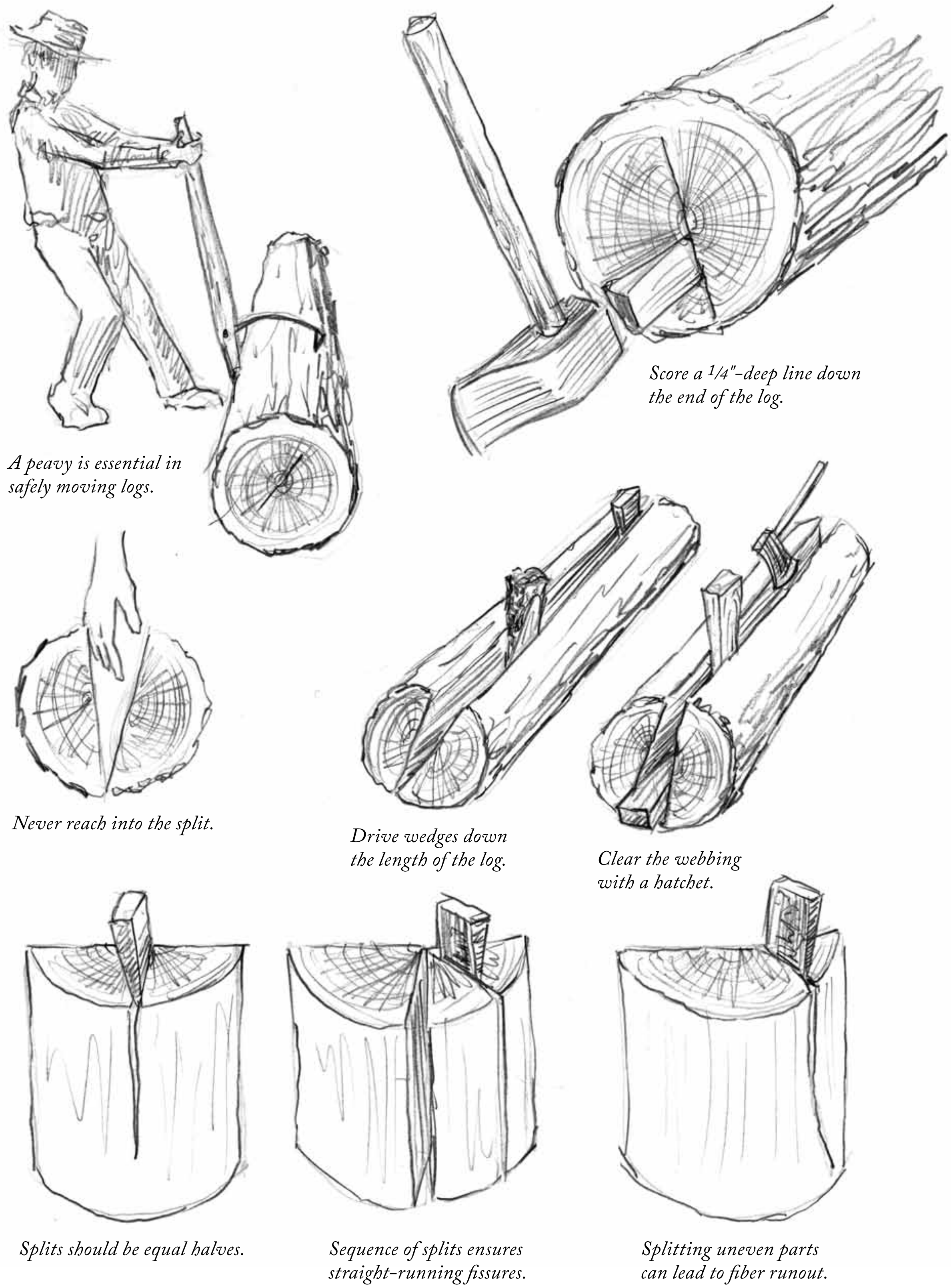



**FIG. 7.2** ***The basics of splitting a log.***

edge on my sharpened drawknife. Wash the log with water and a brush if there is dirt embedded in the bark or wood. Once I have split the parts to eighths or quarters, depending on the size, I look at the end grain to plan out getting the parts I need for the chair I am making. My first thoughts usually turn to getting my longest bends out of a split portion, then I look to getting the spindles out without running into defects. The orientation of parts can be based on your preference or what the log can yield. If the log has high-quality straight wood only near the bark, then split out wide pieces parallel to the bark.

If the piece is still too large to handle with the froe, I determine a spot to split it along the growth rings with wedges so that the split runs straight. First, I determine

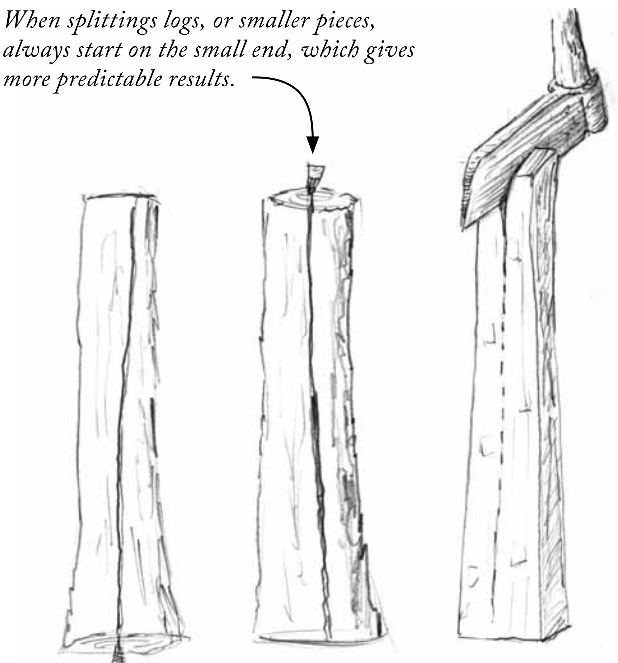



**FIG. 7.3** ***It's best to start a split at the small end of the log.***

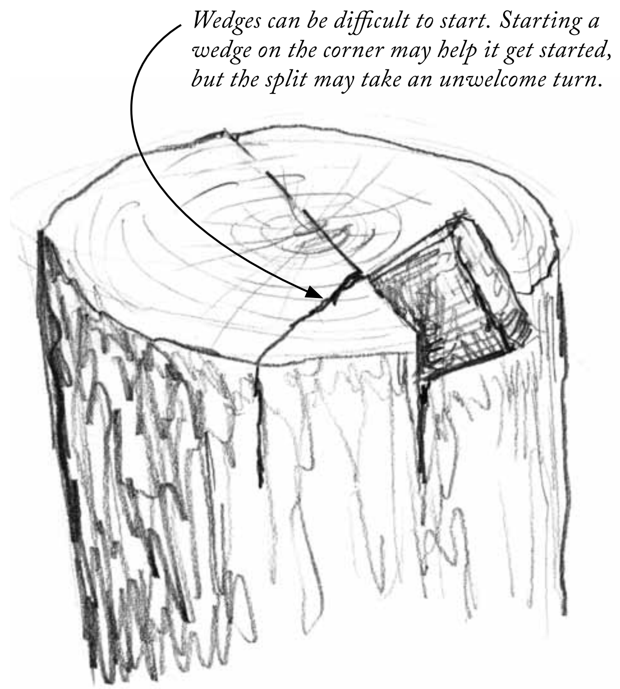



**FIG. 7.4** ***The danger of starting a wedge on a corner.***

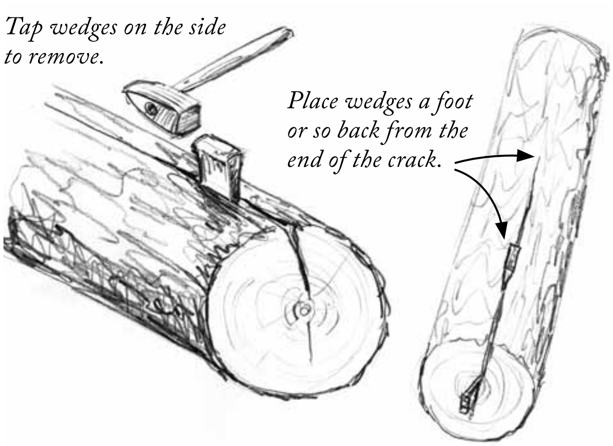



**FIG. 7.5** ***How to set wedges along the length of the log.***

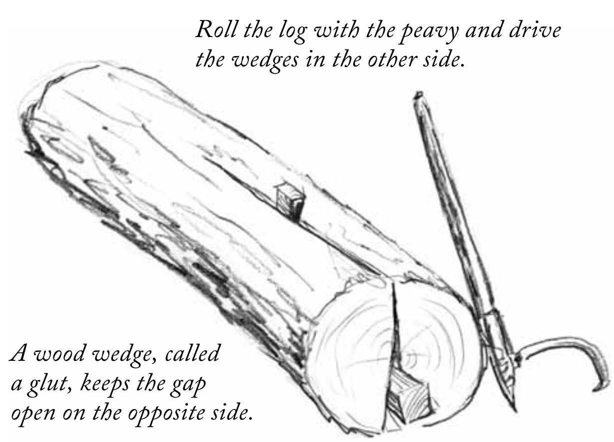



**FIG. 7.6** ***Splitting tough logs.***

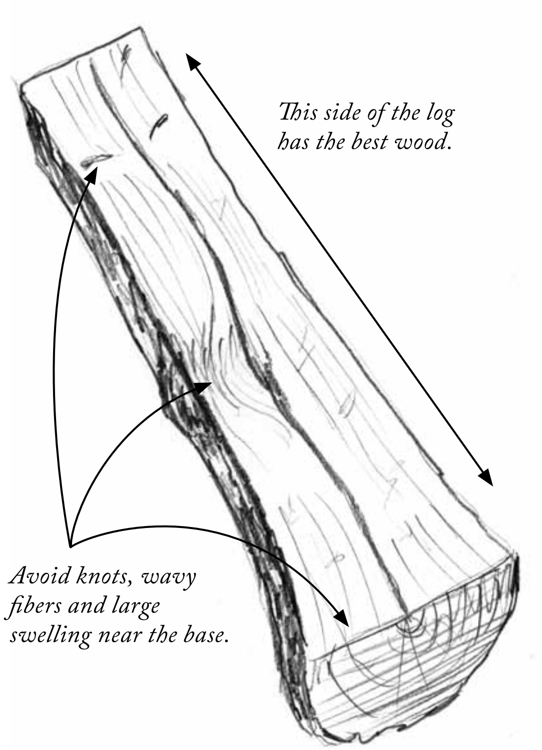



FIG. 7.7 ***Defects you can spot once a log is halved.***

if I should split off the wavy area near the pith by itself. If it is especially large, this may be the best course because the the wavy nature of the wood near the pith can make it difficult to predict what this section will do. Also because of the pie shape of the piece, the wavy section will usually be smaller, and any miscalculation or runout of the split will run into the trash wood. On occasion, I will include an extra inch or two of the "good" wood to split away with the pith, if I feel that it will better approximate the two sides being equal. Later I can separate the "good" wood from the pith. Experience is a good teacher here. I focus on keeping only the very best wood because my time is worth far more than the cost of the material.

## Riving Parts with the Froe

Riving parts from a log is like unzipping a coat. On a coat, the sides of the zipper provide a path for the joining mechanism that is predictable and easily followed. On the other hand, we've all seen a child yank on the sides of the coat, causing the zipper to jam or break (I remember

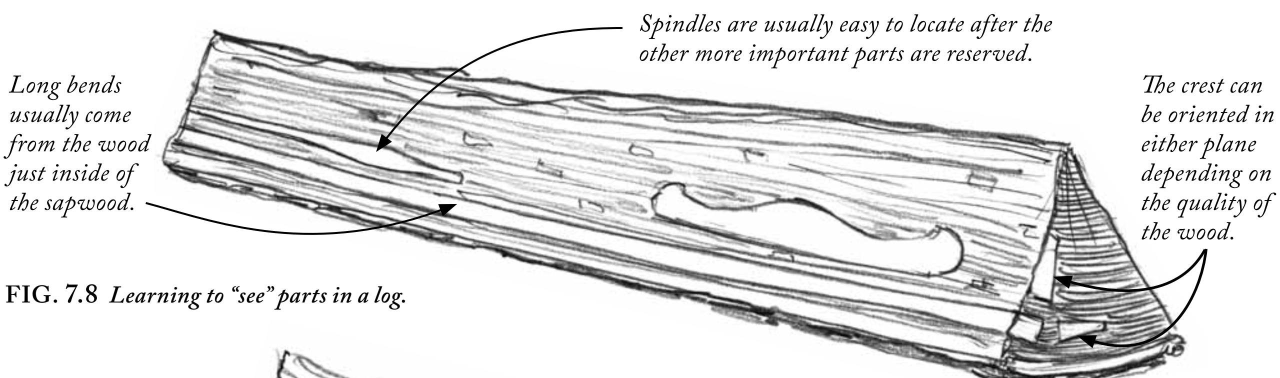



FIG. 7.8 ***Learning to "see" parts in a log.***

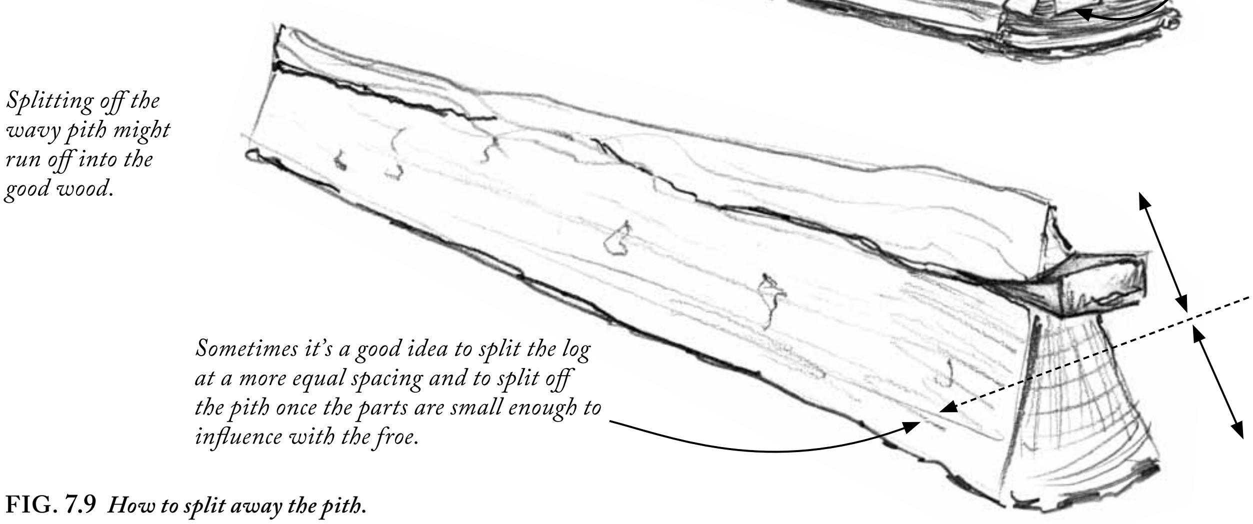



FIG. 7.9 ***How to split away the pith.***

being that kid). Wood is the same way. Trees have a weakness between the fibers that we can exploit to split out the parts we need. The fibers are solid and don't break easily; however, if the forces are applied incorrectly, we override the wood's natural tendency to separate between the fibers and the force will try to run out through the side of the piece instead.

While good technique is essential to success, not all ring-porous species will react the same to being split.

Red oak tends to split easily and cleanly, but can also have a split run across the fibers very easily, whereas a split in white oak doesn't run so far ahead of the froe, but tends to stay in line. My recommendation is to use white oak if you can; even though it takes more work to split the log and parts, the fissures tend to stay more in line with the fibers, which is helpful for the newcomer. Usually, I

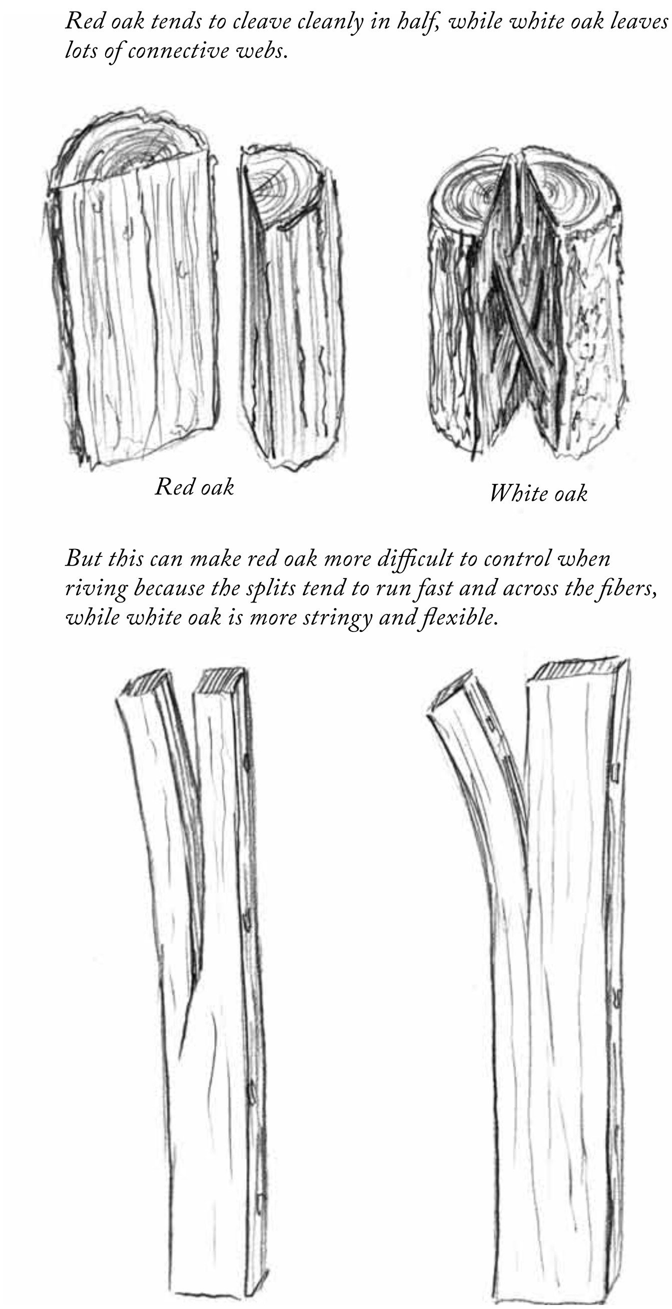



**FIG. 7.10** *Splitting qualities vary by species.*

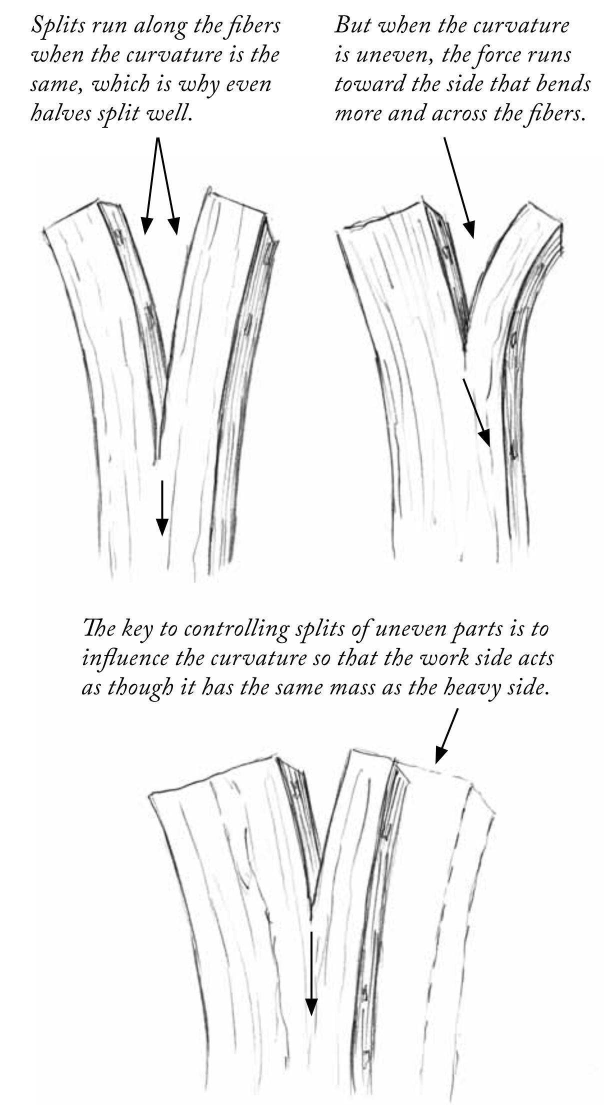



**FIG. 7.11** *Splitting unequal-sized parts can be tricky.*

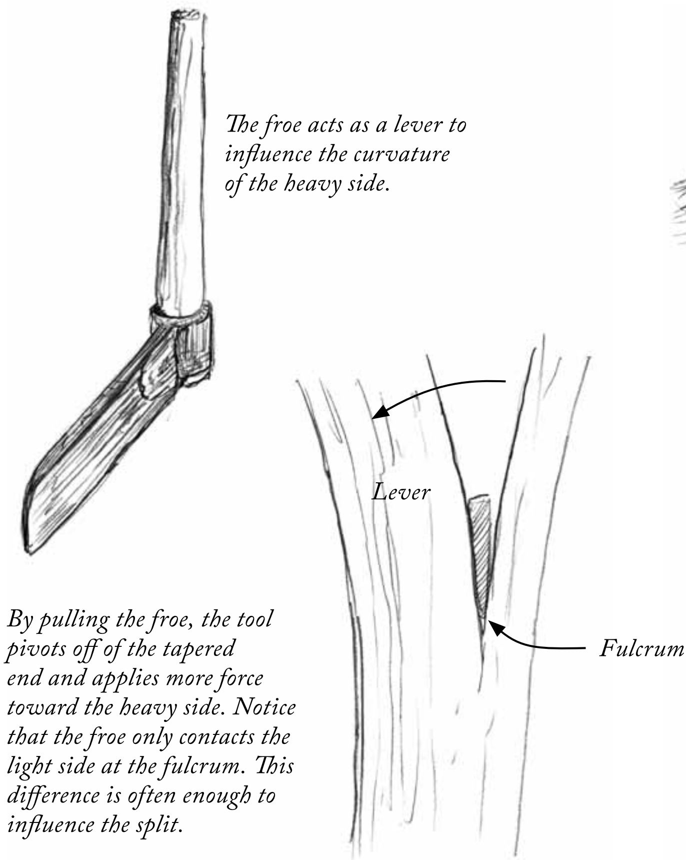



**FIG. 7.12** ***How to steer a split with a froe.***

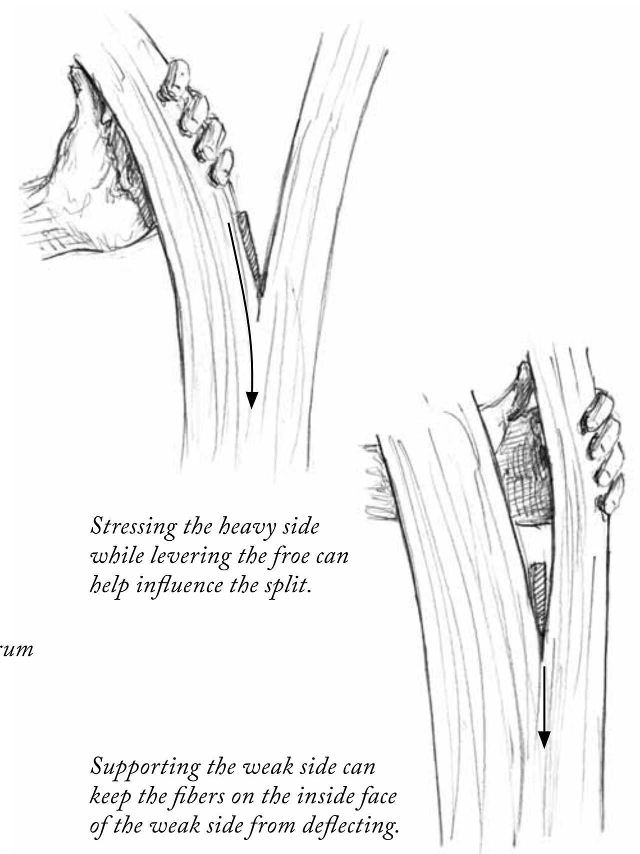



**FIG. 7.13** ***You can also apply pressure with your free hand to correct for the unevenness of the parts.***

peel off a small piece of loose wood from the split log and wrap it around my finger to see how it breaks, which is a good indicator of how to proceed with splitting, as well as how well the wood will bend. If the small piece breaks easily under light deflection, it will likely split easily, but perhaps be difficult to control. This can also be a warning that the wood might fracture easily when bending.

But regardless of the species, the tools and concepts are the same.

While splitting the log in half, the equal masses of the sides deflect equally and cause the split to run straight down the fiber line between them. No matter what size of the workpiece, this is the usual result of splitting a piece in equal halves. But when extracting parts, it isn't always possible or desirable to split each piece equally in half.

When the parts being split are unevenly sized, the froe and some pressure can make two unequal parts act as though they are equal. When splitting unequal-sized parts, the weaker side bends more easily than the stronger one. This causes the fibers on the inside surface of the weak side to rupture and the split to run out.

To control the split and have it run straight down the piece, you either have to strengthen the weak side or weaken the strong one. This is done by using the froe and your free hand. Merely pulling the froe in the direction of the larger side in the split begins to correct for the unevenness. This is because the froe acts as a lever. The fulcrum is at the bottom of the blade, which is wedged in the split, and the leverage is exerted farther up the stronger side, causing it to bend more. The only contact that the froe has with the lighter side is at the fulcrum. It's important to set the froe so that the entire width of the blade is buried in the split before trying to apply leverage, otherwise it will simply pop out of the split. Froes should be struck only with wooden clubs or mallets, never with metal hammers, which will deform the tool.

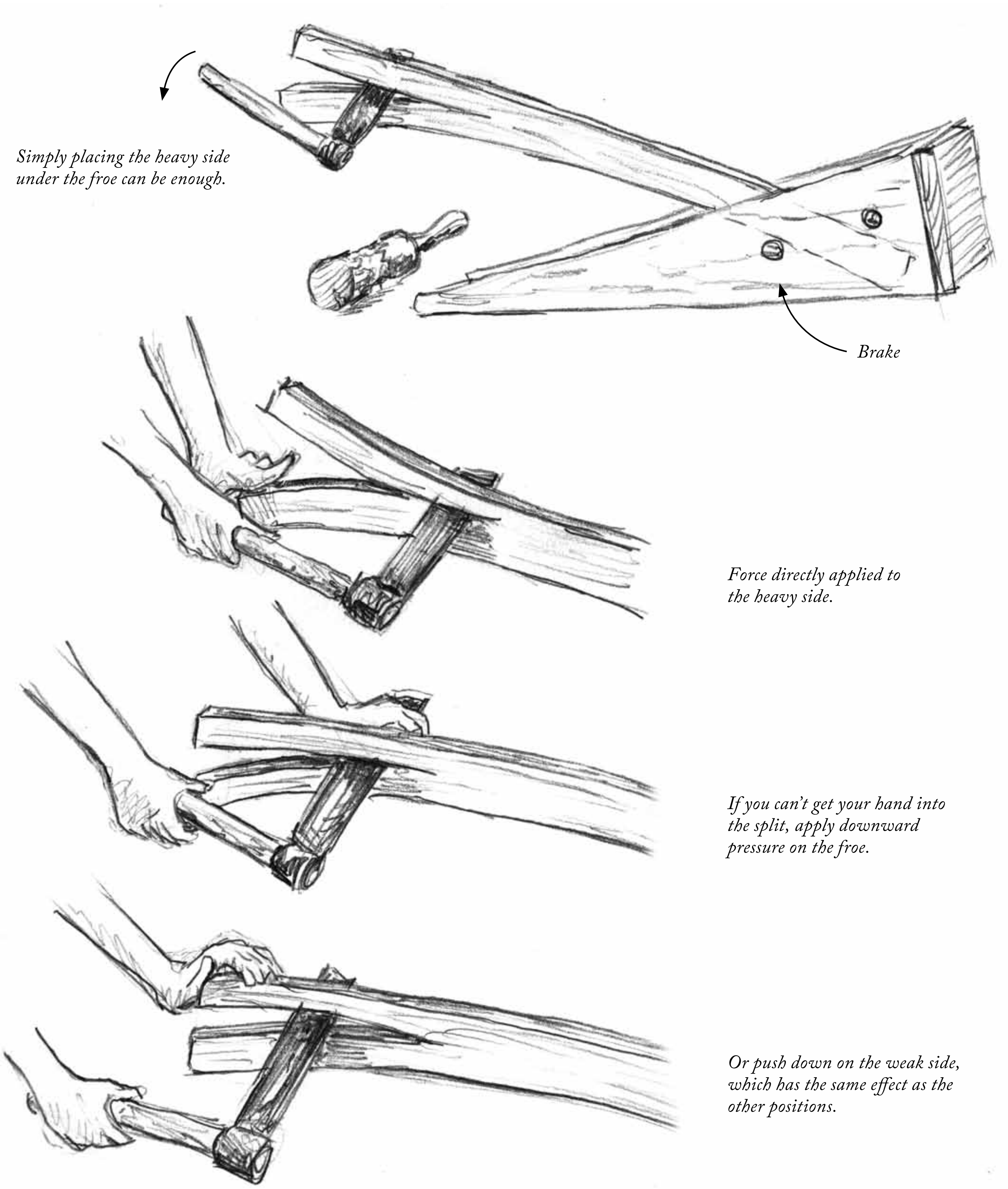



**FIG. 7.14** *How to steer a split in a brake.*

Using a brake to hold the piece as you split it affords you the opportunity to use your body weight. (Plans for a brake are in The Chairmaker's Workshop chapter.)

Face the heavier side of the split down in the brake and place your hand in the split, applying pressure on the strong side (lightly). If you can't get your hand in the split, push straight down with the froe, which has the same effect. I've also found that putting pressure directly on the light side has a similar result to stressing the heavy side. By supporting it while pushing down on the froe, more of the force is directed toward the heavy side.

When the correct pressure is applied, a little downward pressure on the froe handle will cause the split to run straight. Take it slow and you will hear the quiet "unzipping" of the fibers. If you hear the sound of a stick being snapped, the split might be breaking across the wood fibers and toward the side. It's important to watch both sides of a split to make sure that it isn't running out. If the split does do this, don't panic. Release the extra

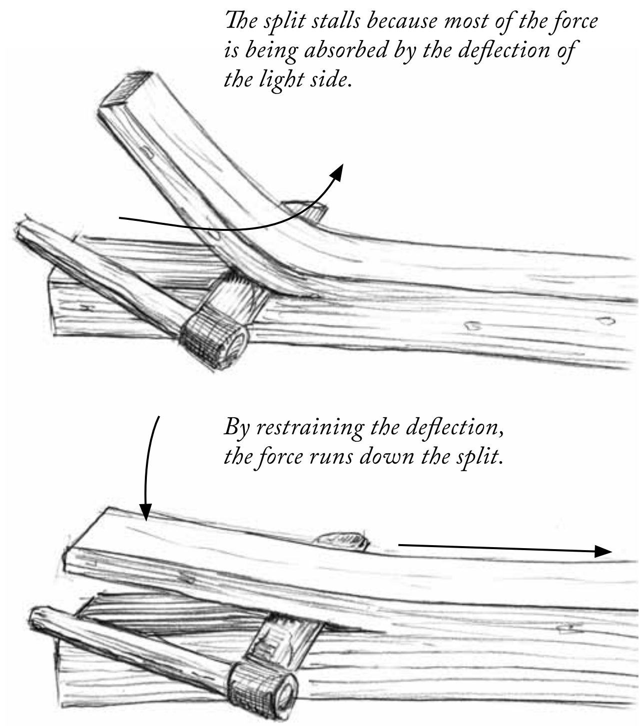



**FIG. 7.15** ***Fixing a split that has stalled.***

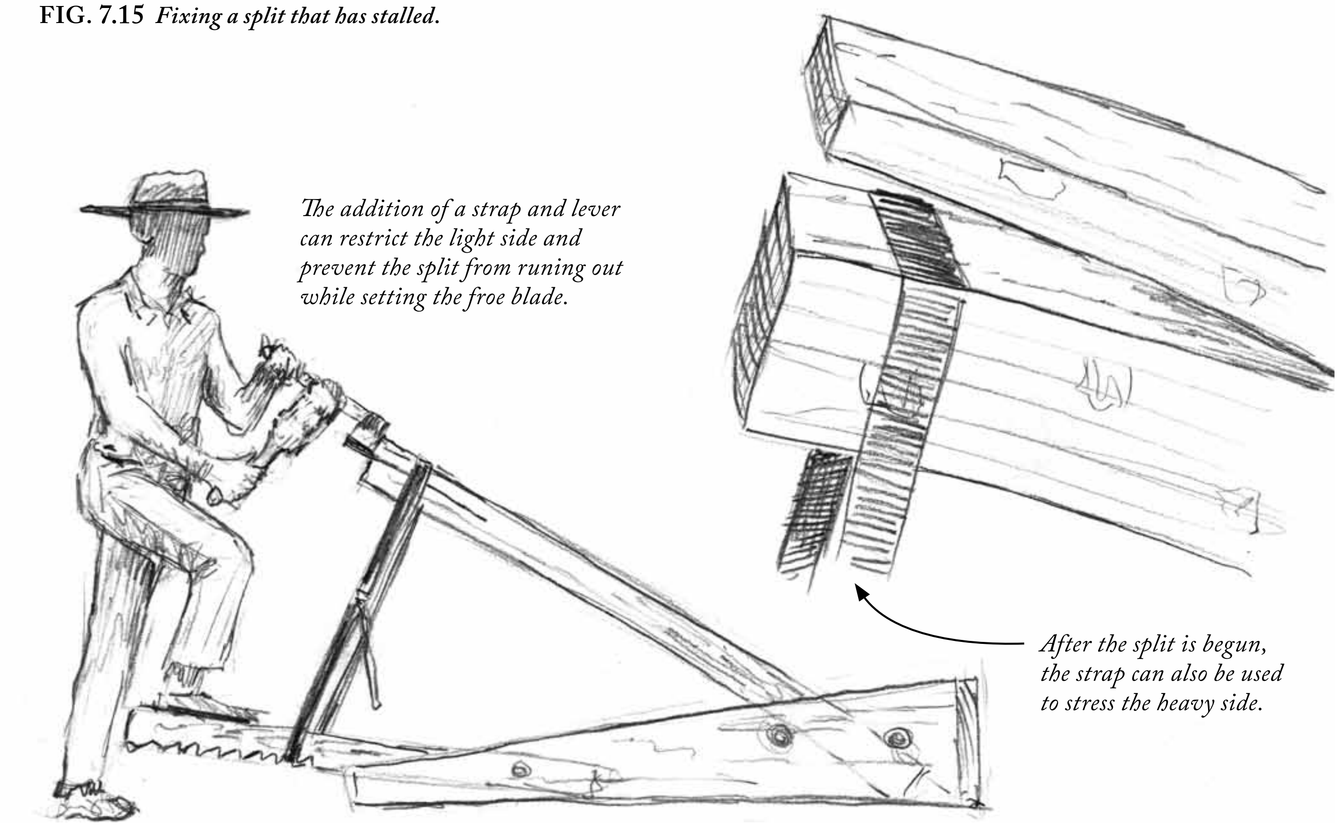



**FIG. 7.16** ***A strap and lever on your brake can increase your control.***

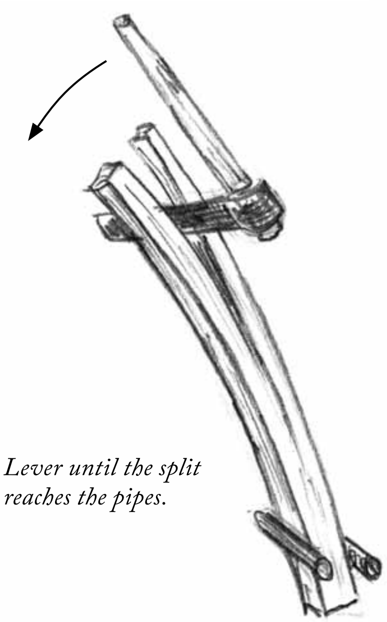
weight on the downside and see if it runs straight or corrects when twisting the froe. If not, try rolling the piece over so that the side to which the split is traveling is now on top. A slight twist of the froe will tell if the stresses on the piece are even again.

A curious thing about riving is that once the pressure is equalized and both parts are curving the same, the split will run with little twisting of the froe. If the split isn't running and you are twisting on the froe, it may be a sign that the curves leading into the split are not balanced and the force is trying to run across the fibers and out the side. Sometimes a subtle adjustment in pressure will correct for this, and without putting any more pressure on the froe the split will run straight.

Riving eventually becomes second nature, with the sound and resistance of the wood guiding your actions. Practice with long (4'-5'), thin pieces. You will have the most control with these because of your ability to flex them. The shorter and/or fatter the piece, the less control you have. Move as though you were filmed in slow motion and you will have the right speed to unzip the wood.

One valuable addition to my brake is a lever and strap. It enables me to achieve unequal splits that might otherwise be unsuccessful.

The lever pivots on the pipe nearest to me in the brake and the strap goes up and around the work. When splitting unequal-sized parts from a blank, I loop the strap over the workpiece, being sure that the smaller of the two parts is facing up, and I stand on the lever while I knock in the froe. The extra support on the smaller part helps the froe get seated without the split running toward the weaker side, which it is apt to do. After that, I can usually continue the split using just my body weight. If I am trying to split uneven pieces, I may place the loop around the heavier part (the lower piece) and use my foot to stress it while I press on the top piece. This equalizes the curvatures of the two parts and the split runs straight. Often, applying more pressure on the froe is not what gets the split to run; instead I adjust the pressure on the workpiece until the curves are even. When the curves are even, the split can follow the easiest path along the fibers and the two pieces "unzip."

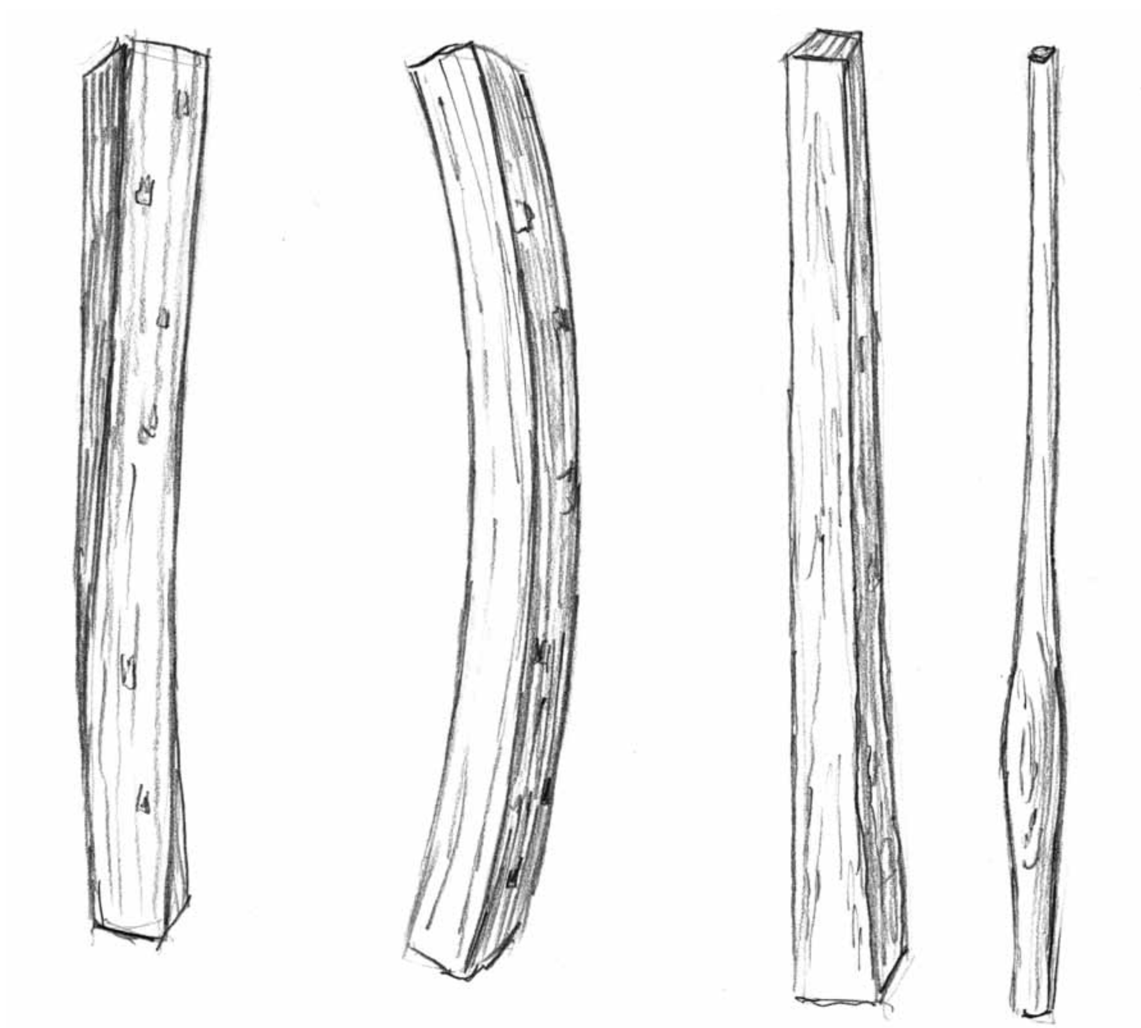


*Lever until the split reaches the pipes.*

*Then set the light side on the ground and stand on both sides of the froe to finish the split.*

**FIG. 7.17** ***Finishing a split.***

When you get close to the end of the split, the pressure from the brake that holds the piece also keeps it from splitting. Because the direction of the split is pretty much determined by this point, the idea is just to "pop" the pieces apart. I do this by placing the lighter of the two sides facing down on the floor and stand with one of my feet on the blade of the froe and the other on the side near the handle. Then I pull up on the handle. The pressure of my weight pins the light piece flat to the floor so that most of the force is directed at the larger piece. Most of the time, I try to keep my workpieces off the floor, where they can pick up dirt that wrecks my sharp tools. If you use this technique, make sure that the floor is swept clean, or use a fresh patch of grass.



*Twisted* — *Bowed* — *Tapered*

*Twisted parts usually work out fine when they make round parts or get bent.*

*Bowed parts can be straightened later.*

*Tapered splits work for tapered parts.*

**FIG. 7.18** ***Some unintended riving results can work fine in your chair.***

## Common Riving Situations & Solutions

For folks used to running lumber across a jointer and planer, the results of splitting parts can look downright odd. There are a few common results that are strange looking but will work fine in a chair, either because the process washes out the problem, or there is actually no problem at all.

Splitting logs becomes intuitive once you surrender to the fact that the nature of each individual piece of wood is going to dictate your approach. Some wood is cooperative and some wood takes every technique you've got, coupled with patience, to yield decent chair parts. Regardless of the muscle, time and waste, splitting is still the most effective way that I know to get chair parts that flow quickly through the process using simple hand tools.

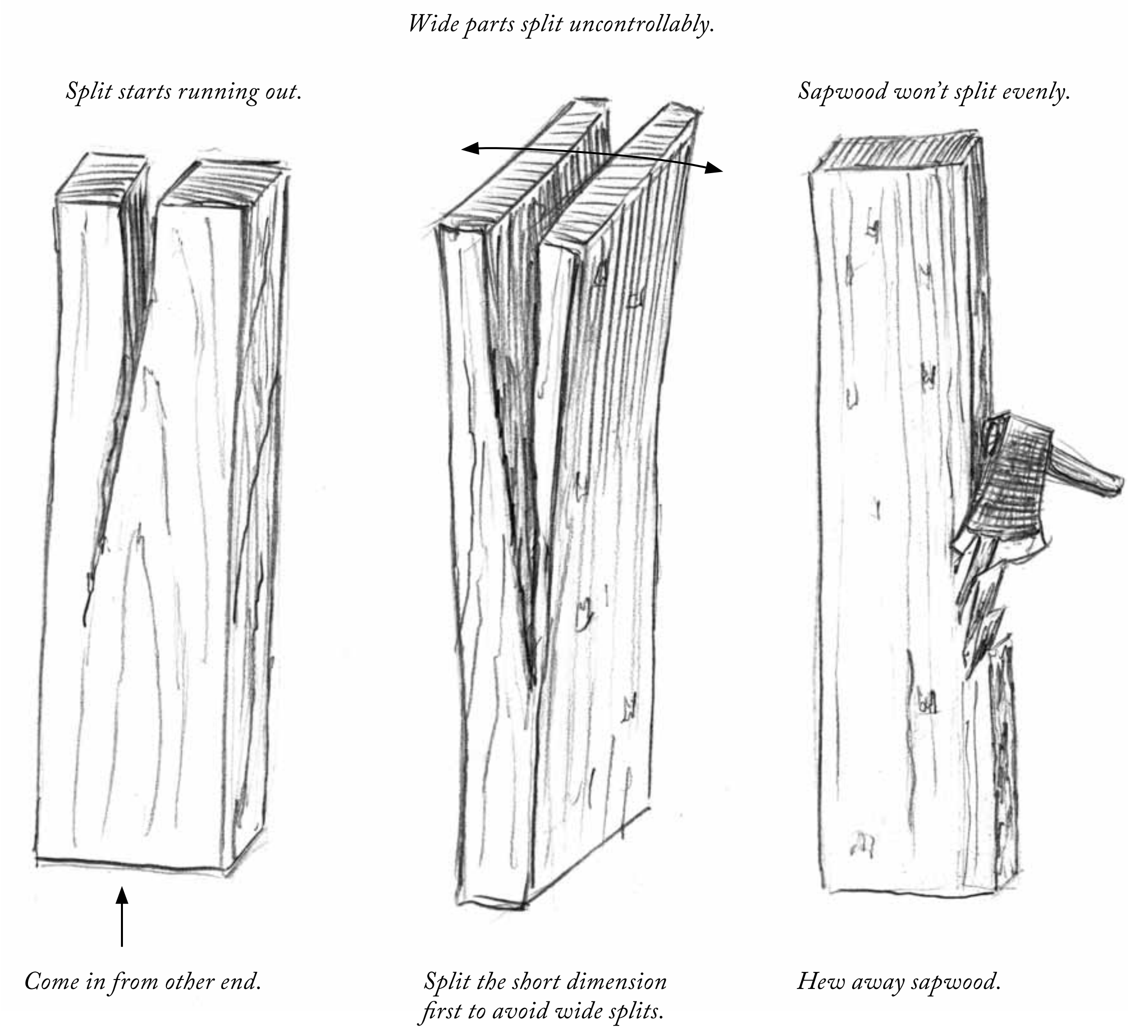
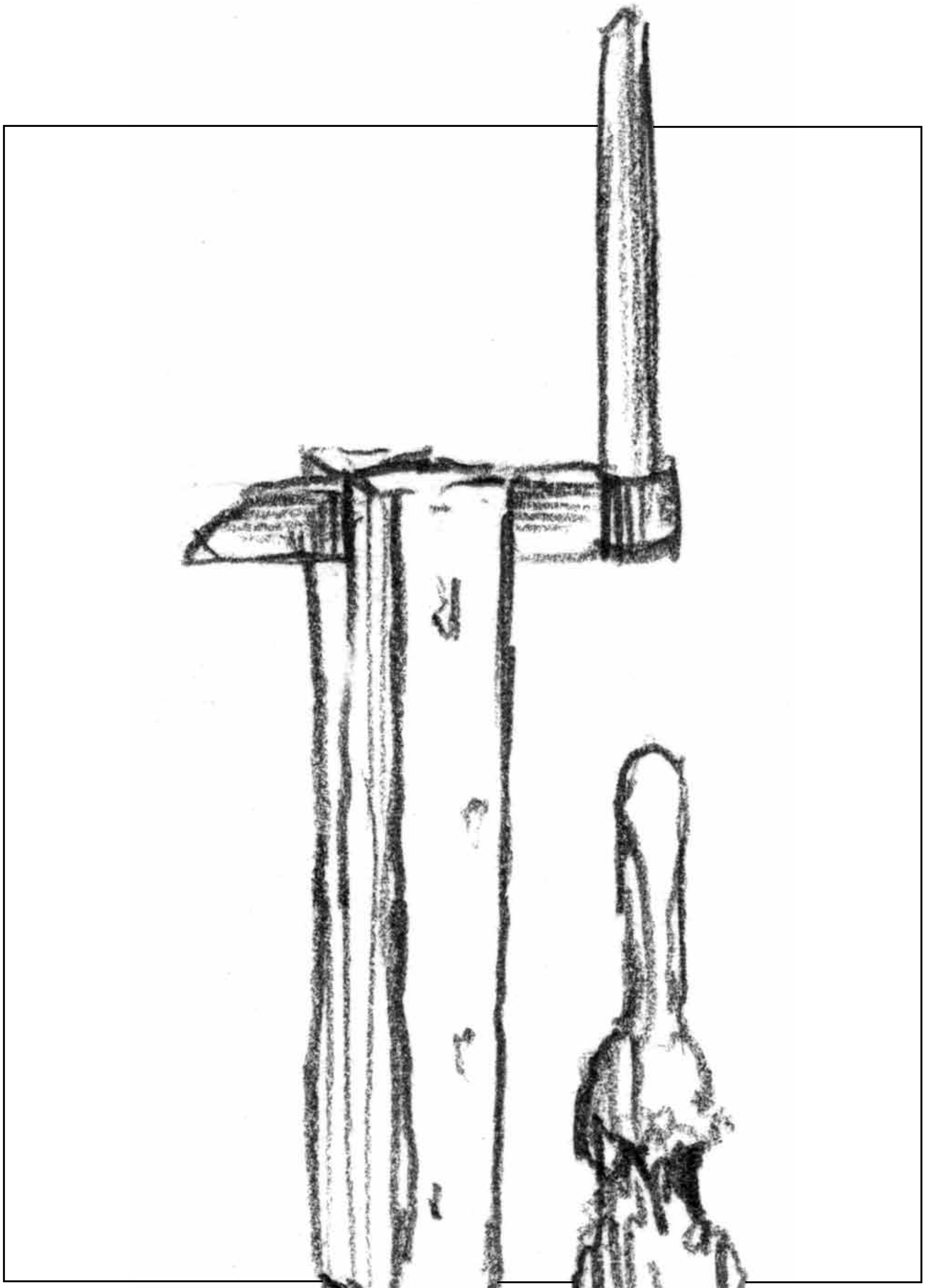



**FIG. 7.19** ***While splitting, there are common issues that arise. The solutions generally call for changing the forces that you are applying, but there are some other steps you can take.***



# 8

# Splitting Parts from the Log

I always approach the log with a cutlist of parts for my chair and start to envision where they will come from after the first split. The quality of the log plays a role when dividing it in a logical and clear fashion. Don't be discouraged if your first log choice makes this process less than simple. With some effort, you will get the parts you need and can chalk up the rest of the log to good exercise and home heating, just like I do.

Here I'll present strategies for getting the parts for two project chairs from a log, then I'll give some notes for those using straight-sawn (air-dried, I hope) wood. First, I'll cover splitting the parts for the upper portions of the project chairs out of ring-porous hardwood, then I'll show splitting strategies for the undercarriage portion out of maple. The plans for the chairs are included in the chapter Chair Design & the Plans in this Book.

## Parts for the Balloon-back Side Chair

The balloon-back requires one long piece (61") that will be bent for the bow, and seven shorter pieces (23") for the spindles. All of the pieces will be split as 1" x 1" squares. I always split the log into quarters before crosscutting so I can avoid any inclusions or trouble spots. Because the bow is more than twice as long as the spindles, I'd first crosscut a 62"-long piece (extra for trimming) from the section of the log, and once I have my long bow piece, I can crosscut the rest of the piece in half to get my spindles.

I usually get my pieces for bending from the wood closest to the sapwood because it is the straightest heartwood. When splitting oak, I usually discard the sapwood, which is less dense and less rot-resistant. If the tree is

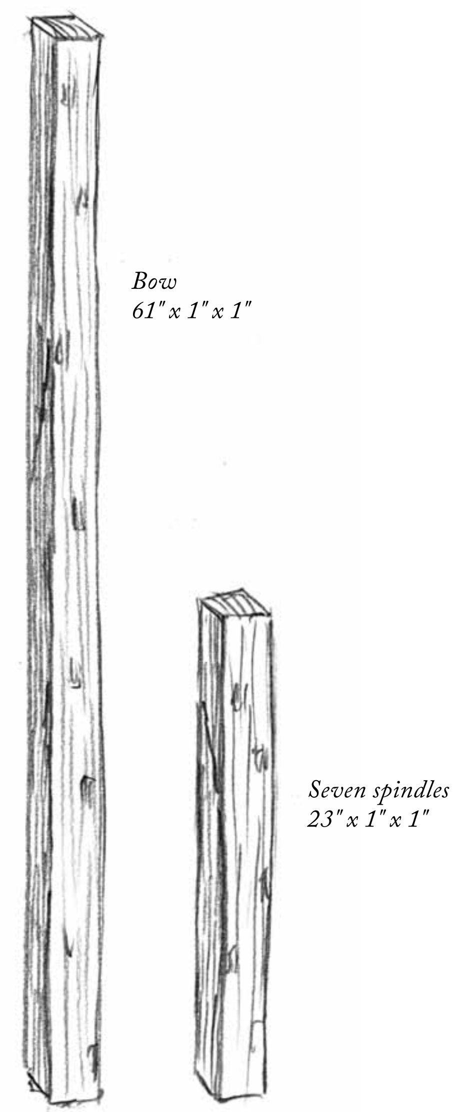



**FIG. 8.1** *Rough splits for the balloon-back chair.*

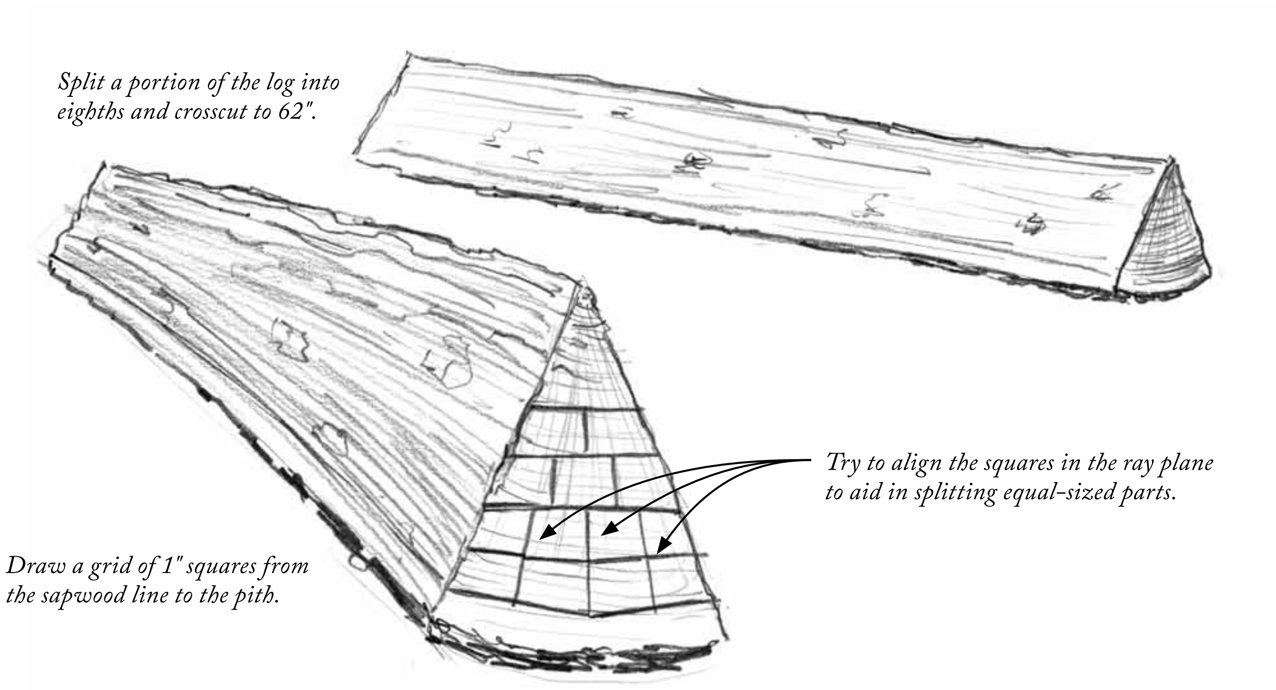



**FIG. 8.2** ***How to mark parts on the log for the balloon-back chair.***

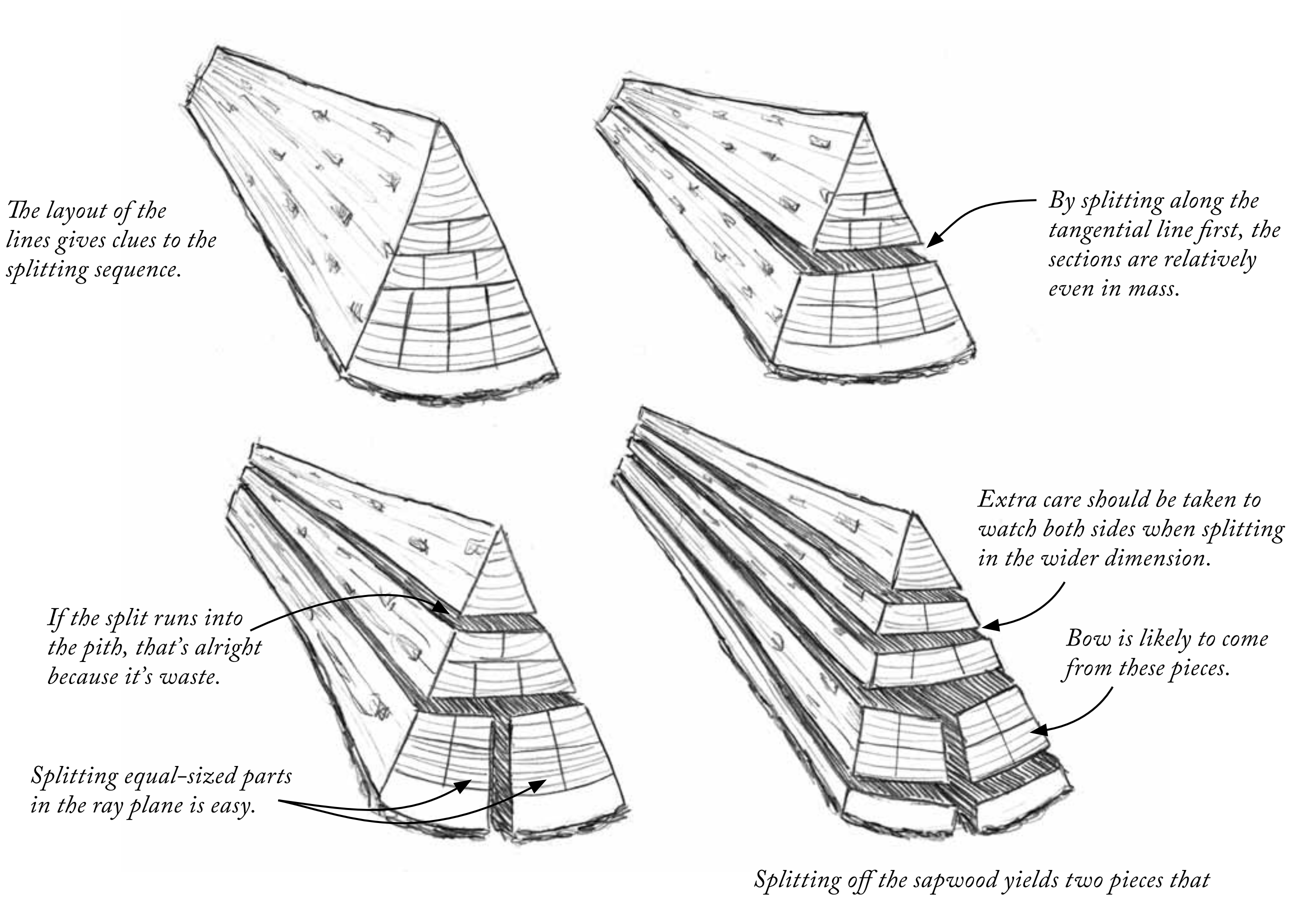



**FIG. 8.3** ***One splitting sequence for a balloon-back.***

freshly felled, however, I might consider using the sapwood because it is the straightest, clearest wood on the log. Even if I don't use the sapwood in the chair, I can use its mass during the splitting process to help get good splits out of the billet, especially for the bow.

My strategy for riving square blanks is to mark a series of lines along the growth rings, starting at the border between sapwood and heartwood, in 1" increments toward the center of the tree. The process is usually a compromise between what parts you need and a plan that you can devise for splitting the parts most evenly.

After drawing the lines along the growth rings, I divide each row into 1" squares based on how many will fit. Sometimes, I'll fudge one of the lines or number of spindles in a row to make it line up with a line in another row. The final size of these parts, when shaved square in cross-section, is actually about 3⁄4", which gives me some leeway. Even though the froe can help influence unequal splits, a more forgiving plan is more likely to succeed. After my grid is laid out, I decide in which order to make the splits. My goal is always to split the piece in equal halves, especially when the billet is still large and difficult to influence with the froe and pressure.

When given a choice, I usually make a radial split first because the ray plane runs straight from the bark to the pith, while the tangential runs across the curved growth rings. In oak, the ray plane also has the rays embedded in it, which aids in splitting. However, in this illustrated sequence, you'll note that I avoid the long radial split that would yield even-sized pieces. I do this because the great difference between the long length of the split and the short width of the piece would make controlling the split difficult. In this way, I am obeying one of the most important factors in my sequence of splits, which is that I am left with halves that are more square than rectangular. If you start to get wide splits, it is more difficult to marshal the forces to split them equally. You'll notice that the control that you can exert increases as the parts get thinner.

At some point, you will find yourself splitting a piece into thirds. This can be tough because just seating the froe can be enough to get the split running out before you get a chance to influence it. In the sequence above, you'll notice that I avoided splitting the section that's divided into thirds until the parts were thin enough that I could exert influence over them while splitting. I've also found it helpful to tap the froe in slowly so that the split doesn't run too far ahead before I have a chance to influence it. There is more information in the chapter Splitting Parts from the Log.

## Parts for the Fan-back

Parts for the fan-back are split much the same way, except that there is a wide crest to deal with. The crest is 26" long, so I crosscut one section to this length and expect to get some spindles and the crest from this. Just as with the balloon-back, I need seven spindles, but these are shorter at 20" long.

Here are a couple of layout suggestions for the fan-back's crest and spindles. The orientation of the crest depends on the size of the log and personal preference. Orienting it in the ray plane will make it easier to split

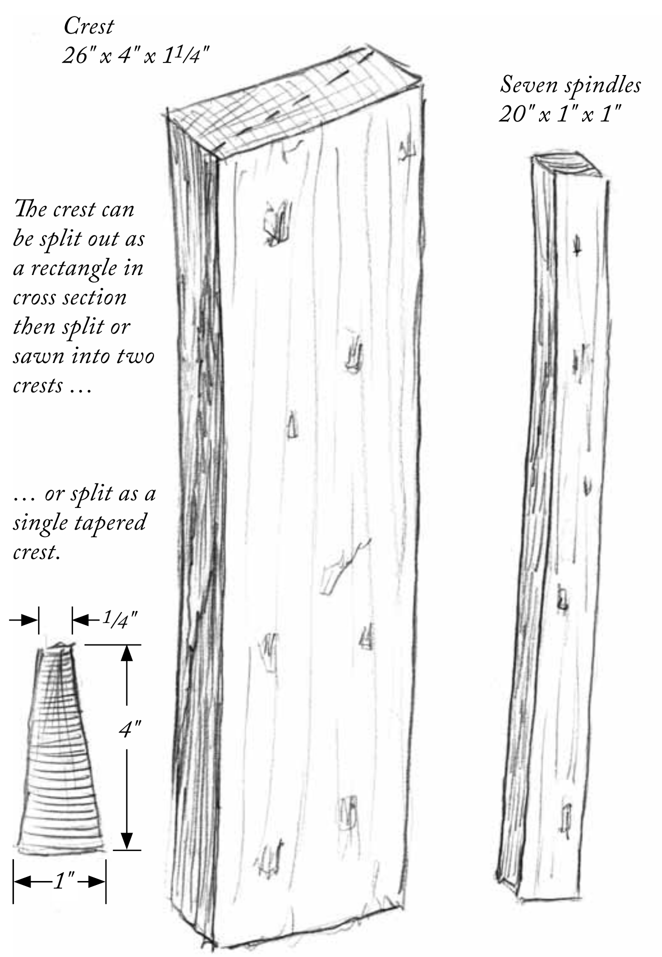



**FIG. 8.4** *Rough splits for the fan-back chair.*

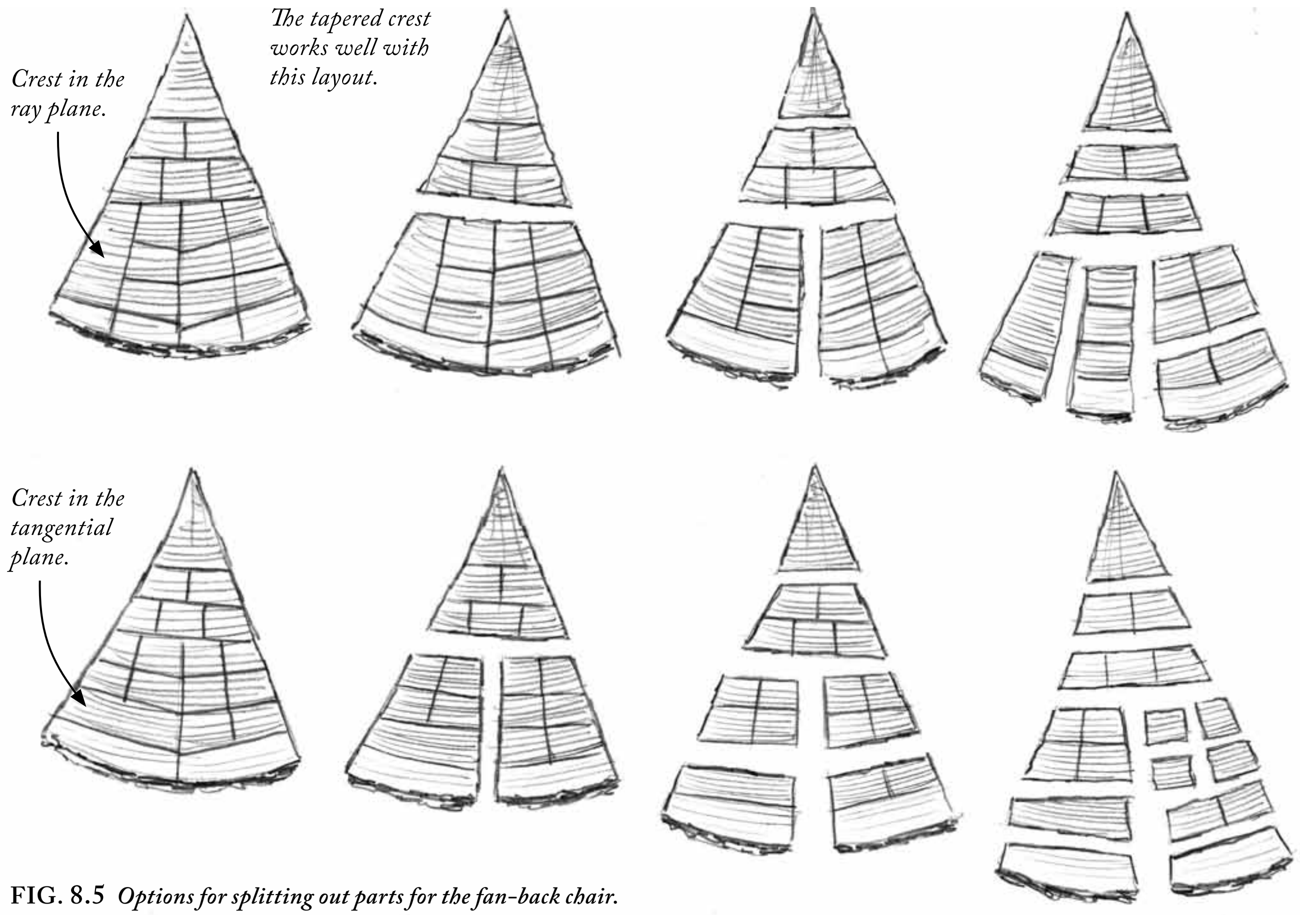



**FIG. 8.5** *Options for splitting out parts for the fan-back chair.*

and shave, but if the log isn't large or has lots of defects near the pith, it may be best to split the crest out of the tangential plane.

## Drying Parts for Shaved & Bent Parts

Once the parts are split, I shave the spindles. Then the bow or crest. If I cannot shave and shape them immediately, I store the parts under a tarp, away from heat, wind and sunlight. I check the parts often to make sure that they aren't drying too fast (checking) or turning colors from mold.

Air-drying wood from a green state is simple once you've worked the parts to their rough shapes. The ratio of surface area to mass allows the moisture to leave the wood evenly as long as you don't shock it by putting it in a kiln or in direct sunlight too soon. I don't bother to coat the end of the parts unless they are thick and made from woods that tend to check more, such as hickory or white oak.

Some woods, such as red oak with its long and hollow fibers, dry faster and with less chance of problems. I simply let these parts sit in my shop until they stop losing weight or distorting, which, depending on the season, can take days or weeks, depending on the size and shape of the part.

I leave green spindles to air-dry for a day or two before placing them in the kiln, but I like to leave larger parts or bent parts out of the kiln for longer. This avoids shocking them with the low humidity as well as introducing too much moisture into the kiln that drier parts then have to absorb. Spindles can be placed in the kiln while still octagonal, which is my preference, because I can refine them once they are dry, and eight sides are easy to adjust. Although you can round them when green, be sure to leave the tenons oversized. There is more information on the actual sizing of parts in the shaving and shaping parts chapter.

If you are making parts in batches, you can leave them indefinitely after shaping and air-drying.

## Parts for Turning: Legs & Stretchers for Both Chairs

Splitting parts from a maple log for the legs and stretchers for turning is different than splitting the ring-porous woods mentioned above. As I mentioned previously, I've found that oak, especially red oak, is very suitable for bobbin turnings, but for baluster turnings, I stick to the more consistently dense maple. When splitting parts, it's important to make them large enough to ensure that they will accommodate the rounding process and shrinkage. The split sizes listed include extra material.

I still split the log in half before crosscutting to find hidden defects, but then I cut out the section that I need for the chair. Maple rots quickly, and because the lengths of turnings for most chairs is standard, it's a good idea to bust the whole log into billets at once. My stock will last longer in the cool months, so I usually try to procure maple logs in the fall. I try to split out parts that are 24" long by 2 1⁄8" square. This will make my largest legs, and any parts that don't make this size will become either bamboo turnings or fan-back posts, which are 1 3⁄4"-square blanks. Smaller sections can be used for stretchers (1 7⁄8" blanks at 18" long) or arm posts (1 5⁄8"-square blanks at 14" long).

Splitting parts from a maple log is more of a strategy game than one of manipulation. The maple parts are so short and rigid that the froe can't assist the splits much. Instead, layout and sequencing are the keys to success.

There are two types of layout that I've used for turning billets. One is to split the log along the ray planes first into pie-shaped wedges then split the billets out the same as spindles. I find that this method leaves me with odd-shaped pieces that are wasteful and take more work to chuck up on the lathe. My favorite method is to split the quartered log into "boards." The small side of a split in maple is large and rigid enough that it won't deflect much, so the split tends to run straight, even when the two sides of the split are unequal. It takes patience and light blows. Once the blank is split into boards, splitting square blanks is clear and easy. You can even band saw out the blanks from the board for higher yield if needed.

If a split starts to run out on a maple piece, it can be effective to flip the work over and split from the other end. The two splits will meet in the middle. Most often, turnings have tapers toward the ends, so a little runout of the split can be tolerated.

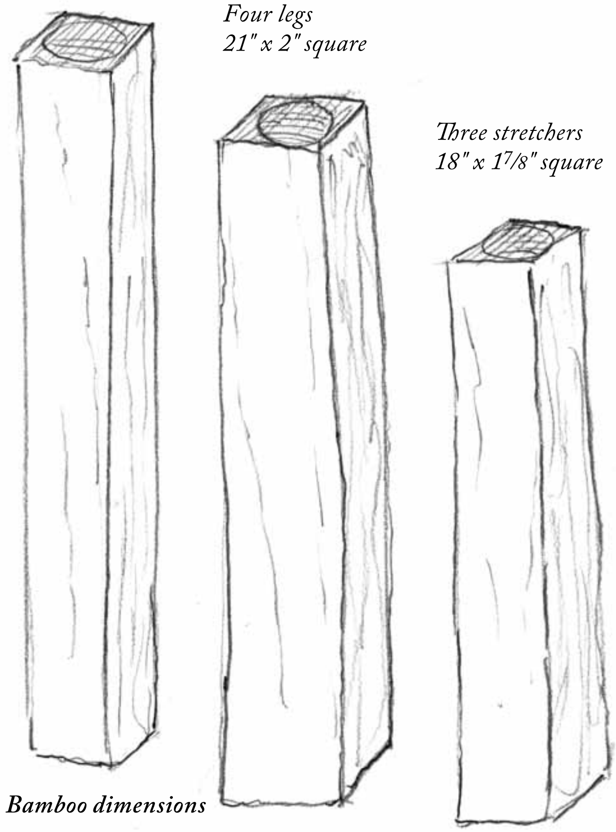



**FIG. 8.6** *Turning pieces for both chairs.*

## Drying Parts for Turning

If the billets will be stored for any period before being rounded, the end grain should be sealed to prevent checking. I use a sealant developed for the purpose called Anchorseal, but a layer of glue on the end grain can also do a good job. Sealing the ends should be done as soon as possible after crosscutting to prevent checking. Wood can be kept green in a plastic bag in a chest freezer for long periods; otherwise, it should be stacked, uncovered, in a cool area with space for air circulation.

Although turning green wood is fantastic, with cool spits of water and ribbons of shavings flying, I avoid it. The distortion of the shapes and the potential for warping makes re-chucking the legs or stretchers for joinery purposes more difficult. For most turnings, I rough-turn them then air-dry my round billets for a week or two before turning them to shape. The priorities of the joinery can all be met when starting with air-dried stock, so if there is any confusion, just rest assured that it is always safe to round the billets and let them sit and dry. Depending on the part, all of it or portions can be kiln-dried before sizing the tenons.

There is more about drying and turning in the chapters that deal with turning.

## Parts from Air-dried Boards

If all you have access to are kiln- or air-dried boards, you can still "split" out your parts and gain the main benefits of doing so. From the chapter Why Green Wood?,

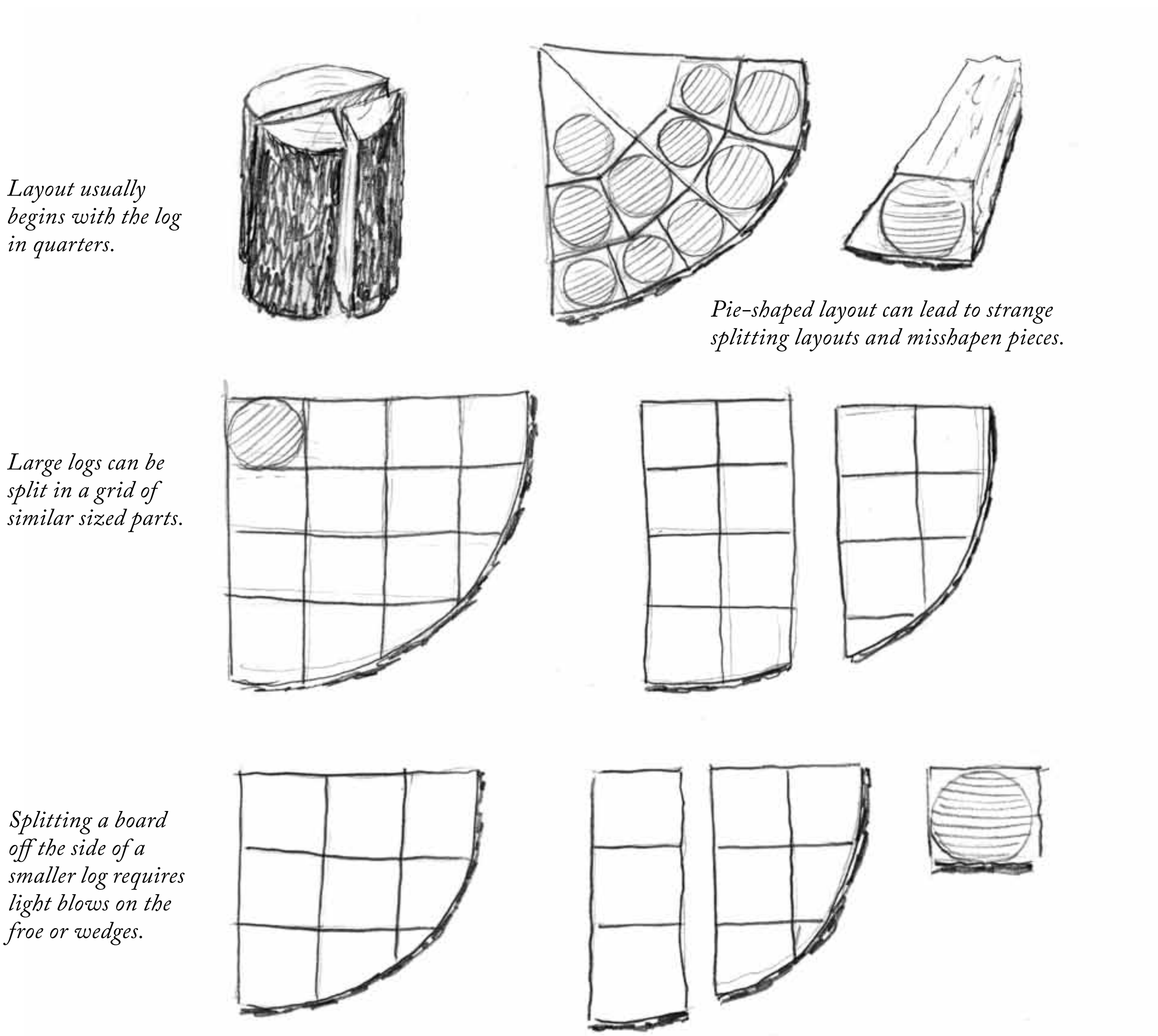



**FIG. 8.7** ***Layout for turnings in maple.***

you might recall that the main reasons for using green wood are the ease of cutting, bending and shaving (the direction of the cut always being from thick areas to thin). While dried wood won't cut as easily, careful splitting and sawing can still provide the strength benefits of straight grain. If the wood has been kiln-dried, it can be split and sawn for strength, but it won't be as easy to bend or work it with hand tools.

Of course, the process begins with proper material selection. Your boards should be from as straight a log as would be selected for splitting. Look for signs of twist or bowing in the tree. If the tree is straight and the sawyer cut along the fiber line, then the surface will look plain with very few cathedrals. Remember, the active figure on a board is formed by cutting across the fibers, which is not helpful to a chairmaker.

But having a broad surface that follows the fibers isn't the end of the story. The orientation of the fibers in relation to the sides of the board must be established. Remember, the saw that cut the board paid no attention. To find the fiber line in relation to sides, I split each board down the middle after cutting it to length. Then I saw out all of the parts using the split face as a reference. If the edge of the board reveals that the fibers run a bit skewed, I carefully hew away the short-grain sections.

Processing the wood from the log is a fundamental part of the process; it's also among the most foreign to most woodworkers. After working parts from a log, I began to see boards of wood as a strange way to organize wood for using in chairs. I know this might sound extreme, but once you've seen splits turn into a chair, the process might challenge your notion that boards are the obvious starting point for furniture as well.

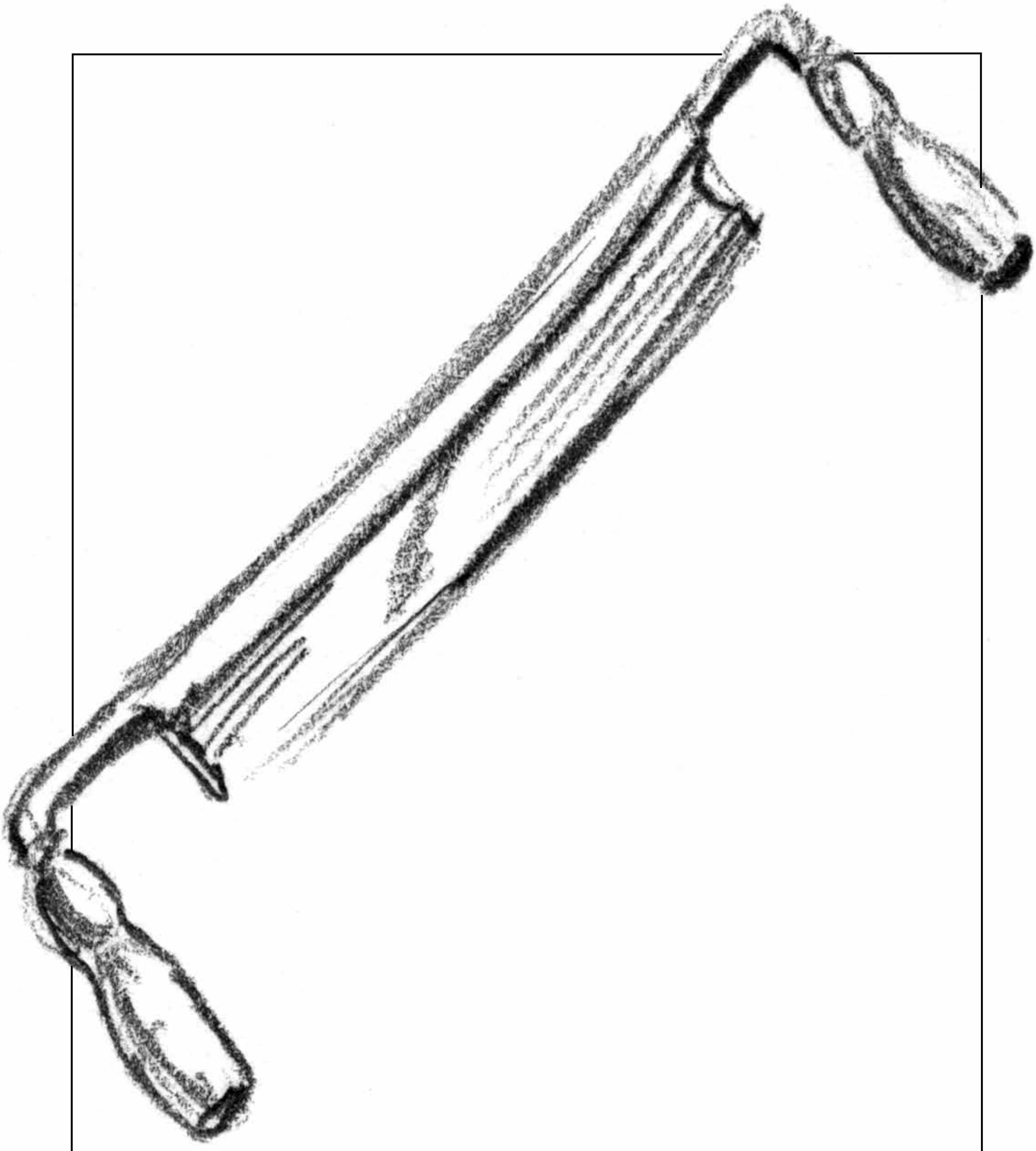
*A highly figured board is a sign that the fibers are not parallel to the surfaces.*

*A board showing long stripes is usually better.*

*Splitting the board down the middle will reveal the fiber line.*

*Inspect the edge of the board to ensure that you follow the fibers.*

**FIG. 8.8** ***Split a board to discover the true direction of the fibers.***



# 9

# The Drawknife

The drawknife looks like a simple tool, and it is. There are no moving parts or settings to fuss with. It has an ominous look about it, and indeed, it can cause great harm when used incorrectly or carelessly. But combined with an understanding of the structure of the wood, the drawknife can be an elegant way to shape wood quickly from start to finish. While your first impression might be that this is a tool meant for force, a little experience reveals that it responds mostly to finesse.

I didn't own a drawknife until I made my first chair. Now it is one of my favorite tools, and I reach for it all the time, regardless of the project.

The drawknife comes in many shapes, sizes and styles. Regardless of the differences, they all share an ability to work wood with great control.

It's important to note that unlike the handplane, the primary job of a drawknife in shaving wood is not to flatten a piece of wood, but to follow along the fibers. The drawknife acts like a refined splitting tool.

You may wonder, "Why is this so desirable"?

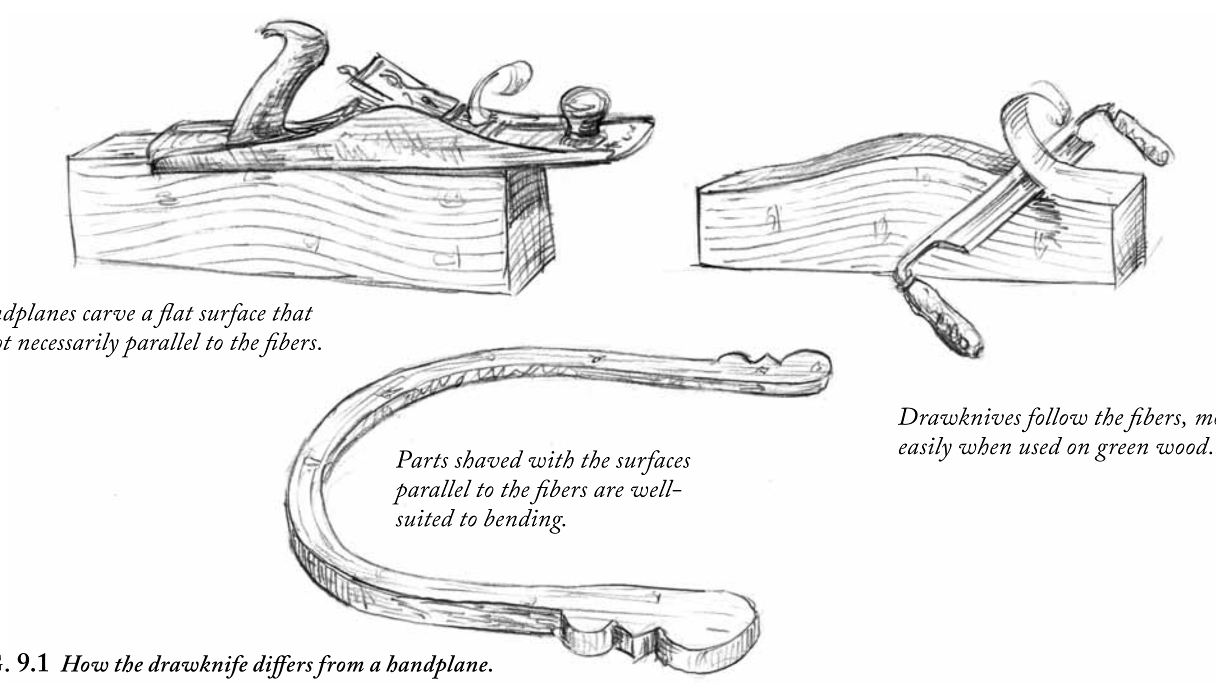
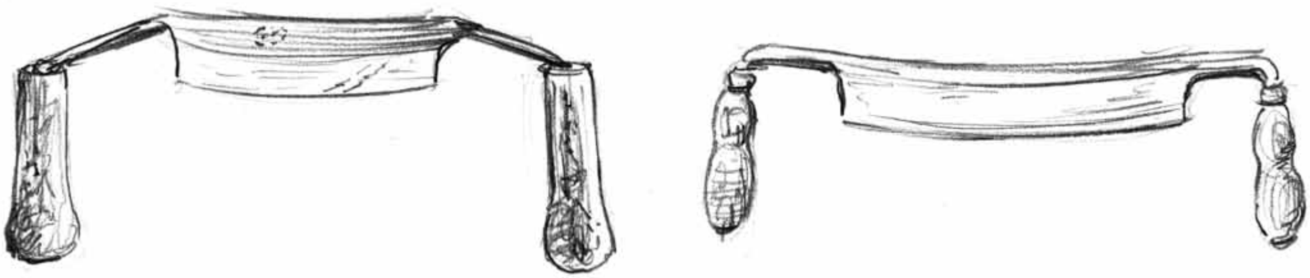
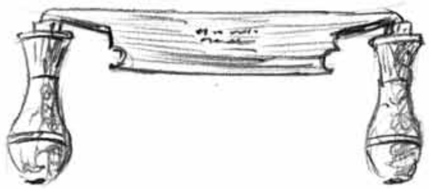
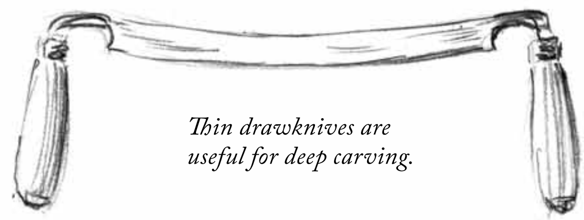



**FIG. 9.1** ***How the drawknife differs from a handplane.***

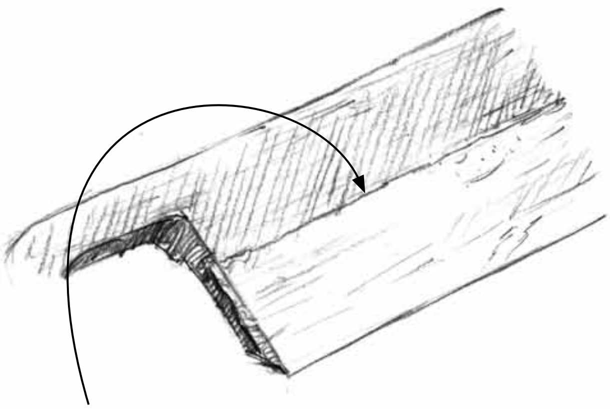




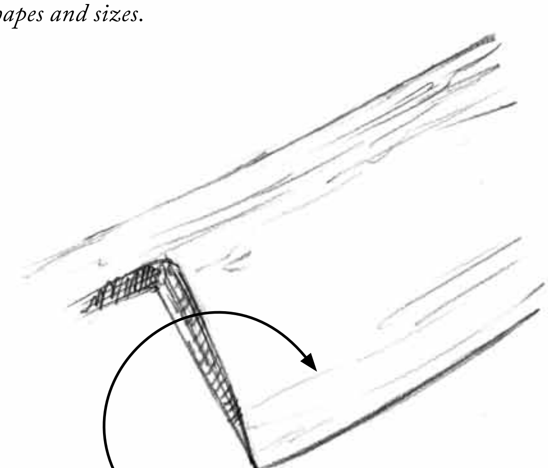


*Thin drawknives are useful for deep carving.*

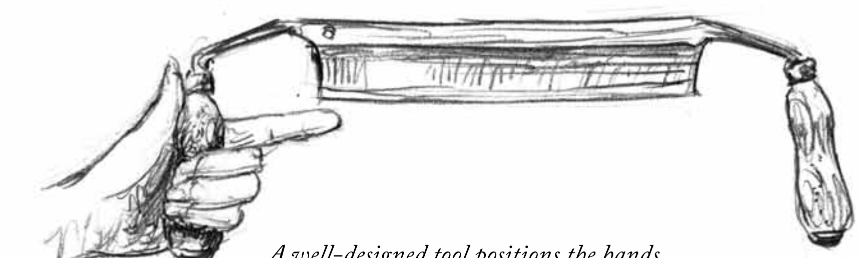
*Drawknives come in many shapes and sizes.*



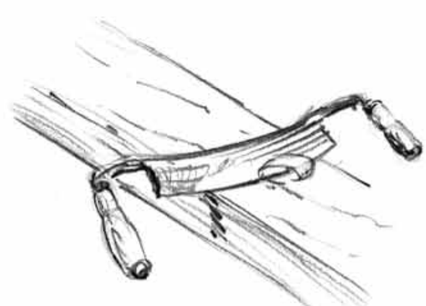
*Most old drawknives have a thin strip of high-carbon steel laminated on a body made of softer steel. Look for the faint line on the back of the tool to find the high-carbon steel.*



*Knife-edged drawknives can be tricky to maintain without a jig.*



*A well-designed tool positions the hands so that the index finger is at or below the cutting edge.*



*Curved blades should lie flat on a workpiece when riding the bevel.*

**FIG. 9.2** ***The variety of kinds drawknives.***

There are a number of reasons that shaving wood along the fibers is helpful. Not only is following the fiber-line the key to making strong, thin parts that bend well, but it's also a remarkably fast way to work wood into consistent shapes. Every piece of wood has an internal logic and once you use the drawknife to find it, you will find that the wood itself has lots of guidance to offer.

Besides tracking along the fibers, the drawknife is also capable of shearing across them, carving with great control and leaving a silky smooth surface ready for finishing.

This chapter focuses on understanding the geometry of the tool and tuning it. The next chapter demonstrates how the drawknife is used to shave and carve wood.

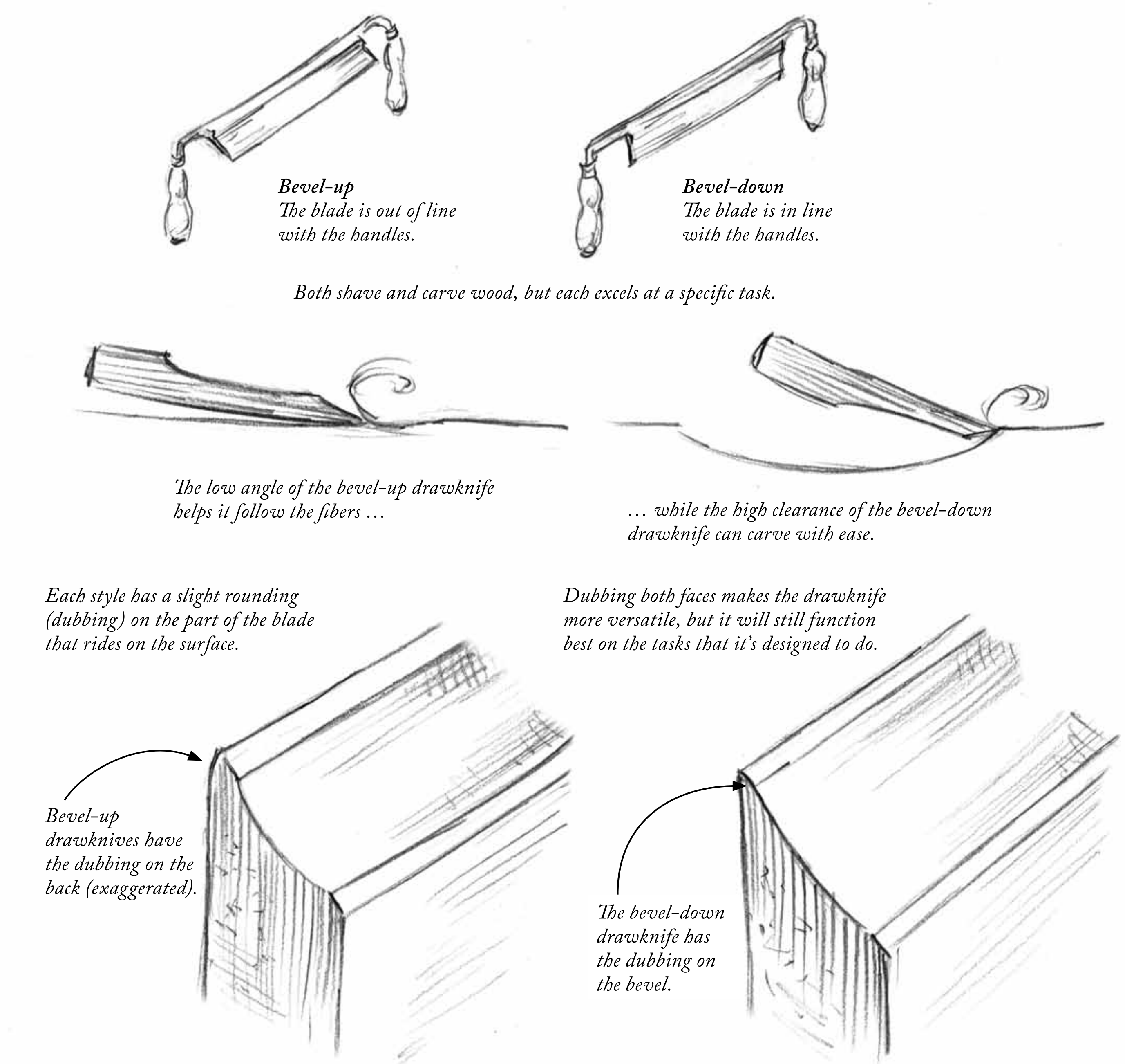



**FIG. 9.3** ***Two types of drawknives: bevel-up and bevel-down.***

There are many kinds of drawknives out there: straight, curved, bevel-up and bevel-down styles, each with their best uses. But it's important to note that one well-tuned knife can handle most tasks reasonably well, though each style and shape has its strengths.

The first trait of a knife, besides the condition of the blade (pitted, chipped etc.) to consider is whether it's straight or curved. I find that curved knives, while they perform fine, can be a bit more difficult for new users to grind and sharpen. Also, because they don't have a straight edge, they cannot be used as easily to judge the flat cross-section of a workpiece.

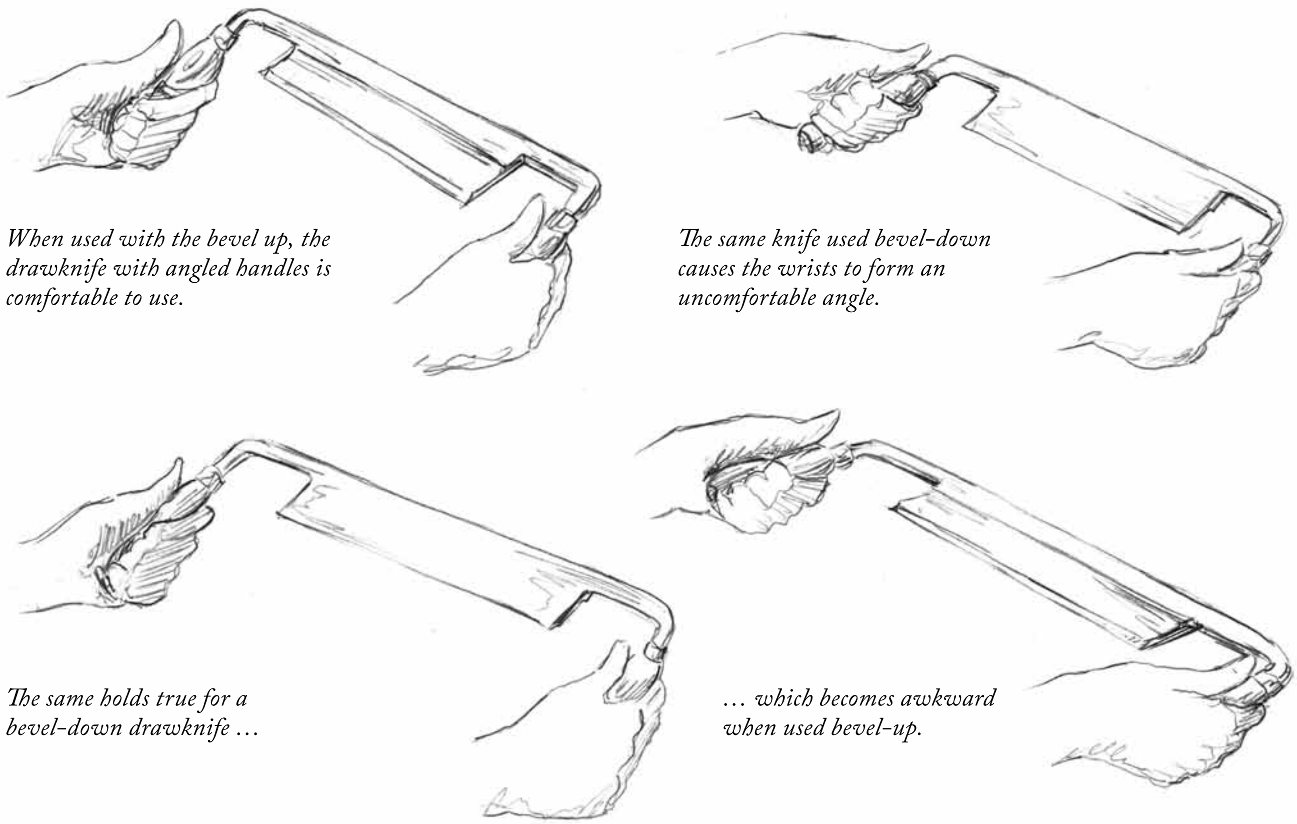
That being said, they work fine and, in some instances, better than other knives. There are enough old straight knives out there that I generally pass on the curved ones. If your drawknife is curved, it can still work great once it is sharpened properly. Some say a curved knife imparts a sort of natural slicing action, but I haven't found it to be advantageous, except when cutting deep hollows.

## Relationship of the Handles to the Drawknife

The angle of the handles on the drawknife help determine the best way to hold the knife, as well as determine the tasks that it will perform best. When held correctly, either kind of tool – bevel-up or bevel-down – will give the user a wide range of comfortable motions. While the tools can be used either bevel-up or bevel-down, and sometimes the fibers dictate that they should be, the range of motion is more limited and takes more focus to control.

## Bevel-up

When the handles are slightly angled in relation to the back of the blade, the tool is generally used with its bevel up. This position has some advantages when shaving with the fibers because the blade lies at a low angle, allowing it to slide between the fibers without greatly deflecting the shaving. With this orientation, however, carving deeply into the wood can be more difficult because the back of



*When used with the bevel up, the drawknife with angled handles is comfortable to use.*

*The same knife used bevel-down causes the wrists to form an uncomfortable angle.*

*The same holds true for a bevel-down drawknife …*

*… which becomes awkward when used bevel-up.*

**FIG. 9.4** ***Drawknife geometry affects how comfortable it is to use.***

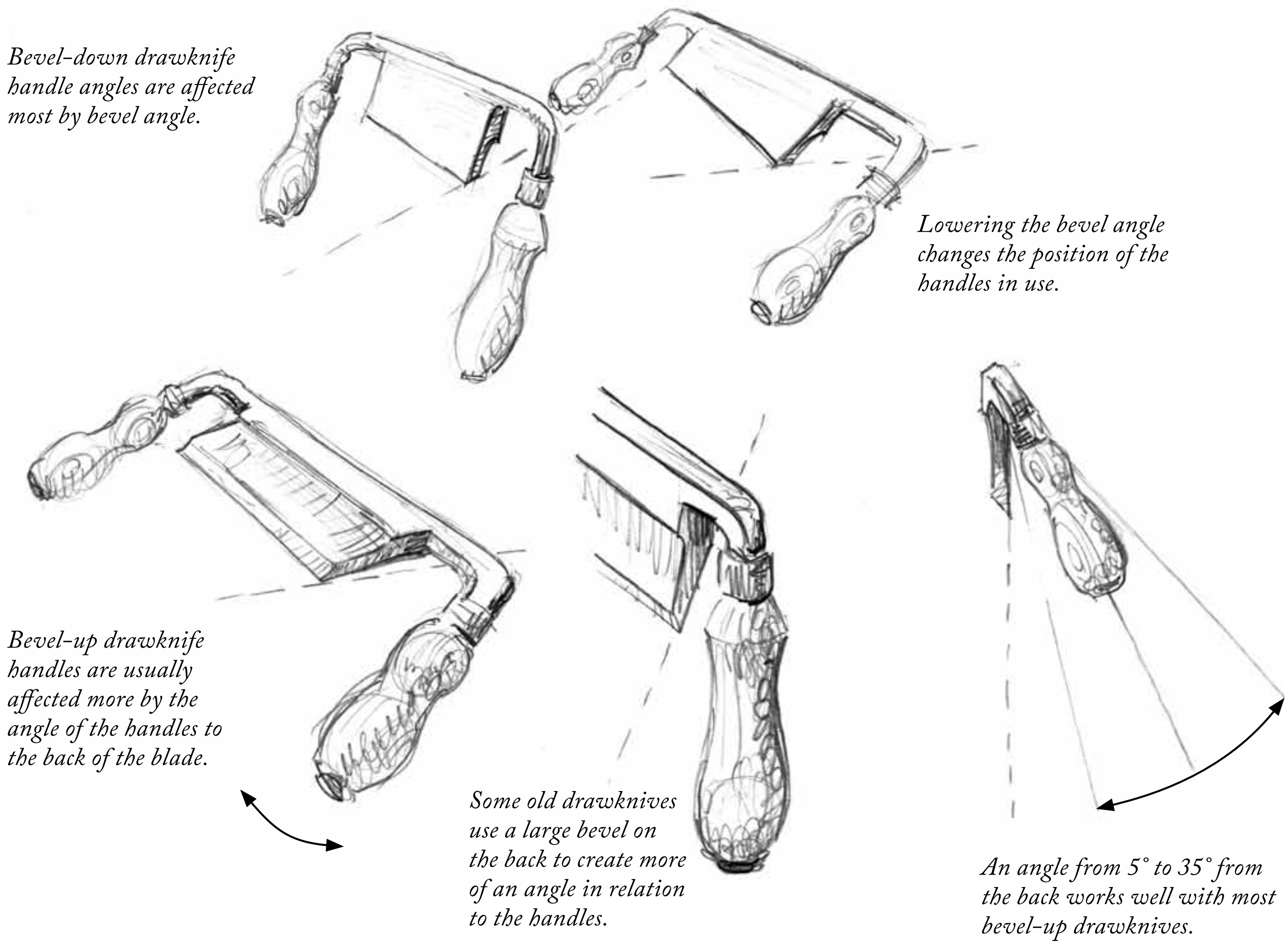



**FIG. 9.5** ***How the handle angle affects bevel-up and bevel-down drawknives.***

the blade, which rides close to the surface, makes contact with the workpiece when trying to come out of the cut, knocking the edge out of control.

## Bevel-down

When the handles of the drawknife are parallel to the blade, it is generally used with the bevel down on the work. This position also gives the user more dexterity when carving into the wood. The tool rides on the short bevel, and the back of the blade is held up and out of the way. This enables the tool to carve into the workpiece and come out of the cut without the back of the blade hitting the workpiece. Plus, when carving across the fibers, the chips are made up of short grain that break easily as they-travel up the long, flat back of the blade. This is handy

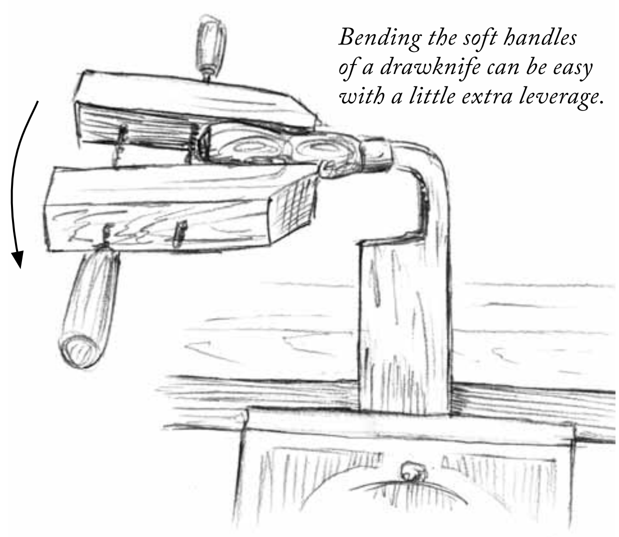



**FIG. 9.6** ***A handscrew adds leverage when bending a handle.***

when shaping a piece. It can, however, get you in trouble when the goal is not to carve the wood but to shave it along the fiber line. In that case, the ease of carving with the bevel-down tool can make it more difficult to follow the fibers without carving across them.

Each type of tool has its place in the process, and most cuts can be achieved with either one. The key is holding the tool correctly so that the position of the wrists will feel more natural and allow for the range of motion required.

## Knife-edge Drawknives

There is one other type of drawknife you might come across that has no discernable bevel, but is sharpened more like the edge on a pocket knife. Using it is the best way to determine the most comfortable way to hold the knife. I address maintaining this type of knife at the end of the sharpening section below.

## Choosing a Drawknife

After assessing whether the knife is a bevel-up or bevel-down tool, I factor in the age, steel and style of the knife. Old forged ones with laminated steel are favorites of mine. If the knife is a bevel-up user, it is also important to take stock of the angle of the handles to make sure that they are comfortable. I like the heft and comfort of old tools, but I often reach for my newer tools just the same. I like medium-length blades, between 8" and 12" along the edge. Larger ones can become unwieldy; smaller ones restrict the slicing action.

The position of your hands when gripping the handles in relation to the edge also affects the cutting action of the drawknife. I find that I get the best leverage, control and ability to shave along the fibers when my forefinger is level with the tool's edge.

Earlier manufacturers knew this and either lowered the tangs or used handles that encouraged a low grip on the blade. With a lower grip on the handles, they act as levers with the edge of the blade being the fulcrum. When you hold the knife up higher than the edge, the force is coming from both sides of the edge and small shifts in pressure tend to affect the cutting behavior disproportionately. I'm sure that many folks would disagree with my assessment, but if you have trouble getting the blade to follow the fibers, try lowering your grip. You might feel that you have lost some control, but you will allow the knife to do its job as you pull it along.

## Adjusting Handles

The way a drawknife functions is a result of the combined bevel angles and handle angles. The bevel angle allows the blade to cut well, while the handles' angles give a good range of motion, balance and power. For bevel-down drawknives, this is usually simply a product of having a bevel angle of around 27°-30°, with a slight dubbing or micro-bevel. For bevel-up drawknives, the perfect mating of handle to bevel angle can be more complex, but just about any drawknife can be improved with a subtle adjustment of the handles.

Bending the handles a bit is usually not a problem on older drawknives where the steel near the handles is soft. I use my bench vise and a handscrew to increase my leverage. Of course, bending it too far – or back and forth – can stress and weaken the metal. So the least amount of movement is preferred.

Besides having some drawknives with geometry suited to various tasks, I also like to keep on hand a variety of drawknives tuned to different degrees, some for fine work and others for rough. This way, I don't shave bark and rough-out spindles with the same tool that I expect to leave a perfect surface on the side of my seat carving.

## Sharpening Drawknives

Drawknives can be tough to sharpen, if for no other reason than the length of the blade and the cumbersome handles. I am going to present two methods for sharpening the tool.

The first follows the steps shown in the chapter Hand Tools: Sharpening & Use, while the second uses a simple jig I developed to get the drawknife sharp using the back edge (opposite the bevel) of the tool as a guide. This doesn't require flattening the back or even grinding the bevel. Instead of sharpening the drawknife as though it were a chisel then dubbing the cutting edge (the first method that I'll describe), the jig creates a small repeatable micro-bevel at the edge of the front and back of the blade. I favor the second method for its repeatable results.

There is more general sharpening information in the chapter Hand Tools: Sharpening & Use.

### Method 1

For years, this was the process I followed to initially tune my drawknives and maintain them.

The back of the blade should be flattened, as described in the chapter Hand Tools: Sharpening & Use, using an angle grinder to hollow it and stones to flatten it. I like to use a wooden waterstone holder like the one pictured in the chapter The Chairmaker's Workshop.

The holder helps keep the handles out of the way and encourages fluid movement and honing of the entire blade. When it comes to grinding the knife, there are a couple of options.

I first learned to grind drawknives freehand without a tool rest. It took some practice to get the gist, and while I can get reasonably consistent results, I usually use a simple jig to increase the control.

The trouble with grinding drawknives is that they don't have a flat area to place on the tool rest. So I use a jig suggested by Steve Kinnane, which references off of the back edge of the tool to get consistent and controllable results. The other problem you are likely to encounter is that the handles of the drawknife hit the body of the grinder as you try to move the blade across the wheel. To correct for this, I create a slight chamfer on the outer edge of the wheel so that I can hold the drawknife at enough of an angle to avoid running into the grinder.

The "notch" jig, based on Kinnane's concept, attaches to the tool rest with magnets or a clamp. You can use a piece of wood with a notch cut in it or a more elaborate jig that allows for fine adjustments.

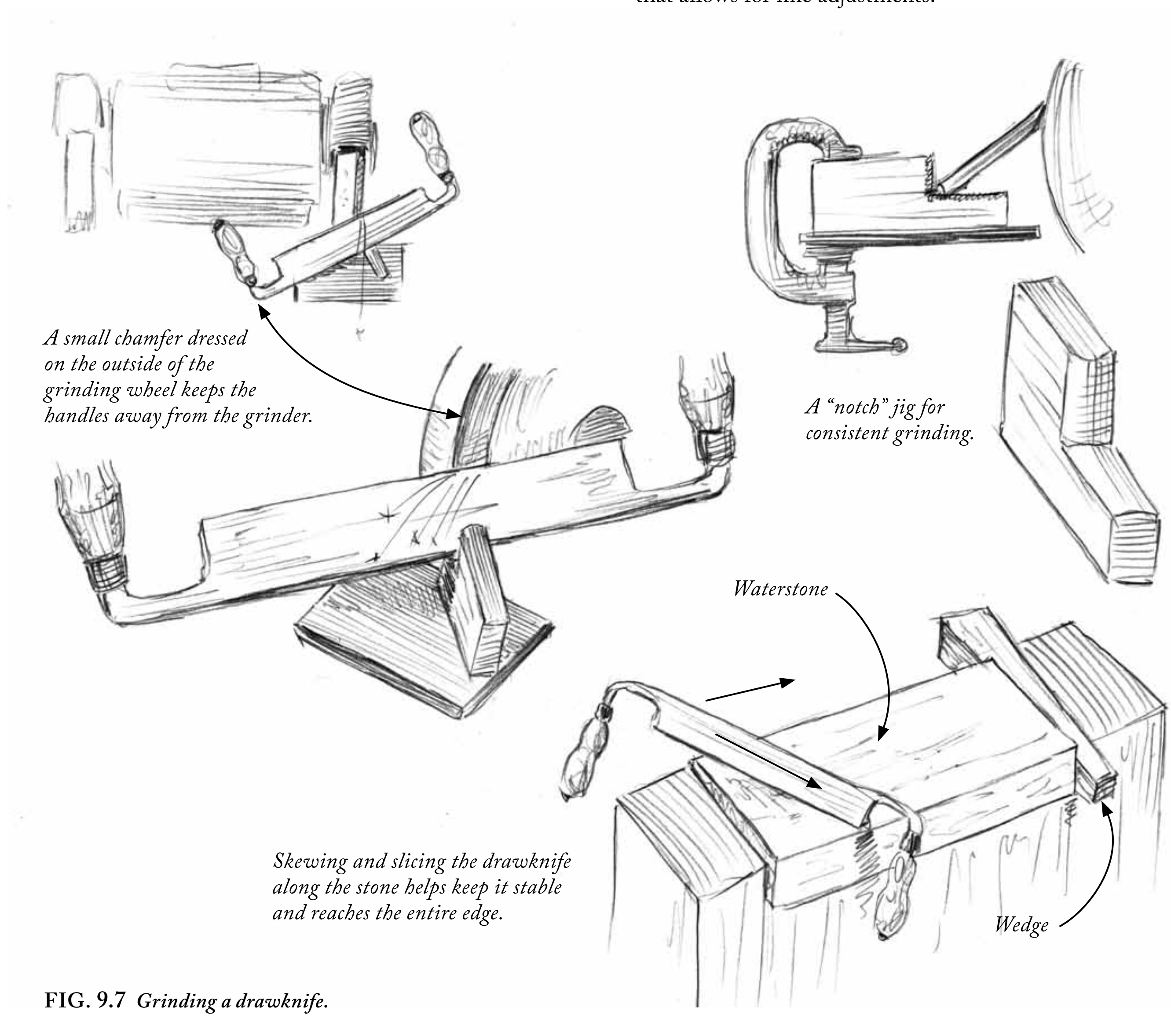



**FIG. 9.7** *Grinding a drawknife.*

Before using the notch jig, file away any roughness and sharp edges on the back of the blade. Be sure to apply pressure only when pushing the file forward, not on the return stroke. Pressure on the the back stroke just dulls the file.

Then polish and wax the back edge of the blade (called the "spine"); this rides in the notch and becomes the pattern for the shape of the edge. Polishing the spine will also come in handy if you should choose to use the jig that I'll describe in the next section to finish the honing.

Light pressure is the key to consistent results. I've found that a bevel ground just below 27° gives optimum results, regardless of whether it is a bevel-up or bevel-down knife. But if it is a bevel-down knife, you will notice that the angle of the bevel will directly affect the angle of the handles in use. Once the bevel angle is established, I follow the usual stoning procedure to hone the edge and remove the burr, with the added step of stropping the surface of the tool that rides on the wood when in use.

When I stone the bevel, I keep the blade at a skew to the stone and start each stroke at the end of the blade. The skewing provides stability. As I push the blade across the stone, I slide the blade its entire length to hone the edge.

To maintain the edge, I strop often. Make sure that the edge is safely pointed away from the hand holding the strop.

For drawknives used exclusively with the bevel down, you can leave the back dead flat and strop only the bevel,

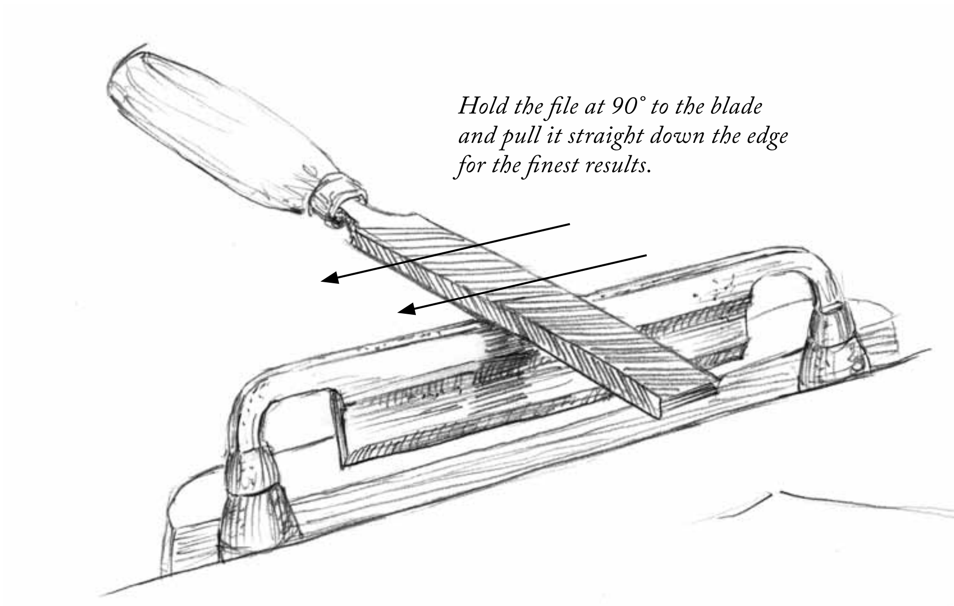



**FIG. 9.8** ***How to drawfile the spine of a drawknife.***

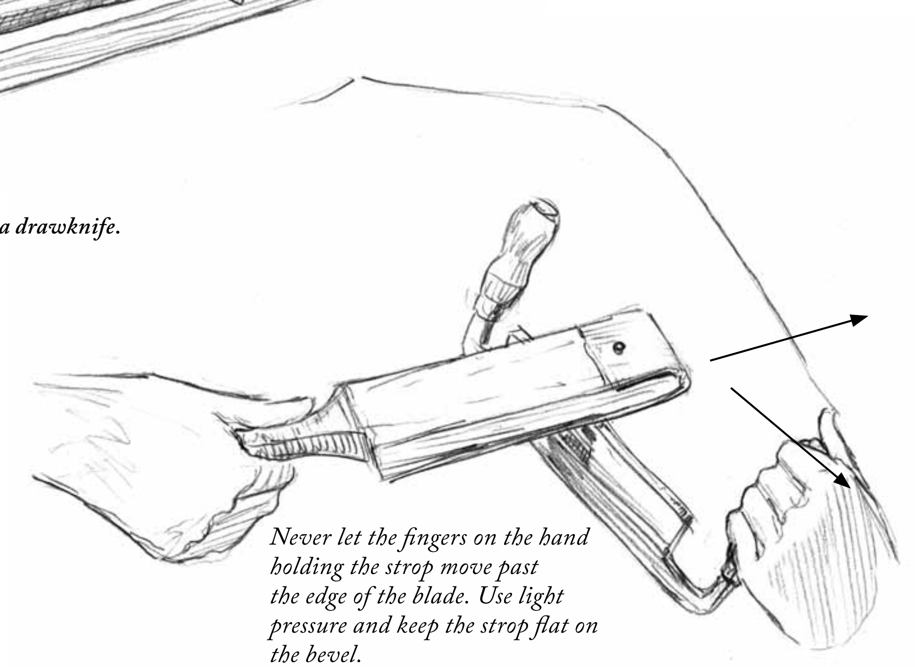



**FIG. 9.9** ***How to strop a drawknife safely.***

alternating with rubbing the back on a fine stone. For more in-depth maintenance, remove the dubbing at the edge by stoning the bevel and turning a burr to the back. Then you will once again remove the burr and dub the bevel with a strop and honing compound. Once the hollow-grind is sharpened away, you can regrind it to make honing easier.

For blades used with the bevel up, the dubbing will be on the backside. Take care to do most of the stropping on the bevel side to avoid rounding the back too much. When the back is too rounded, the back of the blade will be at a high angle when cutting and may track less decisively in the fibers. If the edge is rounded too much on the back of a bevel-up knife, you have little choice but to flatten the back again or grind away the bevel until you are past the rounding, neither of which is any fun. If the knife tends to dig into the wood or feels "grabby" as you draw it along, it most likely needs a bit more rounding of the edge. Slightly more aggressive stropping should do the job.

### METHOD 2

This method uses a jig to hone a micro-bevel on the edge of the blade. While the concepts described can be used to make a shop-made sharpener, the tool shown is available commercially as the "Drawsharp." I developed the tool and licensed it to Benchcrafted for production.

I like this method because it is precise and repeatable. It is also faster because it requires removing metal only at the very tip of the knife. I will cover the concepts behind the jig; for further instruction on using the commercial tool, there are in-depth instructions available from Benchcrafted.

The jig uses the back edge (spine) as a reference, just like the notch-grinding jig, so filing smooth the back edge of the drawknife serves both processes. The Drawsharp works by setting the distance between an abrasive diamond plate and a post on the jig so that when the back edge of the drawknife is placed against the post and tilted to make contact with the diamond plate, the desired angle is achieved. Noting the location of the post on the

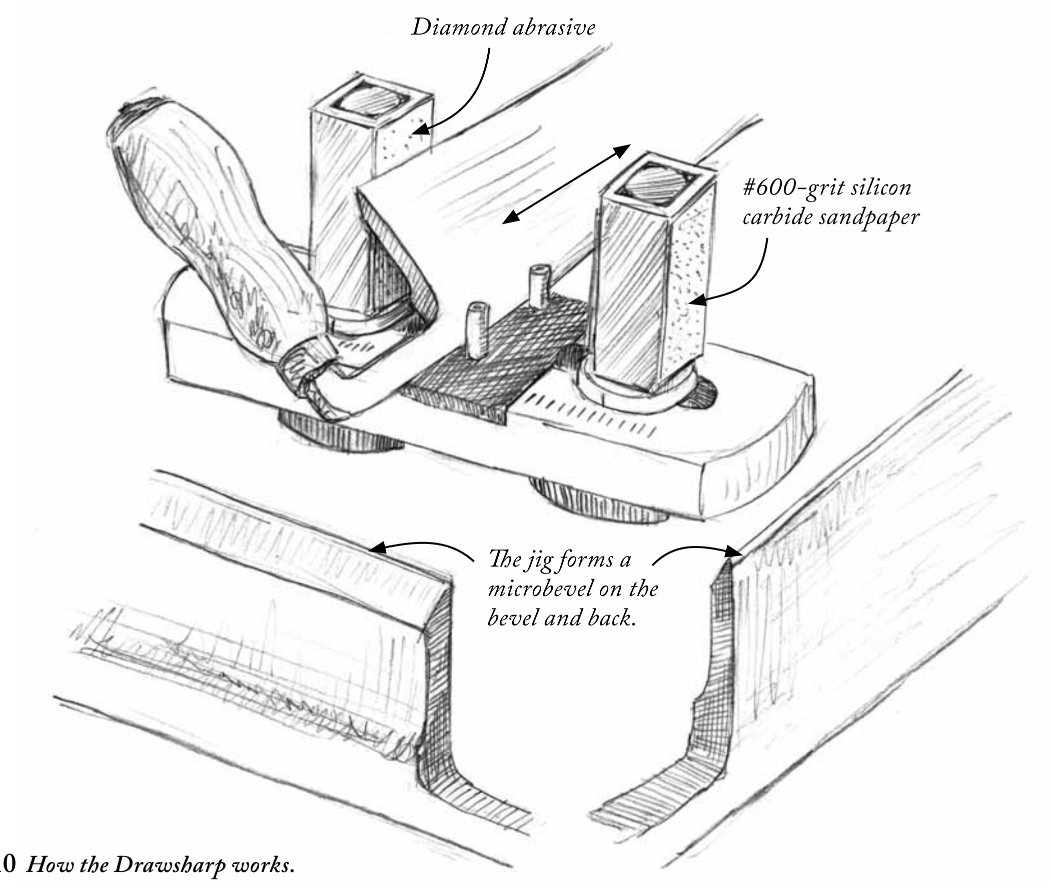



**FIG. 9.10** *How the Drawsharp works.*

scale will allow you to reset the tool if you are sharpening multiple knives.

Then the jig is pushed or pulled along the length of the knife, abrading the edge to the set angle. Once a burr is turned to the opposite side, the jig is repositioned then abrades the opposite face, turning the burr back the other way. The jig is used to roll the burr back and forth and to diminish its size. I prefer oil (camellia is my favorite) as a lubricant and use light pressure. Diamonds do not require pressure to cut and tend to give uneven results if forced.

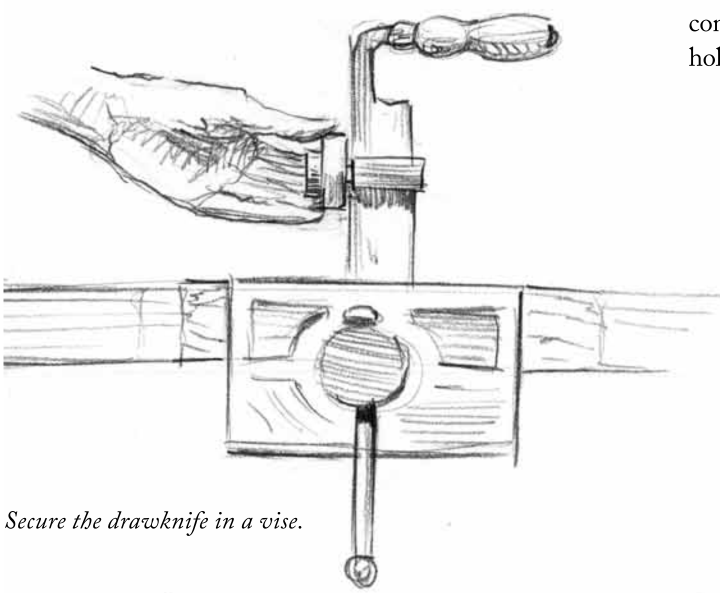
For the last few strokes that I take with the diamond plates, I take only one pass to turn the burr.

Once the burr is gone or nearly imperceptible, I rotate the jig's square abrasive sleeve to use the #600-grit silicon-carbide sandpaper. I raise or lower the sleeve to ensure that a fresh portion of the sandpaper contacts the edge. I then repeat the process as I did with the diamonds. The silicon carbide breaks down into finer particles in use and will leave a high polish and almost no burr. Finally, the edge is lightly stropped to finish the job.

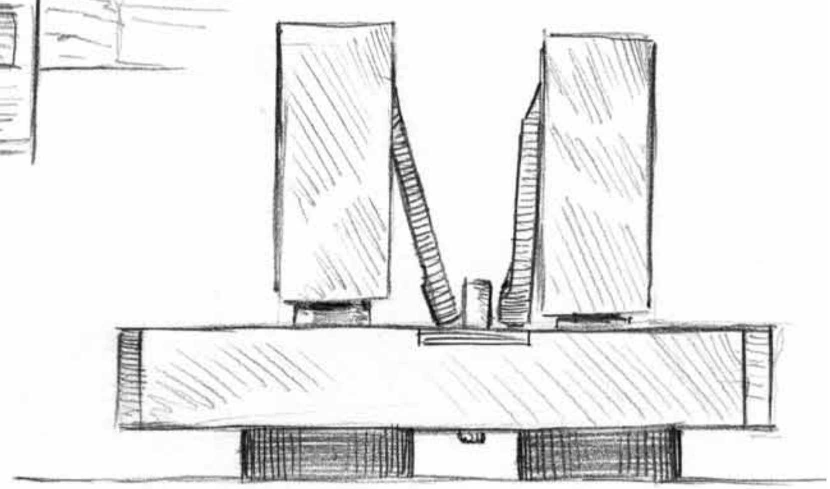
Maintaining the edge is a matter of using the jig to turn the burr from the bevel side to the back and then lightly turning it back. As with the first method of sharpening a drawknife, take care to work the back of the blade as little as possible.

The jig allows you to set the micro-bevel to a specific angle by measuring the back or bevel of the knife when it is in the jig. I find that a bevel of 1°-3° on the back and 3°-4° on the bevel works well, but there is a great range of functional angles. I hone the larger micro-bevel on the bevel side because it's easy to grind away. I opt for a slight bevel on the back, which maintains the tool's low cutting angle (which is ideal for a bevel-up drawknife).

If the edge of the blade is in poor shape or at an angle steeper than 30°, it might be best to grind the bevel on the notch jig, which will also make the edge parallel to the back; that makes the angle honed by the Drawsharp more consistent. Unlike the usual process for honing, where a hollow-grind is the key to honing the bevel consistently, a



*Secure the drawknife in a vise.*



*Move the posts so that the back and bevel are against the diamond plates.*

**FIG. 9.11** *How to set the Drawsharp.*

hollow-grind is not necessary for the honing jig to function. This can be helpful because a slight crown to the bevel makes carving deep cove cuts easier.

## Odd Knives

If your drawknife has a “knife” edge, there are a couple of options for sharpening it. You can locate the side that has the hardened steel laminated to it so you can grind a distinct bevel then sharpen as described in method one. Or you can use the Drawsharp to hone a micro-bevel on each surface.

In the past, I’ve avoided these knives, because without an obvious bevel, I couldn’t make sure that I was contacting the edge when honing. Now I use the honing jig to hone the edge consistently without having to grind a pronounced bevel. The jig allows me to add a micro bevel at the edge of the tool as well as the back.

## Conclusion

Like any woodworking tool, the drawknife needs to be kept sharp. But just having a sharp edge is not enough to ensure that the tool is going to do its job at peak performance. Each knife is different and while there are some general concepts that will make any knife work well, I found that discovering the best geometry for a specific knife or purpose takes some experimentation. I relish the moments where a subtle change in geometry of the edge or handle angle will take a good knife and make it great.

I have a number of knives that I’ve spent years working with and it’s immensely rewarding when I reach for one knowing that it’s suited perfectly to the task at hand.

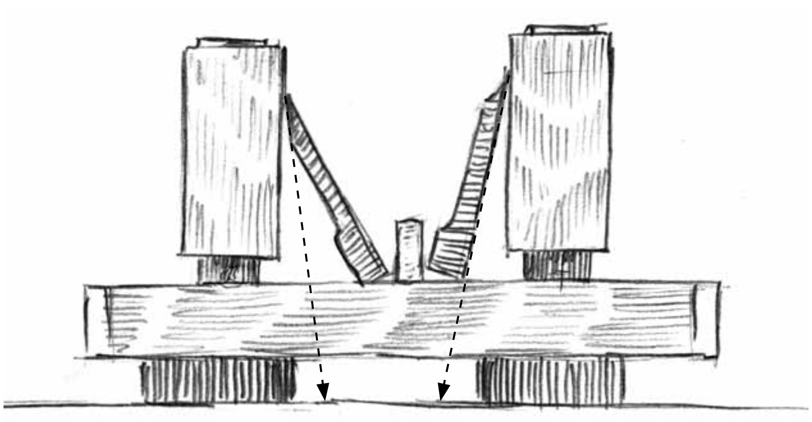


**FIG. 9.12** ***Measure the angle of the bevel and the back.***

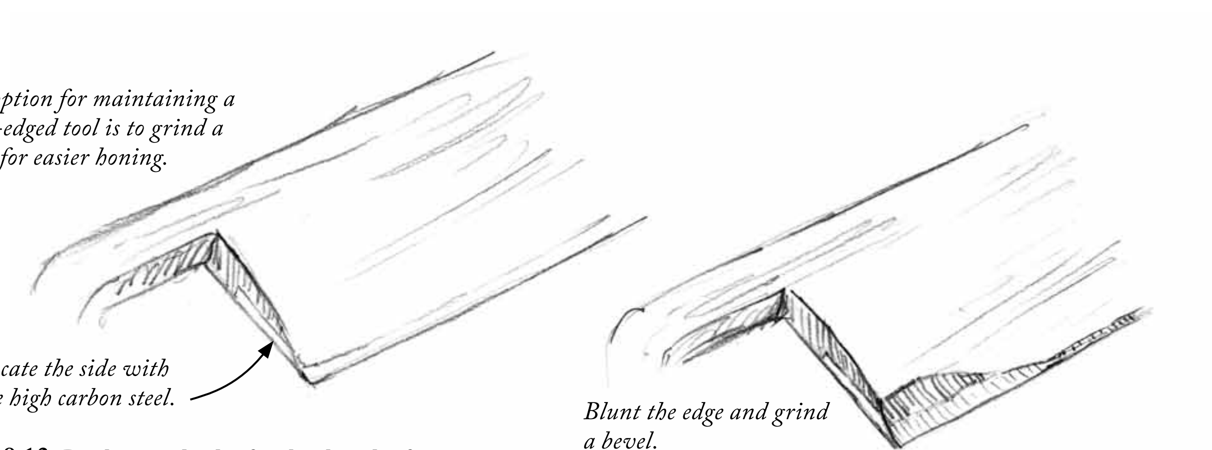
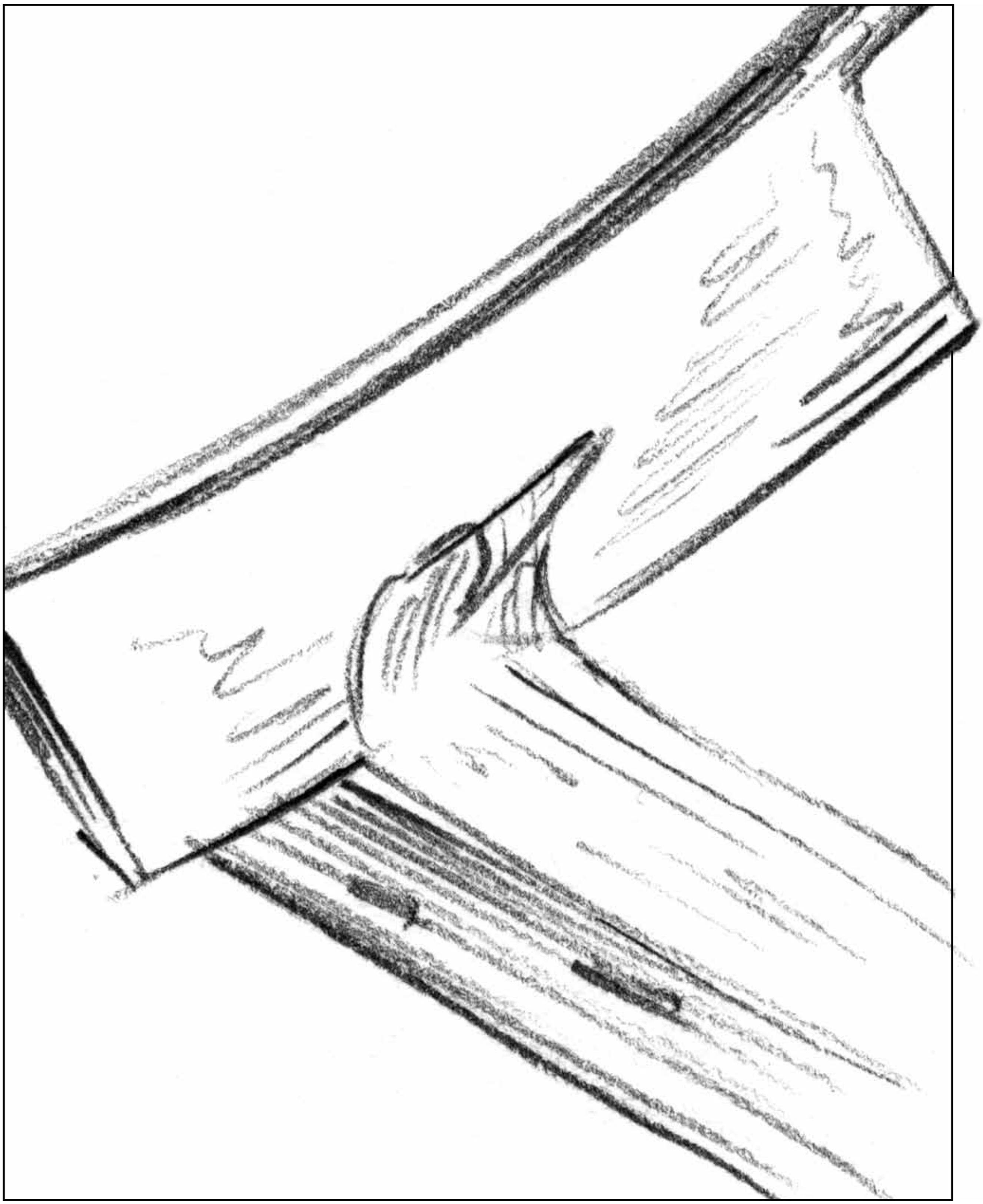



**FIG. 9.13** ***Dealing with a knife-edge drawknife.***



# 10

# Shaving & Carving With a Drawknife

Shaving green wood with a drawknife for the first time changed my concept of wood as a solid, unyielding material. For anyone searching for effective use of hand tools in woodworking, shaving green wood is for you. There is a simple structure in the wood, and the drawknife is the key to unlocking it.

The drawknife has no sole to limit its cut or to guide it to create a flat surface. As with a handplane, a drawknife can be pulled along the edge of a board in the same direction as the ascending fibers and leave a smooth surface, but as you'll see, the drawknife is capable of far more.

Once you've tuned up your drawknife and determined whether your blade is bevel-up or -down, you will want to spend some time playing and just making some shavings. Yes, there are chair parts to be made, but just getting accustomed to this new way of working takes some playing. This can be done with just about any chunk of wood, be it a split billet, firewood or a pine 1x6.

Have fun; I'm sure you can find a use for that pointy stick you'll make. The reason that we gravitate toward the pointy stick shape is because carving downhill, across the fibers, gives pleasant shavings and a glassy smooth surface.

Once you've got that pointy stick out of your system and you have a nice smooth surface, try pulling the knife the opposite direction. The first thing that you'll notice

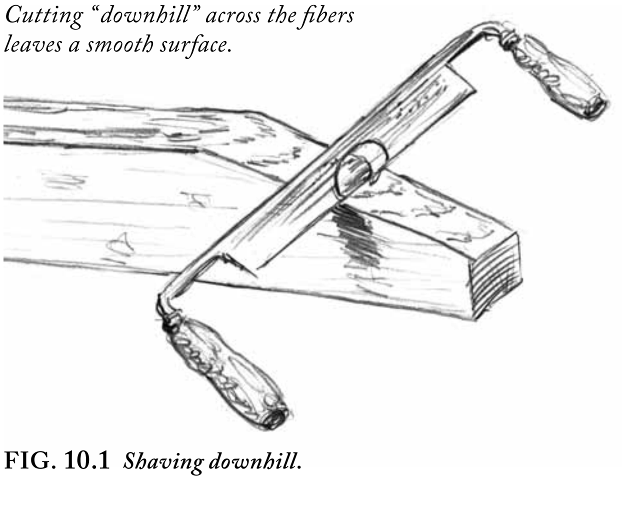



**FIG. 10.1** ***Shaving downhill.***

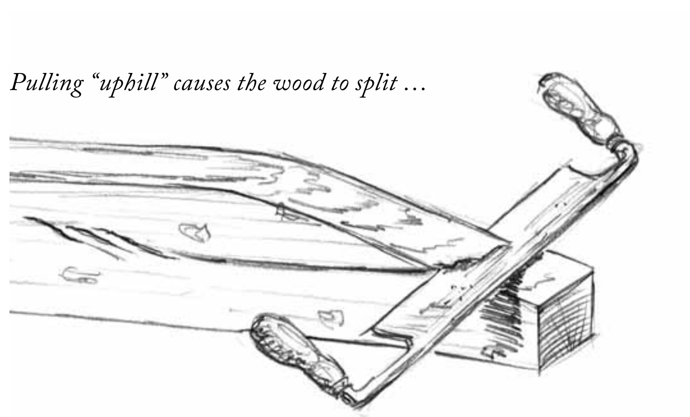



**FIG. 10.2** ***Shaving uphill splits the material.***

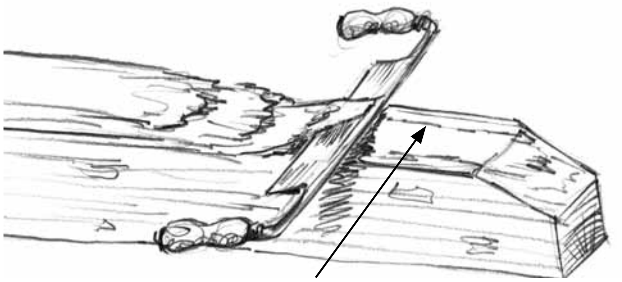



**FIG. 10.3** ***Pull the drawknife toward the rough layers to shave them off.***

is that the tool wants to dive into the wood, leaving a rough surface, possibly even splitting away large chunks. As abhorrent as this seems, this is the drawknife doing its job. Shaving with the drawknife is a continuation of the splitting process. It's important to remember that you are not trying to make a flat surface on the workpiece. If the piece is curved along its length, then the shaved surface will follow it and also be curved.

Sure, taking cuts downhill like with a handplane leaves a lovely surface and makes wispy shavings, but what sets the drawknife apart is what it does when you pull it uphill, into the end grain.

When a drawknife meets exposed end grain, it will slide between or under the fibers. Learning to let the knife do this and trusting the path it's taking requires a leap of faith. It's difficult to imagine that it's a controlled process as you watch the wood split away like that, but take another stroke and you'll notice that the splitting action is reduced and the surface gets smoother.

Once you've become accustomed to it, it's no more mysterious than peeling a banana.

Stop once the knife no longer catches fibers from the surface. You now have a face that has no exposed end grain and is parallel to the fibers. There will probably be some surface imperfections, especially in the radial plane. These are the result of the splitting action of the drawknife running ahead of the edge. This is normal and can be remedied by taking lighter cuts, which allow the shavings to break more easily closer to the edge. Skewing and slicing as you cut will also result in better surface quality. Regardless, the point of the initial shaving is to get the surface parallel to the fibers, and small surface issues can be dealt with during later shaping or when the piece is drier. Once this face is established, it can serve as a reference face for shaving the rest of the part both to size and in line with the fibers.

## Carving vs. Shaving

Here is another way to define the different ways to use a drawknife. You can either "carve" or "shave" with it.

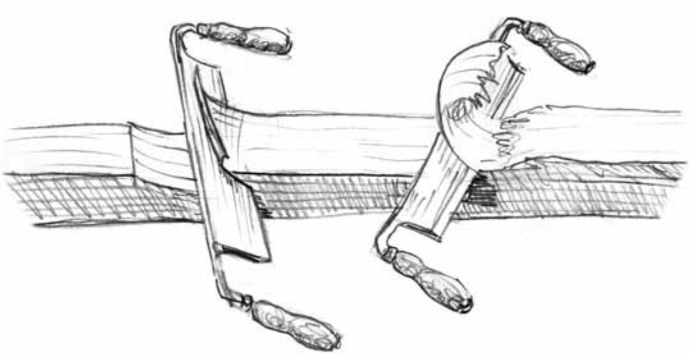



**FIG. 10.4** ***Carving vs. shaving with a drawknife.***

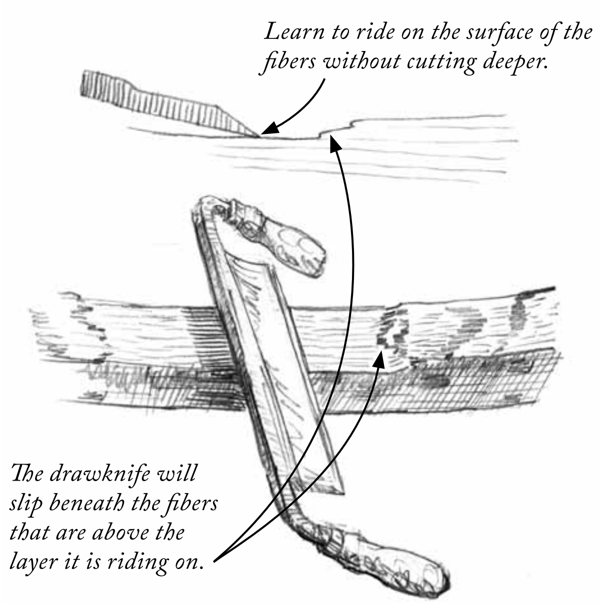
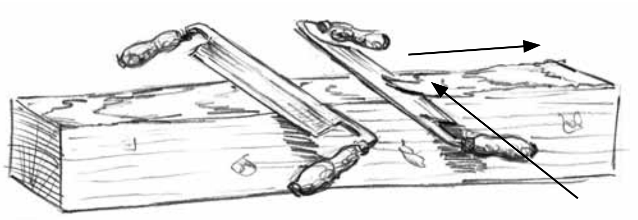
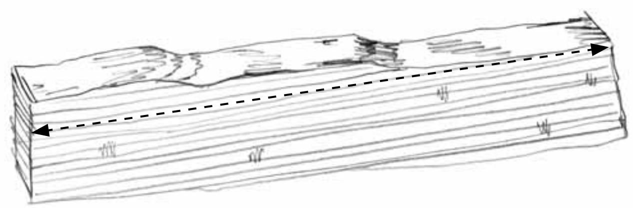



**FIG. 10.5** ***Riding the fibers.***



*The direction that the drawknife digs is the direction to shave.*

**FIG. 10.6** ***Shave both directions to find the direction to shave.***



*The goal of the "landing strip" is to expose a layer that runs from one end to the other.*

**FIG. 10.7** ***The landing strip is a continuous layer of fibers in the workpiece.***

When you carve, you remove wood beneath the layer on which you started; when you shave, you are removing wood that's above the layer where you started.

To use the drawknife with control, you must be able to ride on the surface of a layer, shaving the fibers above it and without carving into it.

Shaving with a drawknife is similar to shaving hair by scraping a razor across skin. It's no coincidence that both are called "shaving." Sticking to the razor analogy, every time that you draw blood you've switched from shaving to carving!

It may sound like it takes a great deal of care, but the drawknife is designed for this job and almost does it on its own once you learn to let it work. As I mentioned above, holding the handles lower than the edge of the blade may help the tool follow the fiber line.

Unlike when using a handplane, the direction to shave with the drawknife is always uphill, toward ascending fibers. So finding the lowest layer on which to start is the first order of business. There are many ways to determine which direction that will be.

Pulling the drawknife along a workpiece can help determine which way the fibers ascend to the surface. The drawknife works much like your fingernail when finding the beginning of a roll of tape. To locate the end of the tape, you drag your nail along the roll until it runs into the end. If you are running the wrong direction, there is nothing to catch on and the slight drop might not be noticed as you pass over it. It's the same with the drawknife; it will "find" the fibers that are stacked up, but if descending across the ends of the fibers, it won't shave anything. I know it's tough, but resist the urge to carve down into the wood just to see a curl and a smooth surface.

## The Landing Strip

Simply pulling the drawknife across a workpiece can tell us a lot about the relationship of the surface to the fibers. Most of the time though, the most efficient way to establish the location of the lowest layer is intentionally to carve into the surface a little, exposing a layer that you are certain is below all the others.

I call this layer the "landing strip."

Thinking back to the tape analogy, imagine a roll of tape that has been picked at so that it has remnants of many layers on the surface. Instead of searching out each little piece for the lowest one, it's simpler to breach the surface down to a layer that you know is beneath all the others and then peel them all away.

When wood is freshly split or sawn, it will have many different layers exposed. Getting beneath them all to find a common layer that runs from one end to the other is a great time saver.

I'm using oak as an example because of the clarity of its growth rings and distinct medullary rays. Any of the ring-porous hardwoods, such as hickory or ash, will behave similarly. Other woods with a more homogenous structure, such as cherry or walnut, can be shaved to follow the fibers, but the clues are more subtle and the fibers are more difficult to follow. These woods don't split cleanly, so the first step should be to choose a straight tree and have it sawn parallel to the fibers.

In order to establish a landing strip that follows the fibers, you will most likely have to carve across a couple of layers to expose a surface that will eventually run from one end to the other. Holding the workpiece is much easier if the landing strip is exposed in the center.

To achieve this, start by allowing the knife to dig in at the beginning of the cut. At first, make the depth only

1⁄16" or so. Once the knife is in the cut, relax your grip and just pull the knife along so that it doesn't dig any more, but so it also doesn't come up and out of the cut. This cut will follow the fibers.

After about 5", raise the handles so that the knife comes up and out of the cut. Raising the handles should be practiced until it becomes a habit. It's better to have the drawknife come out of the cut than to dig deeper.

You'll observe the ragged torn fibers where you come out of the cut, which is a great clue for the next pass. If you come up and out of a cut and there are no torn fibers, then the landing strip might not be deep enough. With woods that don't have clear growth rings, the ragged fibers left at the end of a cut become your most important guide for shaving the ray plane.

To continue following the fibers, pull the drawknife along this "landing strip" area so that the knife rides on the newly established surface without cutting. As you pull toward the edge of the cut area, the drawknife will slip underneath the torn fibers. After 5" more of shaving, pull up and out of the cut again. Once again, the drawknife will leave rough fibers as is exits the cut.

Repeat this until you reach the end of the workpiece. Resist the temptation to shave the fibers deeper at the end of the cut. This is a common misstep because the piece might be deflecting and you attempt to compensate by lowering the handles of the drawknife, thereby cutting across the fibers. If this happens, you will need to establish a new "landing strip" that is at the same layer as the deepest cut you've taken.

Then turn the piece around in the shavehorse, return to the "landing strip" in the center and pull the other way. Once again, the drawknife will slip beneath the stacked fibers. Repeat the strokes until you've chased the stacked fibers off of the edge.

It's important to note again that a perfect surface quality is not the goal of this task. While following the

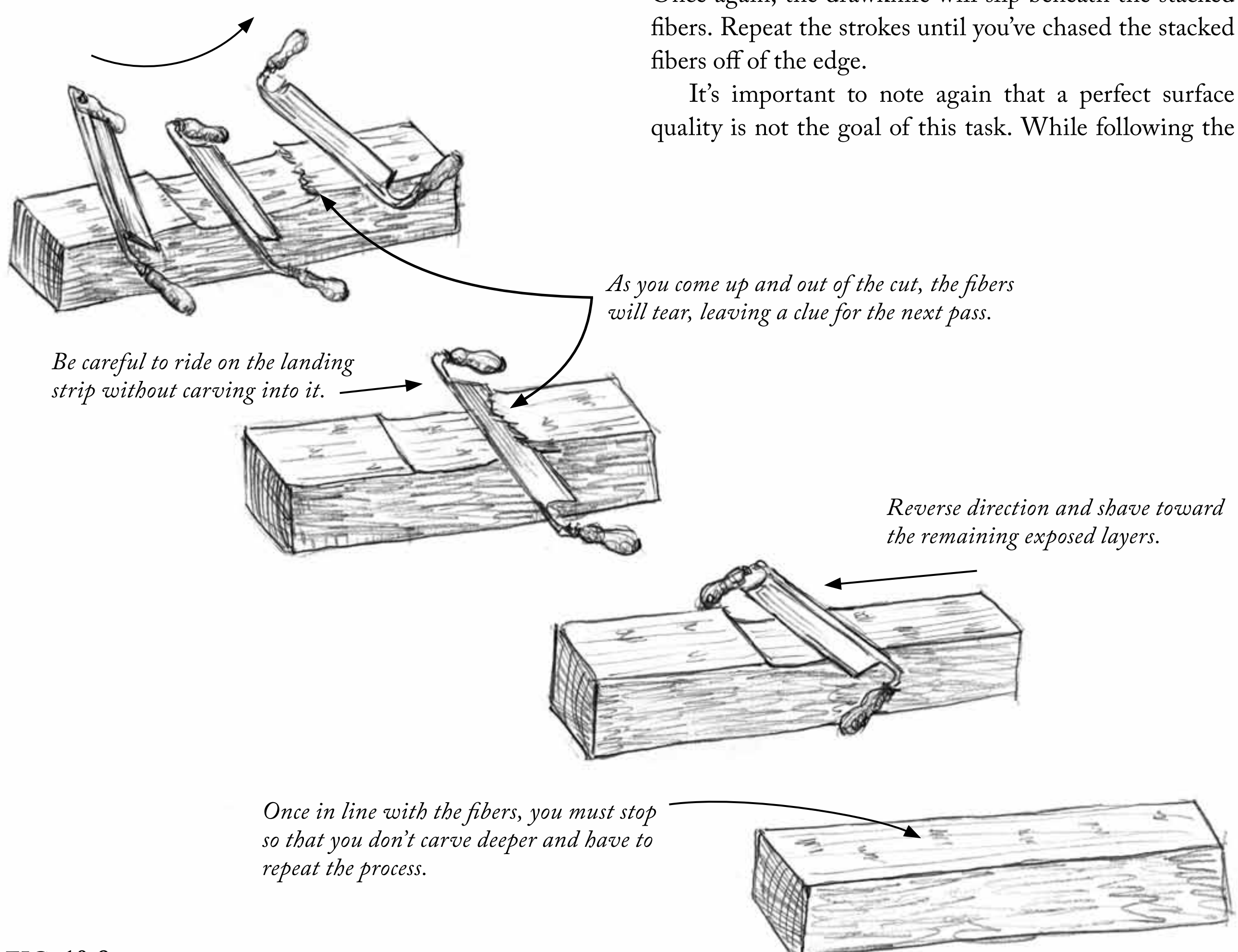



**FIG. 10.8** ***How to shave using a landing strip.***

fiber line, the surface should be relatively clean, and the transition from a rough surface to a smoother one can be a good clue, but it is easy to shave down across the fibers, cutting deeper, which gives a very smooth surface quality but also defeats the purpose of trying to follow the fiber line.

If there is a large chunk of wood above the landing strip layer, it might split off instead of shaving, just like in the example at the beginning of the chapter. This is OK, as long as the piece isn't so large that it forces the split to run below the landing strip layer. When I fear this will happen, I first remove the large chunk by shaving chamfers on the corners and then remove the center portion.

Most often, I place the drawknife about 1⁄8" above the layer that I hope to finish to and pull hard, which splits the chunk off with a dramatic "POP." As long as the piece that you are splitting off is thinner than the rest of the piece, you can count on the deflection to mainly be in the waste, which will cause the split to run straight or up and away from the portion that you wish to leave.

## Looking at Layers: The Clues in the Wood

Now that you have your tool tuned up and some technique under your belt, you need to know a little more about the wood so that you can understand what you've done, and need to do. Wood has a very predictable structure; learning to "read" it will give you more confidence as you learn to shave along the fibers.

One of the more unexpected aspects of looking to the wood for clues is that the important information about a surface is usually best seen on the adjacent face. Think of a ream of paper; looking directly at the top sheet offers no information about the depth of the stack. Wood is the same; if you want to know about what is happening on the face you are shaving, the information about the layers will be best seen on the adjacent face. Even the growth rings, which are obvious when seen directly on the tangential face, are easiest to understand when viewed from the adjacent side. While looking at the tangential face may tell you that there are layers built up on the surface, the adjacent ray plane will tell you which ones are on top.

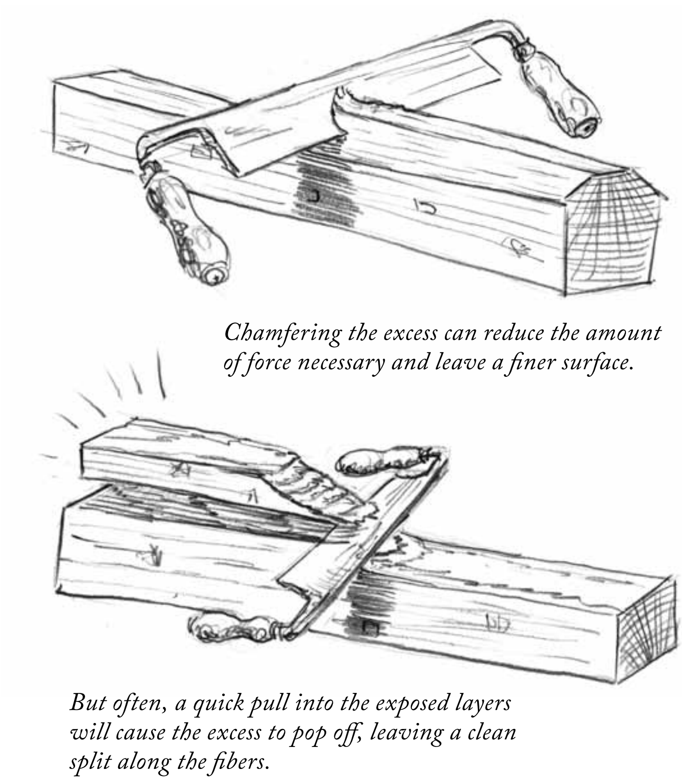



**FIG. 10.9** ***Remove large chunks by pulling into the end grain above the landing strip.***

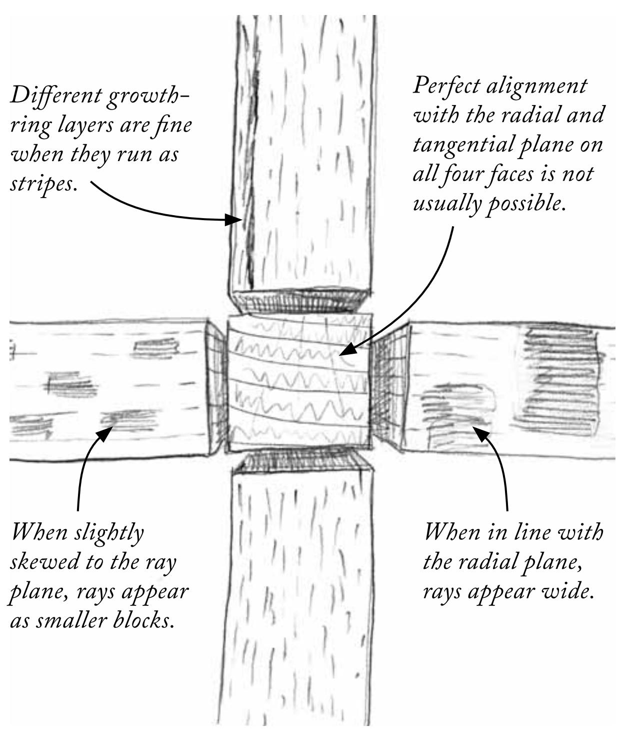



**FIG. 10.10** ***How to "read" the surfaces of the wood to know in which plane you are cutting.***

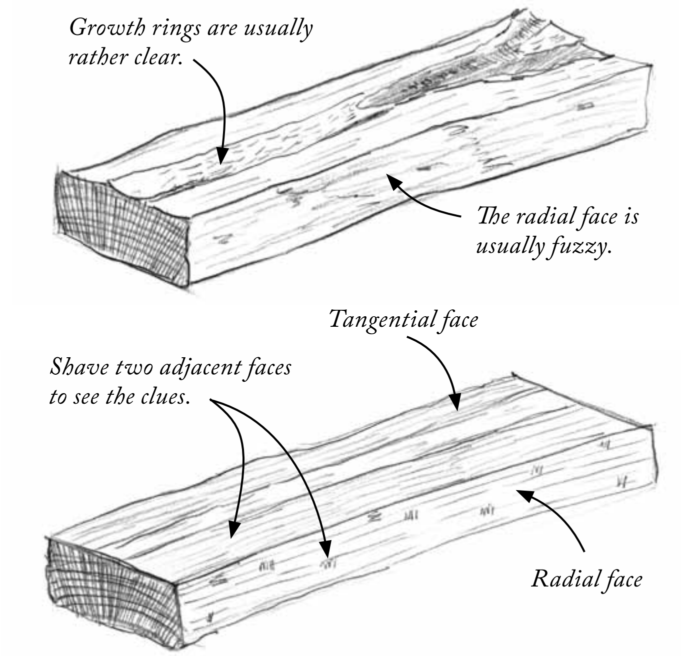



**FIG. 10.11** ***Clues in the wood are more easily seen once two adjacent faces are shaved.***

Inspecting the piece for visual clues helps determine the condition of the workpiece, but don't get overwhelmed. The drawknife, coupled with the shaving process detailed above, naturally finds and follows the fibers. Analyzing the results is helpful when developing your technique, and it quickly becomes second nature.

Start by trying to look at wood as a block made up of layers of fibers. Most parts start as square or rectangular sticks, so I'll start by focusing here on looking at the planes on the surface of a squared workpiece.

While the tangential and radial planes are helpful landmarks, most of the parts you will shave end up as round pieces, so while getting your piece closely aligned with the two planes is helpful, it is not essential to the success of the workpiece. Actually, because you are cutting square cross-sections from a round tree, it will be likely that not all the faces can be exactly in the ray or tangential plane. However, all the faces should be shaved to follow the fibers, regardless of the orientation of the growth rings or rays.

Once you grasp the overt structure of oak, you'll see it in more subtle woods. Some clues, such as growth rings, are obvious; luckily, the wood holds many more clues to guide our way.

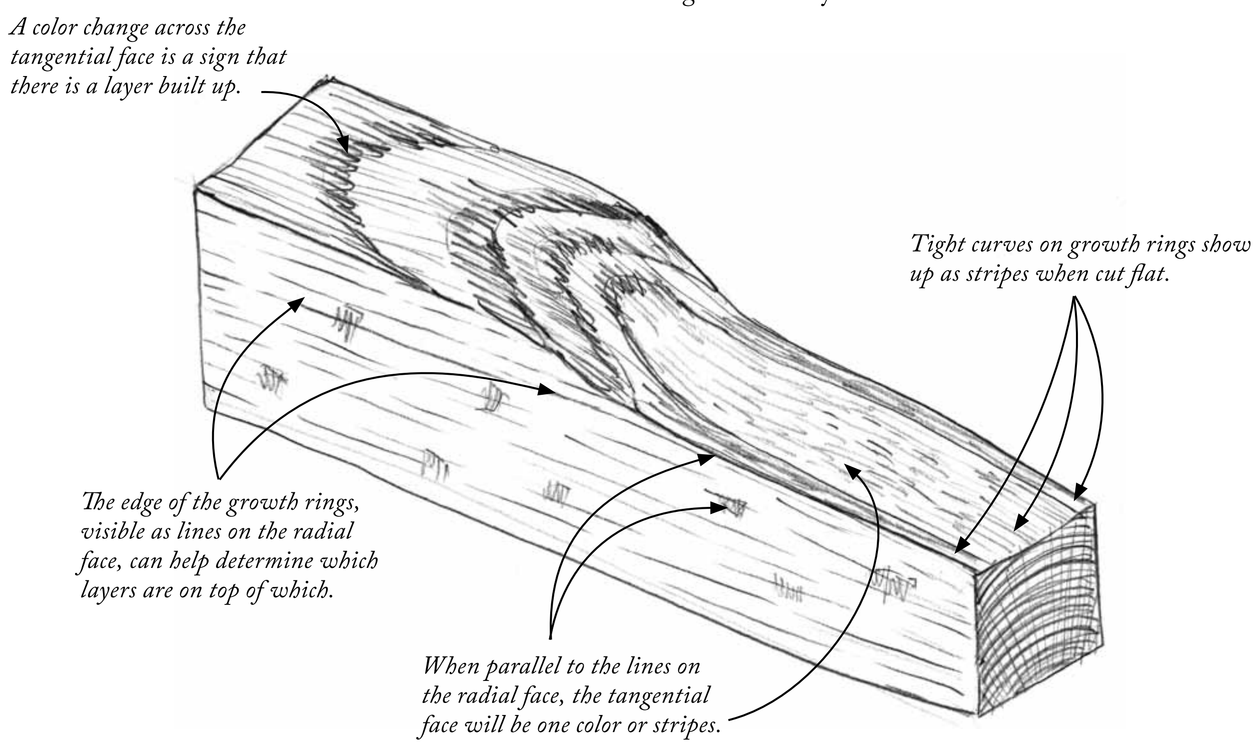



**FIG. 10.12** ***Look for a color shift, a clue there is material that needs to be shaved away.***

The fuzzy, uneven surface of split stock can make it tough to see the clues clearly. It's much easier after two faces of the blank have been shaved clean.

The first clue about the tangential plane (parallel to the growth rings), is the color shift on the surface as you cut across the growth rings. The difference between the growth rings is usually distinct and easy to spot.

When parallel to the fiberline, the tangential plane will appear as a solid color from one end to the other, but if the growth rings have a tight curve or the plane you are shaving is slightly skewed to them, the surface will appear striped. This is fine as long as the stripes travel the entire length of the piece. Whenever a color shift happens across the tangential plane, it is a sign that there is a step from another layer so you are not following the fiber line.

The growth rings can indicate that there are still layers built up, but it can be tough to determine which are higher. For this, look at the adjacent ray plane. When you look at the ray plane, the series of lines that you see is actually the edge of the growth rings. This makes it easy to see which layers are higher and where the surface is parallel to the fibers.

The medullary rays are very distinct and helpful when working with the oaks. The rays are most easily recognized on the quartersawn face, which corresponds with the radial plane. On sawn wood, the rays are prized for their lovely and unusual patterns. This wild patterning is the result of sawing through and across the rays. But when shaved in line with the fibers, the rays become uniform, and you can use their shape and relationship to the surface to guide your shaving.

The first clue to note is seen on the tangential plane. The small dash marks are actually the rays seen on edge. If these little dashes are not parallel to the edge of the ray face, then the radial face is not in line with the fibers.

It's important to remember that the ray plane radiates from the center of the tree (like spokes on a wheel) and only one side of the workpiece will be able to be in plane with

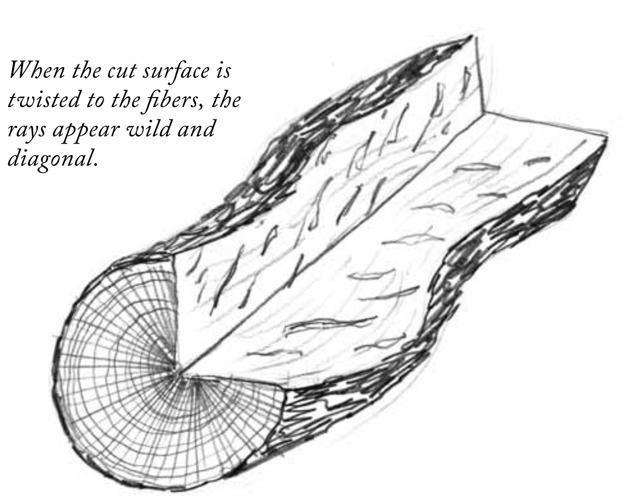



**FIG. 10.13** ***Quartersawing reveals rays that are not uniform.***

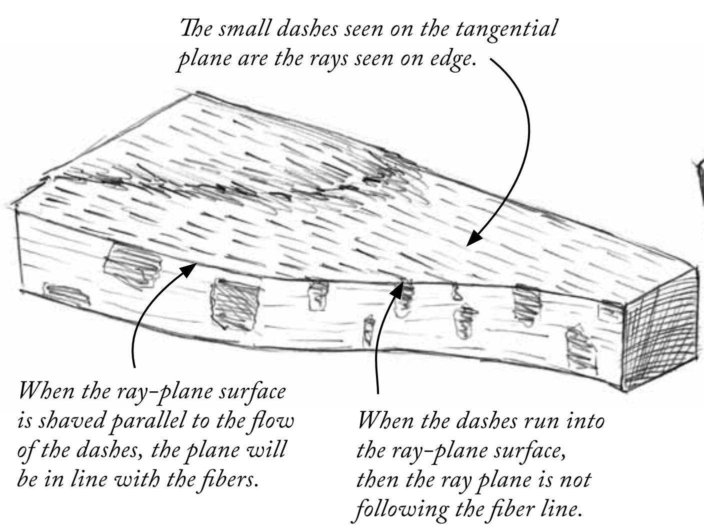



**FIG. 10.14** ***The relationship of the medullary rays to the ray plane.***

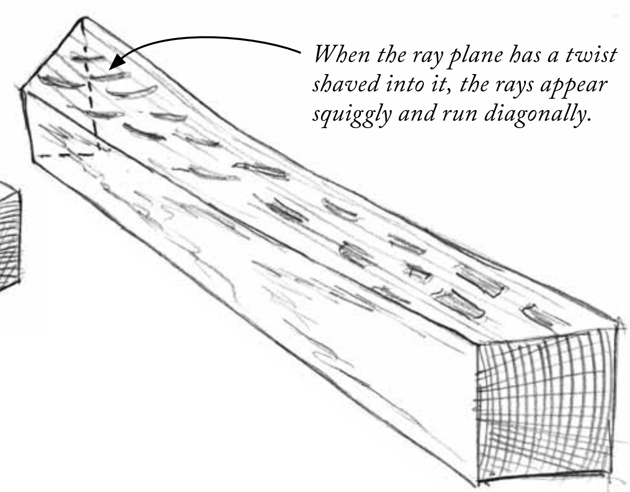



**FIG. 10.15** ***Diagonal rays indicate the surface is twisted.***

the rays. The other side will show the rays as smaller squares or dashes. Don't worry if neither side shows the rays as full-sized flat squares – the spindles end up round anyway.

When shaving the radial plane, the rays should appear as rectangles or squares traveling down the length of the piece, never as squiggles moving diagonally across the piece. Any diagonal rays are a sure sign that the surface is twisted in relation to the fibers, usually caused by dipping one handle of the drawknife as you shave.

To correct for a twist cut into the surface, repeat the landing strip technique, establishing a horizontal cut in the middle and following it off both ends.

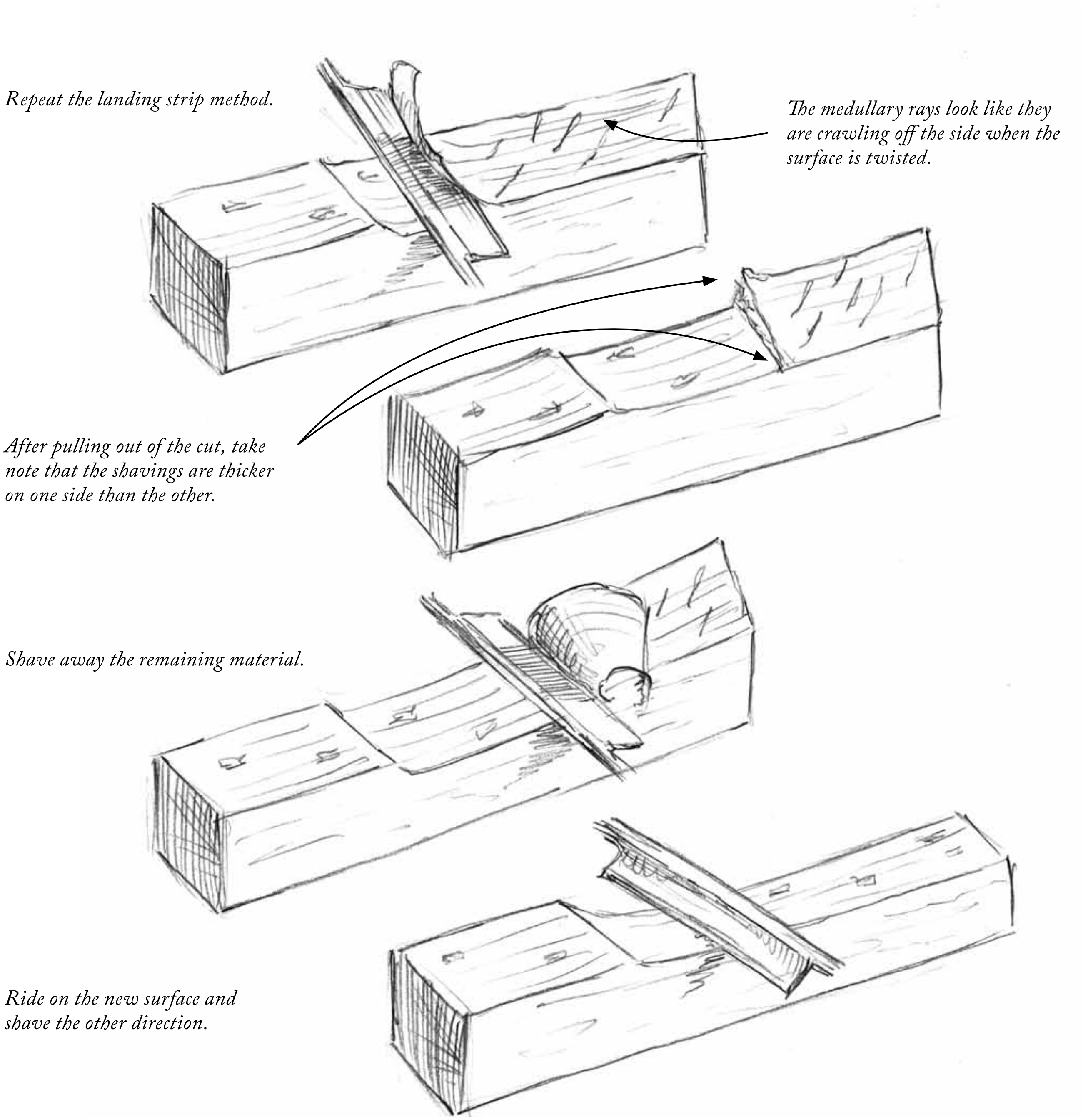



**FIG. 10.16** ***How to correct a twisted surface on the radial plane.***

When the twist is on the tangential plane, the growth rings run off the edge, which may be obvious enough to simply shave away the rings that are stacked on one side.

It's important to note that a twist carved into a surface is different than when the piece has a natural twist to it, which is covered below.

Another way to evaluate the workpiece is to hold it up to a light as though you were sighting down a rifle barrel. When the light strikes the surface, it makes it easy to see the texture on the piece. If the pores are at an angle to the sides of the workpiece or (in the case of the tangential face) if there is a growth ring cutting across the workpiece, you know that you are not in line with the fibers.

## Going with the Flow

Once the surface is following the fibers, you may notice that the piece is not straight. This is a tough one to wrap your head around, given the usual requirement for wood to be flat as the first step in woodworking. It is helpful to work with the straightest wood available, but even so, following the fibers will not yield a truly straight part. Any attempt to "flatten" a workpiece by carving is going to cut across the fibers, which will make the rest of the process troublesome. Folks often ask, "Is it alright that the part is curved?" I assure them, "If we can bend it curved, we can bend it straight."

I don't go as far as to steam the pieces to straighten them, but with green wood, a little flexing will limber and stretch the fibers. And if you repeat the flexing a few times throughout the different drying stages, the parts can be made near dead-straight. Once the parts dry, if they are still distinctly bowed, a few minutes flexing the piece while heating it with a heat gun can correct the problem, but more on that in the chapter Bending Wood. Obviously this is a very different approach to dealing with wood where splitting replaces sawing and bending the wood straight is as natural as bending it curved.

Hopefully there isn't a serious twist in the wood fibers. This kind of twist is different than a twist that you cause by dipping one side of the drawknife while cutting. The twist that I am talking about is inherent in the wood. As you shave along, it will naturally occur on each surface. This makes things a little tougher for the newcomer, but usually doesn't result in any problems once it's been shaved correctly, because most parts either become round in the end or get bent, at which point the twist usually comes out.

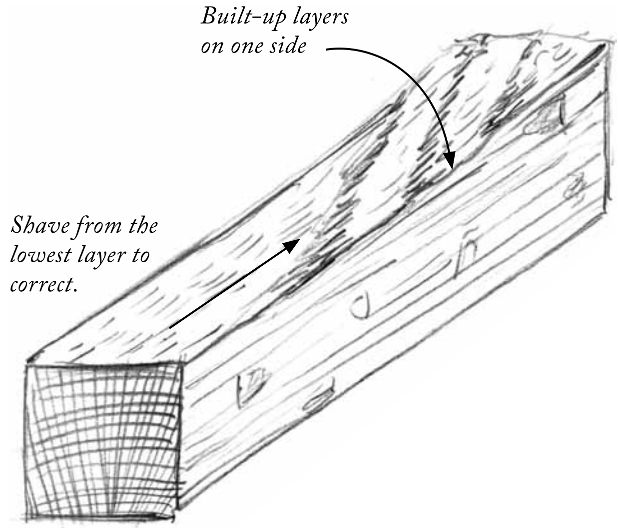



**FIG. 10.17** ***How to discover a twisted surface on the tangential plane.***

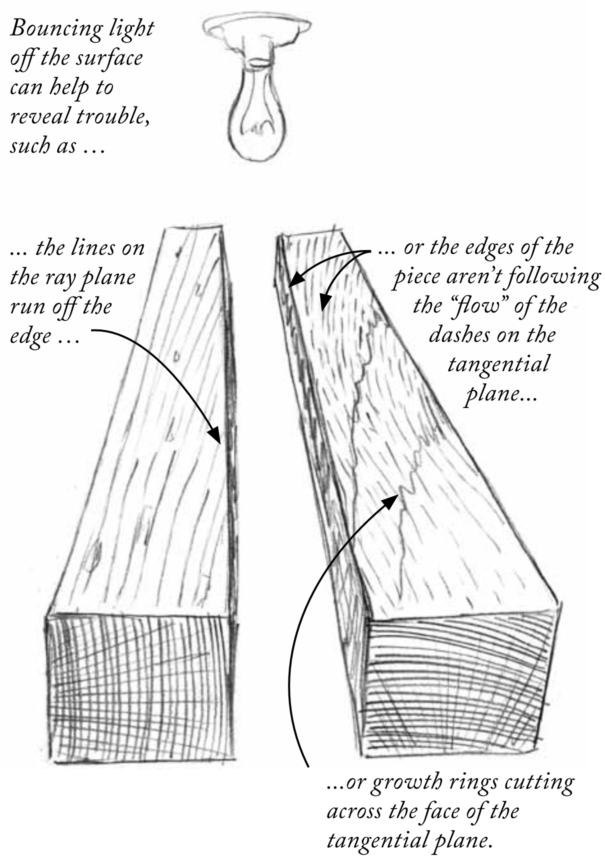



**FIG. 10.18** ***Sighting down the workpiece can reveal issues.***

The goal is not to correct the twist, which would require carving across fibers on each surface, but to follow it. If you follow the landing strip method, the drawknife will follow the fibers and therefore, the twist.

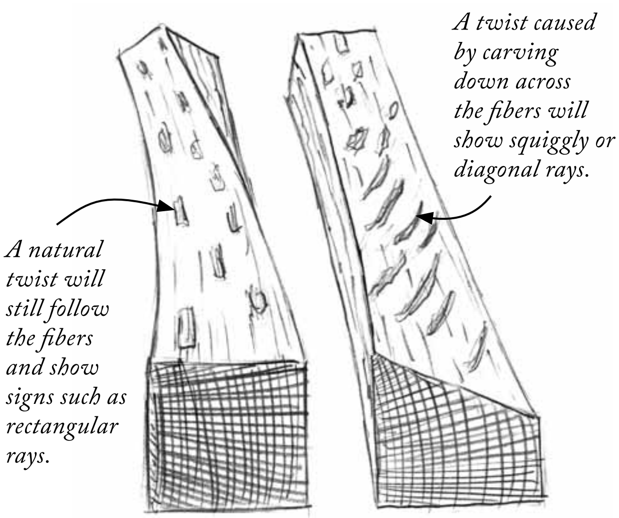



**FIG. 10.19** ***A natural twist can be followed and still result in a strong part.***

## Essential Technique: Skewing & Slicing

While most tools will benefit from skewing and a slicing motion, the drawknife, with its long blade, is made for it. Understanding the reasons and benefits of this might be helpful when considering the way that drawknives are shaped and used. Just as I am certain that this technique is vital to good results, I am certain that it is not intuitive, so be patient and expect to practice before it settles in.

To begin talking about the benefits of skewing and slicing, it's helpful to focus on the way that shavings are formed when cutting a piece of wood. When a shaving is formed parallel to the fibers, it will travel straight up the blade until the angle gets too great and it crimps. The repeated crimping is what gives shavings their distinctive curl. It takes a certain amount of force to cause these breaks; the higher the angle of the blade, the more frequent the breaks will occur. This translates to an increase in force required to perform the cut. Of course, grinding a lower bevel angle can help, but most steel can hold an edge only so thin before being too easily damaged during use.

One goal of skewing and slicing is to lower the effective angle of the blade, reducing the amount that the shaving must deflect and the force required to pull the tool.

When a shaving is formed perpendicular to the fibers (working across the grain), the short-grain bond between the fibers is weak, allowing them to deflect and separate easily. Because of this weakness, they also break closer to the edge of the blade, which helps with surface quality.

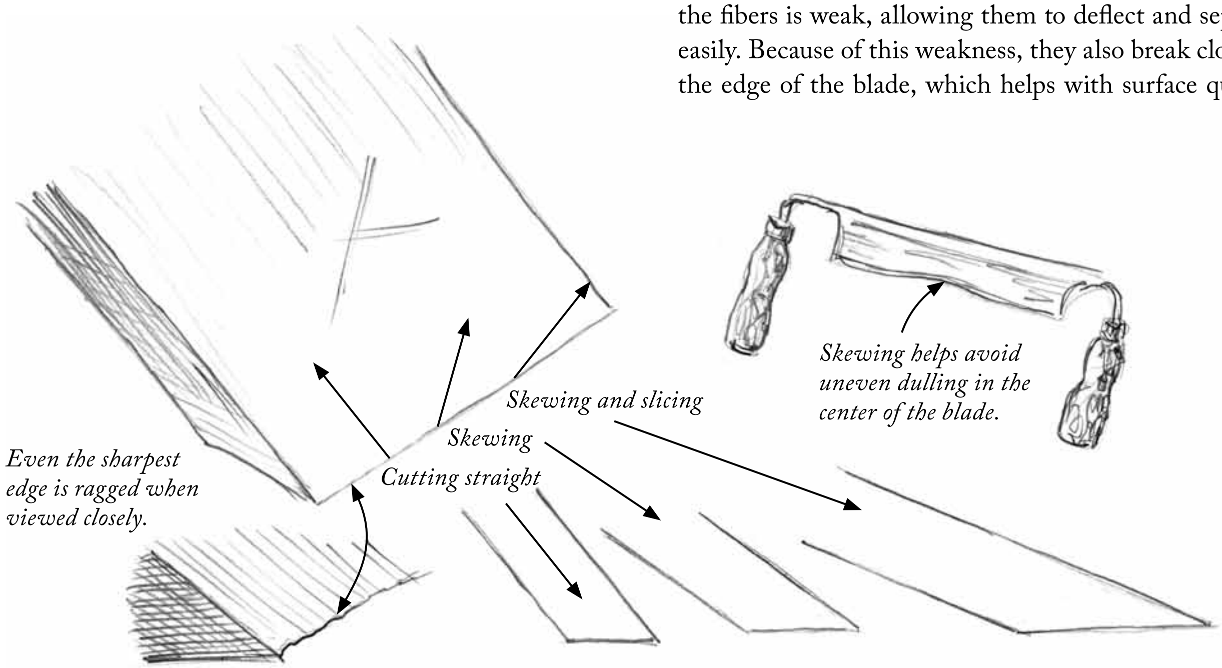



**FIG. 10.20** ***Skewing the blade of a drawknife lowers its effective cutting angle.***

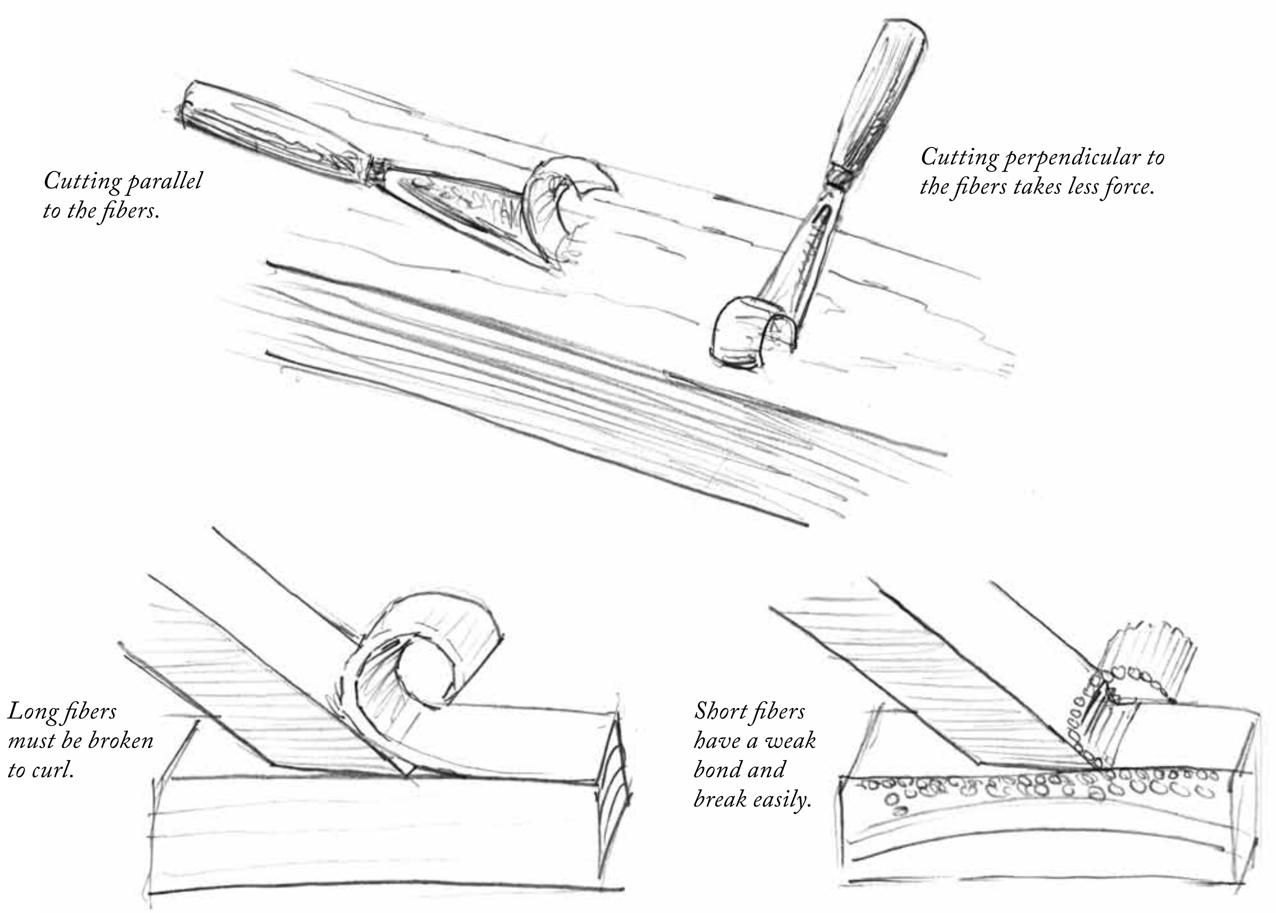



**FIG. 10.21** ***Why cutting across the grain is easier than cutting parallel to it.***

Crosscut shaving requires less force than shaving parallel to the fibers.

Another goal of skewing and slicing is to direct the cutting force at a diagonal to the fibers to gain some of the benefits of cross-grain cutting.

Skewing the blade while cutting lowers the effective cutting angle. When cutting parallel to the grain of the workpiece, the angle that the blade is cutting will be close to whatever the angle the bevel is ground. When skewed, the path that the chips will follow is lower because they are traveling somewhat across the blade, not directly up it. This lessens the rate that the chip must crimp and therefore the force needed to take the cut.

Also, skewing the blade causes the shavings to break partially to the side – not just the front. This reduces the amount of force required to cut because a portion of the

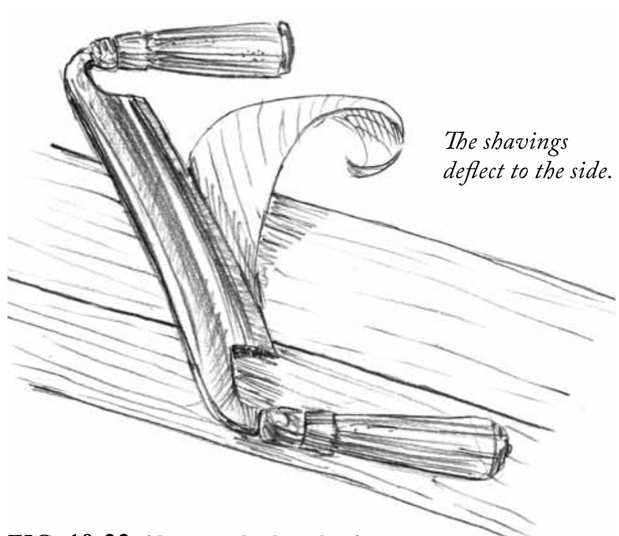



**FIG. 10.22** ***Skewing the drawknife reduces the force required to move it through the work.***

force is directed to cross-grain cutting. Shavings made with the blade skewed will have a telltale spiral.

Viewed under magnification, a sharp edge is actually somewhat serrated like a bread knife, and as such, it will cut best if a slicing motion is used.

Slicing (moving the blade laterally through the wood) while skewing decreases the effective cutting angle even more, which means that you can reap the benefits of a much lower angle – such as reduced effort without incurring the weakness of a blade that's ground to a thinner edge. Slicing actually makes the blade sharper and tougher, which we have all enjoyed in the form of a paper cut.

Another reason to slice when cutting is that it increases the longevity of a sharp edge by making sure that the whole length of the blade is used, instead of wearing down one spot in the center of the blade.

Check your blade after an hour of use and note whether the middle is duller than the sides to assess your slicing technique. I find it helps to think of the drawknife as a saw.

Slicing can also improve the surface quality of the workpiece. Just like a cut made with a fine-toothed saw will leave a smoother surface, a cut made with greater slicing action will do this as well. The lower effective cutting angle of the blade also causes the fibers to deflect less as they are lifted from the surface, which helps leave a cleaner result.

There is more about the surface quality benefits of skewing and slicing in the chapter Carve the Seat.

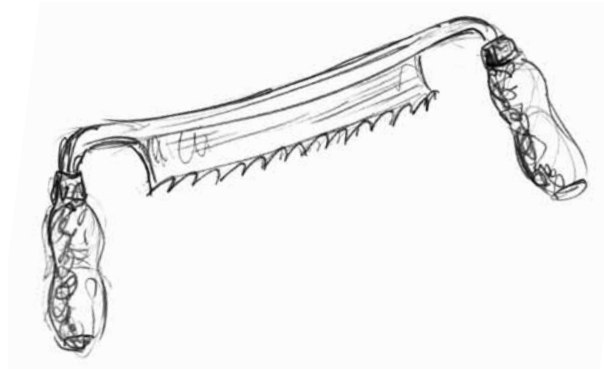


**FIG. 10.23** ***Think of a drawknife as a saw to encourage a slicing cut.***

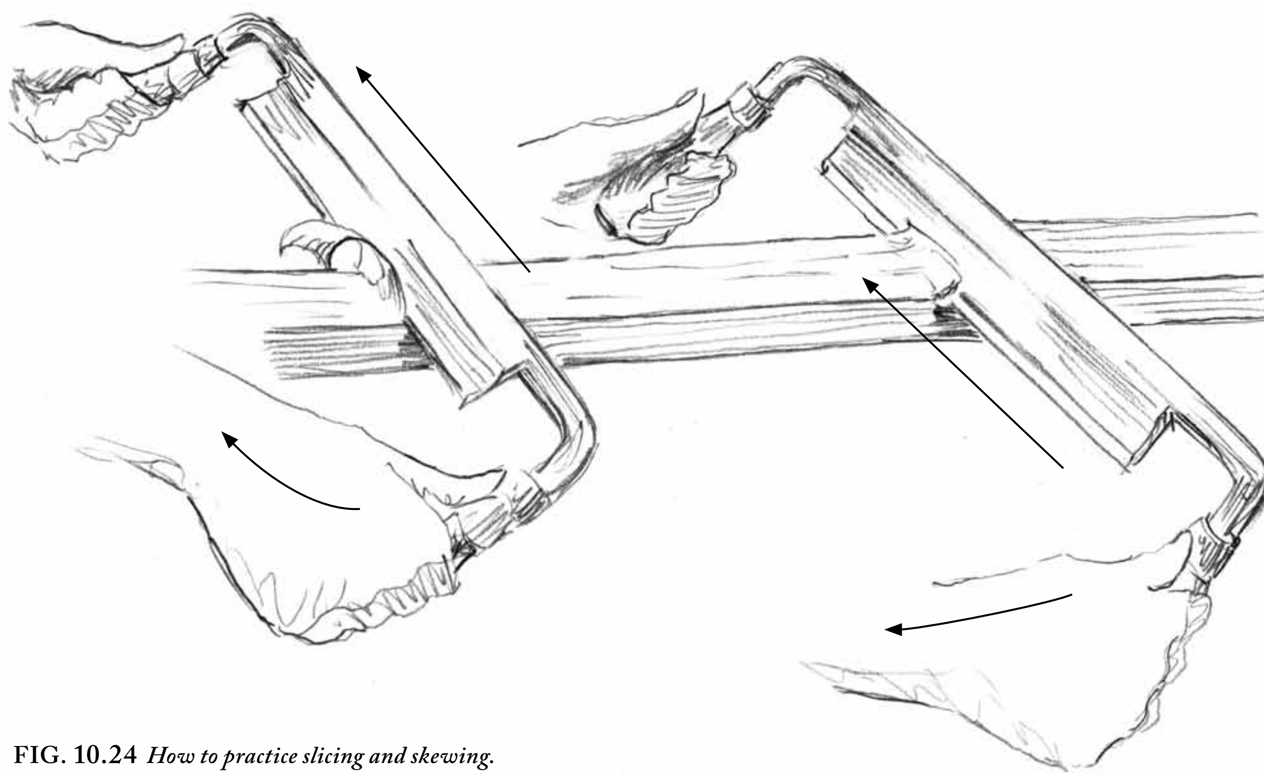


**FIG. 10.24** *How to practice slicing and skewing.*

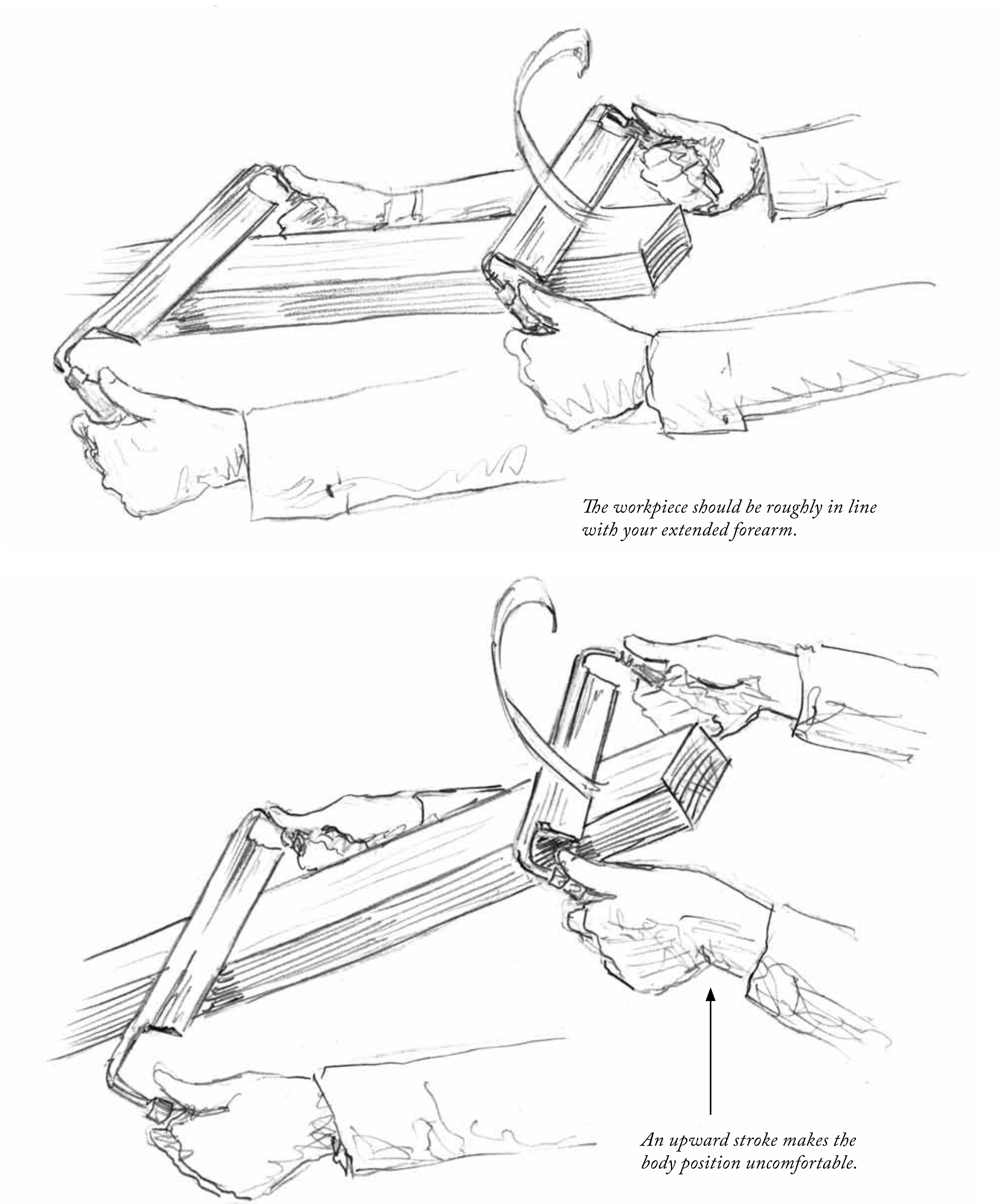



**FIG. 10.25** ***Proper workpiece position can make the work easier.***

For any tool, the most stable and comfortable way to cut is usually in the center of the blade, especially with one like a drawknife that has two symmetrical handles. The trouble is that if you begin each cut in the center of the blade with both hands equally positioned, you will have no incentive to move away from the most comfortable position and gain the benefits of slicing. So to encourage slicing, I always position the drawknife so that the cut starts near the corner of the blade. Once I start moving, I naturally head toward the balance of the center of the blade, which imparts the slicing motion. Then it's only a small effort to go past the center of the blade to end the cut on the other side of the blade.

This sideways motion also imparts more control over the tool and cut. When you are pulling in the direction of the cut, the tool has a tendency to jerk forward when the material being cut gives way. When you slice sideways to propel the tool, you can stop moving the tool sideways at times to halt the forward motion of the cut. This is helpful when trying to control carving and shaving.

## Body Position & Shaving

The only way to utilize the skewing and slicing motion while shaving is to have the correct body position and a full range of motion in relation to the workpiece. The workpiece should be held so that it is roughly parallel to your forearm as you hold the knife at the farthest point of contact. This will allow you to follow through with the cutting stroke with your wrists in a stable position.

If the workpiece is angled too high because of the platform of the shavehorse, then the position of your wrists must compensate throughout the stroke to keep the drawknife in the correct cutting position. This is awkward and usually leads to abandoning the skewing and slicing in hopes of keeping the tool's position constant.

## Troubleshooting

Managing the condition of the tool and the expectations of the results can be difficult at first because there are so many variables. Below, I've presented a list of common problems with drawknife use.

***Problem:*** Poor surface quality

***Solution:*** It can be that the initial shavings are too thick, causing a splitting action to pull fibers apart ahead of the blade. On the radial plane, it is common to have small "peck outs" in the surface because the radial plane peels apart more easily. To correct for this or improve the surface, skew, slice and take a thinner cut.

***Problem:*** Chattering

***Solution:*** Chattering is usually the result of a dull tool or poor edge geometry. If the edge is too blunt, it will skip out of the cut and skitter down the surface. Correcting the geometry of the edge – plus skewing and slicing – should take care of this problem. Also, working closer to the support of the shavehorse's stage can help.

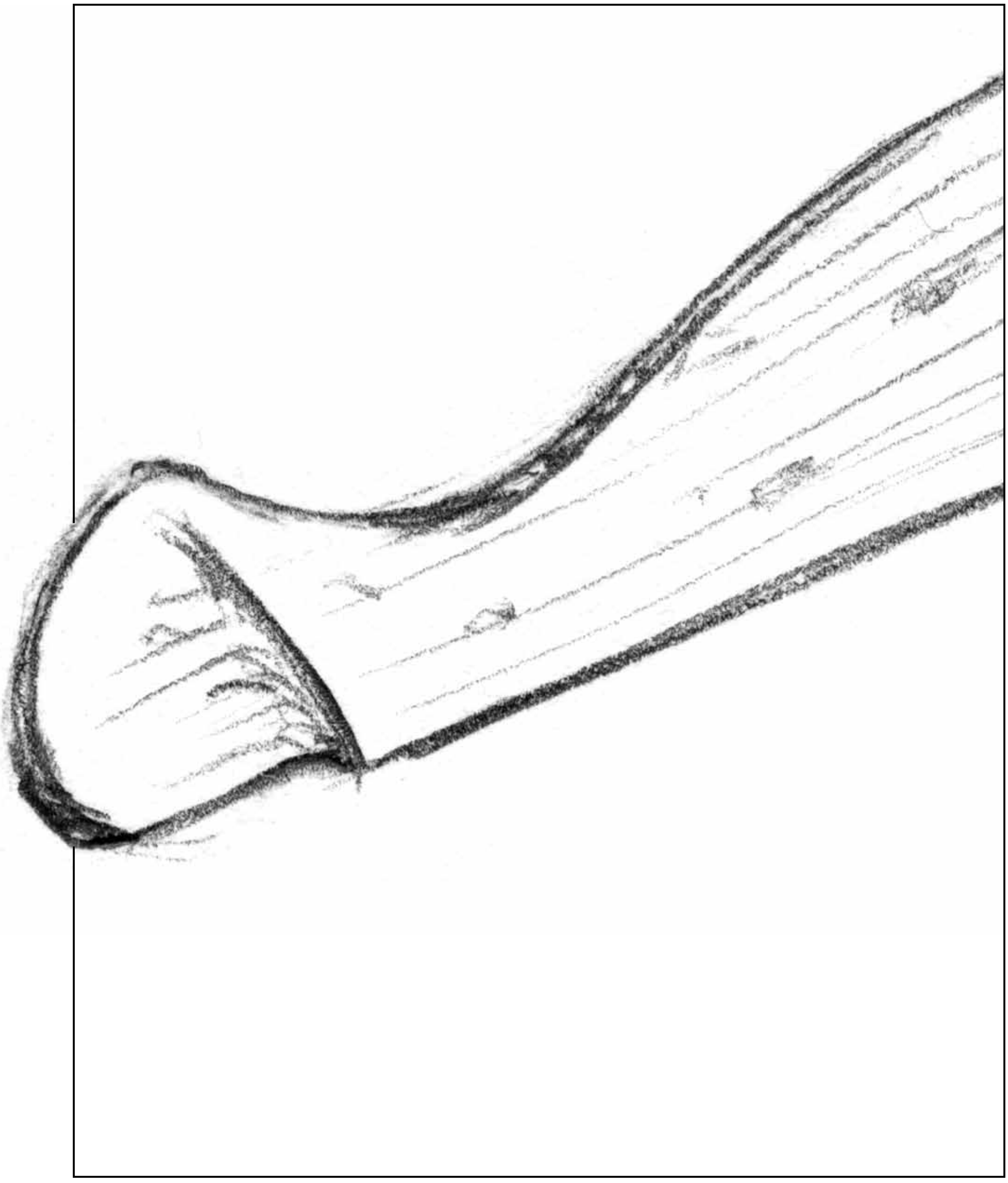
***Problem:*** Drawknife digging

***Solution:*** If the blade seems to dive into the surface, which I call being "grabby," it is usually a sign that the dubbing at the edge is insufficient. The drawknife is acting like a chisel because it is sharpened like one. A few extra stropping strokes tends to tame this problem.

***Problem:*** Unintentional tapering of the work

***Solution:*** It is common for new users to taper a workpiece without intending that result. The smoother surface quality left by cutting downward across the fibers is tough to resist. Also, as you draw the drawknife toward you, it is natural to drop your wrists slightly, causing the blade to cut across the fibers. This is the opposite of the desired motion when shaving along the fibers. Consciously working to raise your wrists as you shave will follow the fibers, or cause the blade to come up out of the cut, which is not a problem because you can simply take another stroke.

The drawknife is on the top of my tool list as the most fun and versatile tool. The first question that I ask myself when deciding to cut something is, "Can I do it with the drawknife?" If the answer is "No," then I go on to ask whether the problem is my skill or my understanding of the job. Such is the range of this tool.



# 11

# Shaving & Shaping Parts

This chapter details the process for shaving the parts for the project chairs. For those who are new to the drawknife and to shaving wood along the fibers, it will be helpful to read the chapters The Drawknife plus Shaving & Carving with a Drawknife.

## Shaving Spindles: Why Not Turn Them on a Lathe?

When seeing spindles for the first time, folks often assume they were turned on a lathe. I have turned spindles, and as long as you start with arrow-straight stock, you will most likely not lose much in the way of strength or flexibility, although the surface will not have the pleasing facets that come from shaving. Unless you are an experienced turner, the thin pieces are tough to manage on the lathe, and frankly, the shaving process is so pleasant and fast that the lathe doesn't even enter my mind as an option.

The first step in making the parts for the upper carriage of the chair is to split and shave them so their surfaces are parallel to the fibers in the wood. This makes bending more likely to succeed, as well as shaping the parts simpler because it takes the guesswork out of picking the direction to shave.

I start by shaving two adjacent faces of a billet parallel to the fibers. Then those faces can be used as references for the opposite faces, which ensures that they too will be parallel to the fibers. After that, all shaping is a matter of carving toward the thin areas, which simplifies the process dramatically. Slight bows in the wood don't cause any problems and can be straightened if necessary later.

Getting to this point with dry wood isn't as simple. Working dry wood with the drawknife isn't as easy or effective; with extra care and effort, however, you can end up with similar results once you understand the concepts.

Power saws and to some extent the jointers and planers used to cut dry wood aren't very sensitive to the wood fibers. With their fences, chipbreakers and limited depth of cut, they handle most dry wood as if it is a homogenous material. Their role is not to follow the fibers but to create a desired shape with a smooth surface. Because of their high speeds and small cuts, they can bully their way across a piece of wood with little regard for the structure of the material.

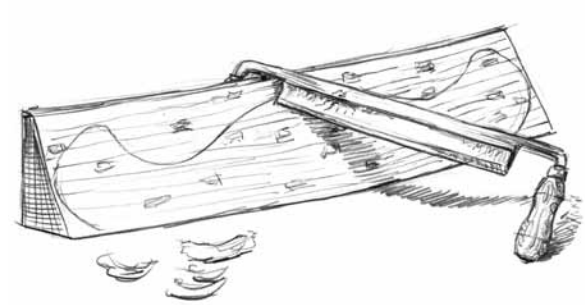


**FIG. 11.1** *Many shaping operations can be handled by the drawknife.*

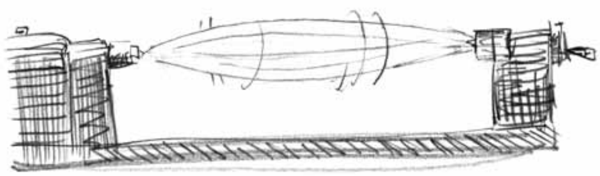


**FIG. 11.2** *Thin spindles tend to whip on a lathe.*

As a result, power tools are not good at following the natural curves and structure within the wood. It's the drawknife, especially when used with green wood, that's designed to do just that. I think of it as a tool for dissecting the wood. With a few preliminary steps, you also can gain the benefits from using the drawknife with dry wood. This chapter will focus on learning what to look for in the wood and how to use the drawknife to shave and shape it into chair parts.

The process of shaving a spindle is reductive. Establishing a series of shapes that lead to the desired final shape will create consistency and speed.

The first shape is a square cross section. The illustration below shows the five steps to shaving the blank. I will elaborate on each step in the following section.

Because I am using green wood, all of the dimensions that I use will be larger than the final size to account for shrinkage. As a note on process, I always take the spindles through the stages as a group. For instance, I shape them all square in cross section first before moving any of them to the next step. That way, I am constantly mixing them up and choosing a different order to perform each operation. This allows me to focus on a single task and makes the results more consistent. If I were to begin with one blank and take it through all the steps, the first spindle of the day and the last might look quite different, for no other reason than having warmed up a bit.

I first inspect the spindle blank. If it has four well-split sides, I choose the two adjacent faces that are most square to each other to shave first. If the blank has one side that is much more in line with the fibers, I will usually opt to use it to help ensure that I will have enough material to achieve my final size.

I prefer to begin shaving one of the faces that is in the radial plane. These faces will shave more easily and allow

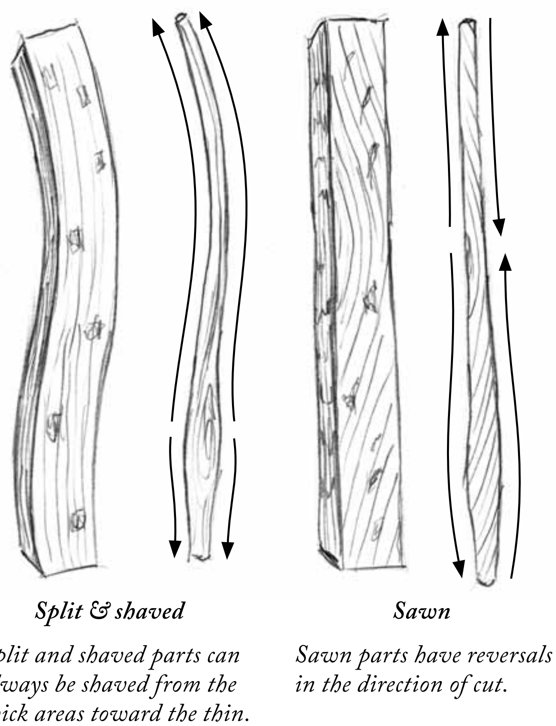



**FIG. 11.3** ***Shaving split parts is easier than shaving sawn parts.***

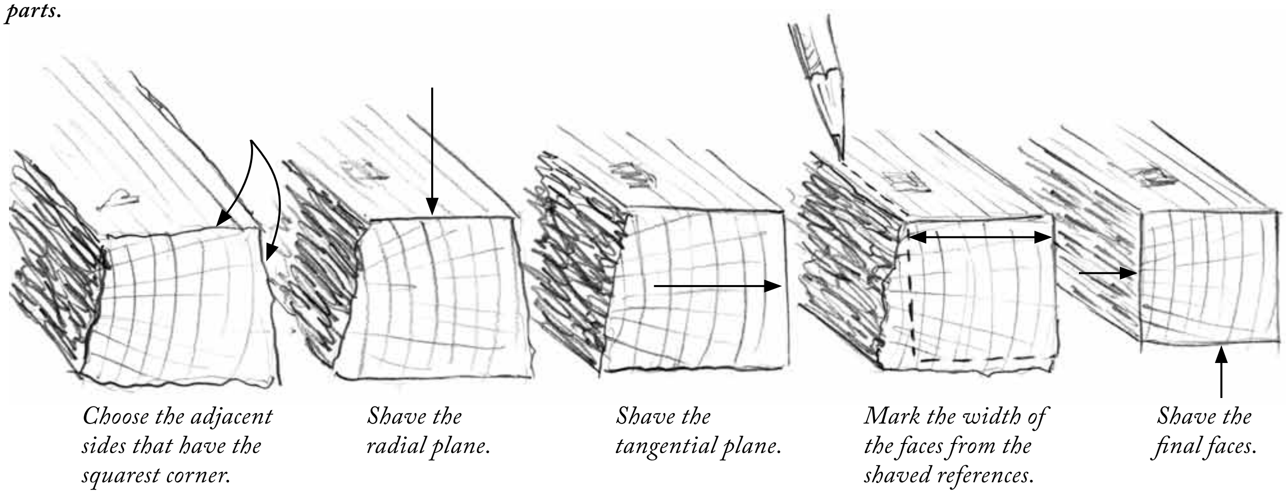



**FIG. 11.4** ***The five steps to squaring a spindle blank.***

me to remove wood quickly to establish the fiber line. I use the landing-strip method, described in The Drawknife chapter, to establish my lowest layer that runs from one end to the other, then I shave off all the wood above that layer. Remove only enough wood to get a layer that runs the entire length of the blank to ensure that you will have enough material for the final dimension. The surface quality should be good, but don't expect it to be perfect. The ray plane tends to have small areas that "peck out" just below the surface. These small defects will get shaved out during the remaining shaping processes.

Following the landing-strip process carefully is the best way to ensure that you are in line with the fibers, but checking the visual clues to evaluate your results can help refine your technique. I inspect the small dashes on the adjacent tangential plane, which are the ends of the rays, to ensure that the surface is in line with them. This may be clearer once the tangential plane has been shaved as well.

If the results are not in line with the fibers, pull the drawknife toward the area with the built-up layers to shave them off. If this is difficult to determine and there is still enough material in the piece, repeat the landing-strip technique.

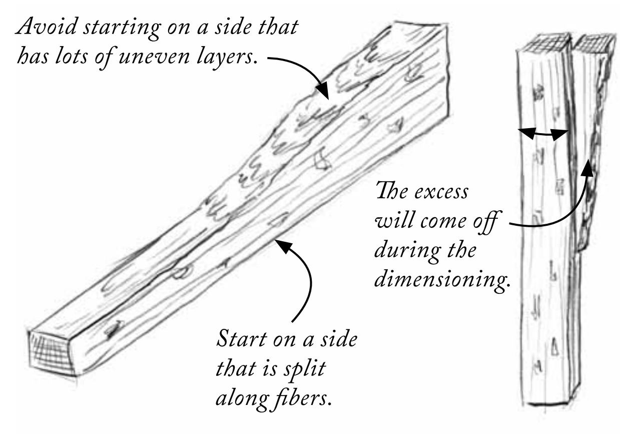
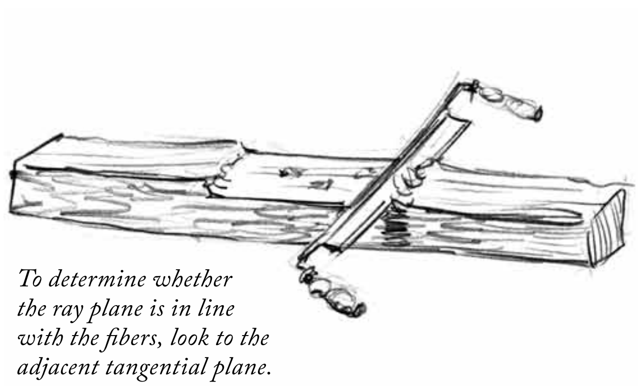



**FIG. 11.5** ***Step 1: Choose your first face to start shaving.***



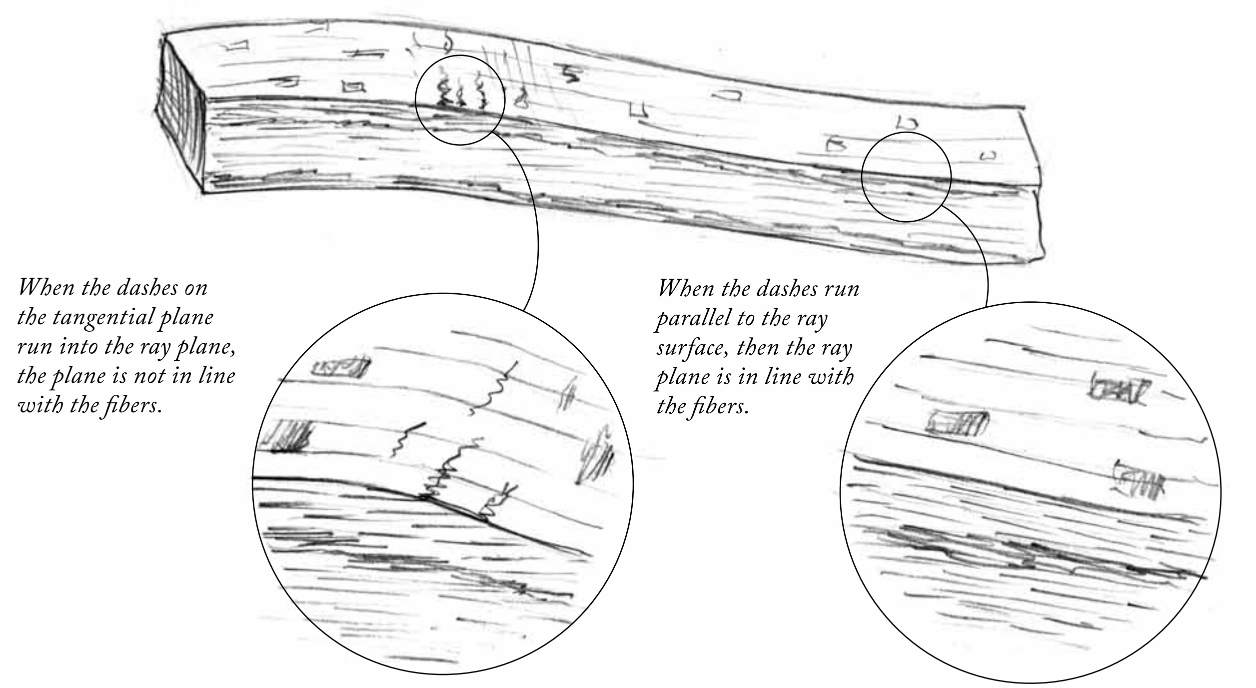




**FIG. 11.6** ***Step 2: Shave the radial face.***

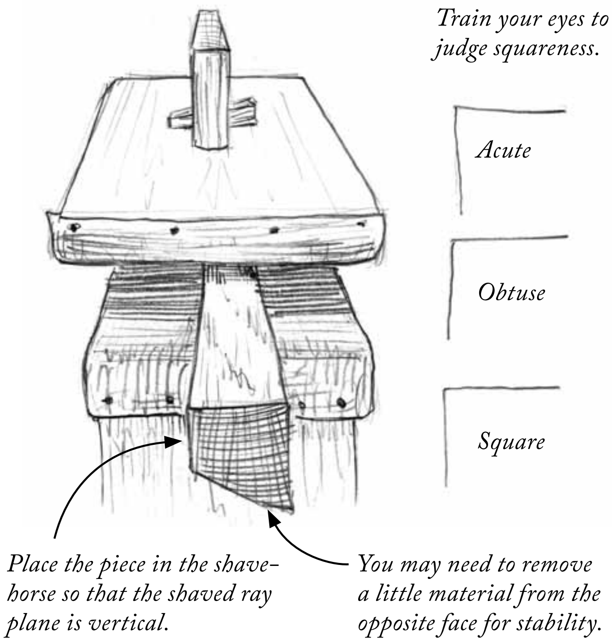



**FIG. 11.7** ***Step 3: Shave and square the tangential face.***

To shave off any layers that are above the landing strip, remember to pull the drawknife along the landing strip toward them.

Once the initial radial plane has been shaved parallel to the fibers, the next step is to shave one of the adjacent tangential planes.

The process of establishing a "landing strip" in the middle and expanding it out toward the ends is the same as before, but with the added task of keeping the surface square to the established radial plane. This doesn't require a tool to measure; simply align the blank in the shavehorse so that the shaved ray face is vertical then focus on shaving horizontally. We all have a sense of balance that makes shaving horizontally easier than you might imagine. Plus, the head of the shavehorse offers a close reference to guide you. When judging square, just ask yourself, "Is the angle formed by two sides acute or obtuse?" If the answer is obvious, then it isn't square. When you remove material to correct for square, make sure to remove it evenly along the surface using the landing-strip method.

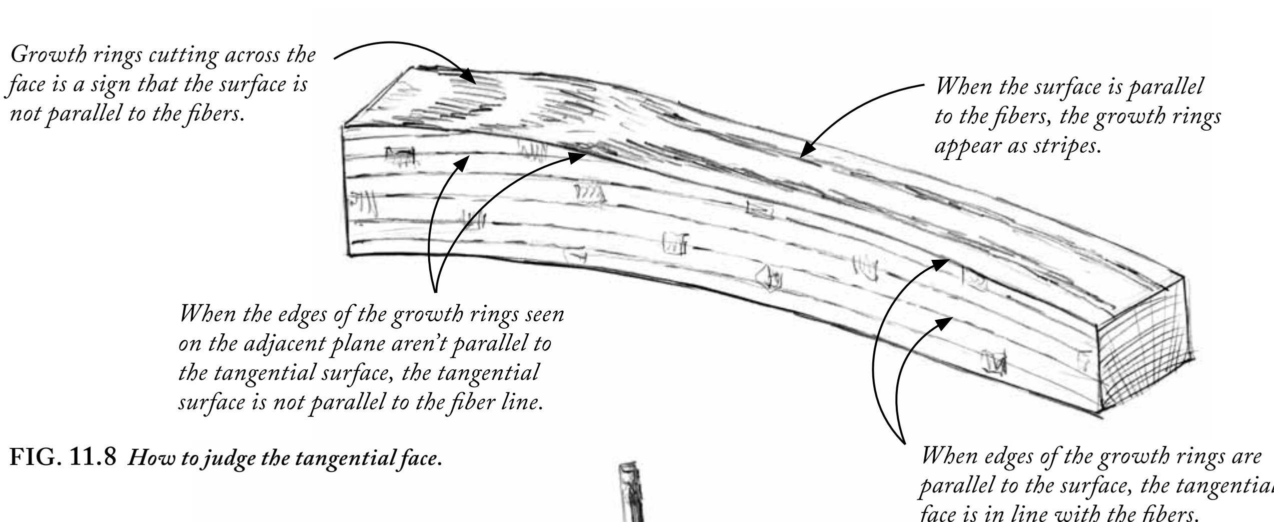



**FIG. 11.8** ***How to judge the tangential face.***

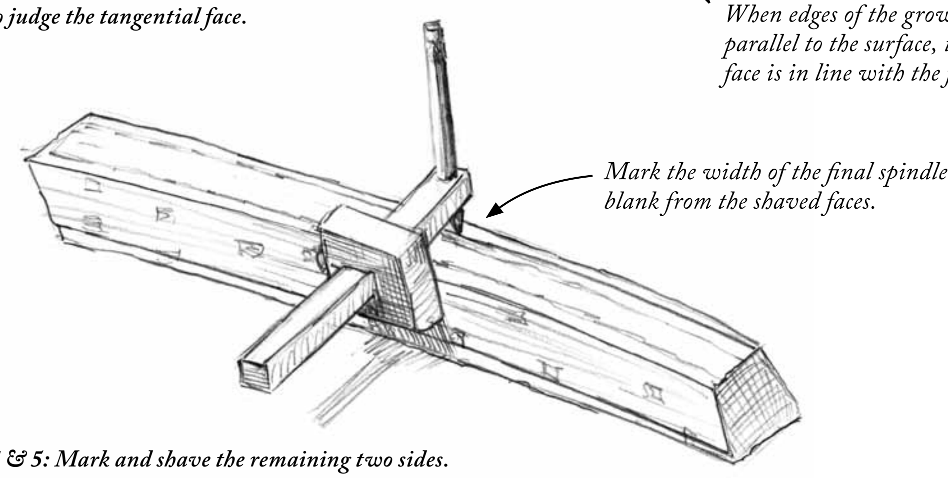



**FIG. 11.9** ***Steps 4 & 5: Mark and shave the remaining two sides.***

To judge whether the surface is parallel to the fibers, you can look at the surface of the tangential face to see if any growth rings cut across it. Or you can inspect the lines on the ray plane, which are the edges of the growth rings, to make sure that they are parallel to the edge.

The next step is use the established surfaces to mark the width of the squares that represent the final size of the square billet. In this case, 3⁄4" is the desired size. This size will allow the piece to shrink and still be large enough for the final dry shaping. To mark the distance, run a marking gauge's fence along one of the shaved surfaces while marking on the other. You can use a dull marking pin for this, which will pull up fibers and help make the line obvious, or a pencil. Repeat the marking process, registering off the other completed face.

Because the reference surfaces for the marking gauge follow the fiber line, the newly marked line will automatically follow the fiber line. I then remove the excess material on the radial plane to within 1⁄8" or so of the line. This gives me the chance to confirm that the final line is indeed parallel to the fibers and to remove the excess material quickly without fear of the final surface quality being affected.

To remove large amounts of wood, I like to chamfer the long edges first then finish off across the whole face. This decreases the effort and increases the control. Once again, following the fiber line and staying square to the existing planes is vital. Once I've done this to within 1⁄8", I remove the material down to the line.

The final step is to remove the excess material from the uncut tangential face, following the same steps as before. Once this is achieved, the piece should have four sides of equal width that are square to each other and perfectly parallel to the fiber line. By working all of the spindles to a square cross section at one sitting, the task should become easier, which is necessary skill-building before tackling the pieces that will be bent.

## Shape the Spindles

Here are the steps that take the spindle from a shaved blank to an octagonal, tapered shape ready for drying. Shaping the spindles in stages helps build speed and consistency.

The first step in shaping spindles is to establish the area for the "swelling." This is the bulbous area just above the seat that adds aesthetic interest and comfort. This process entails a combination of carving and shaving.

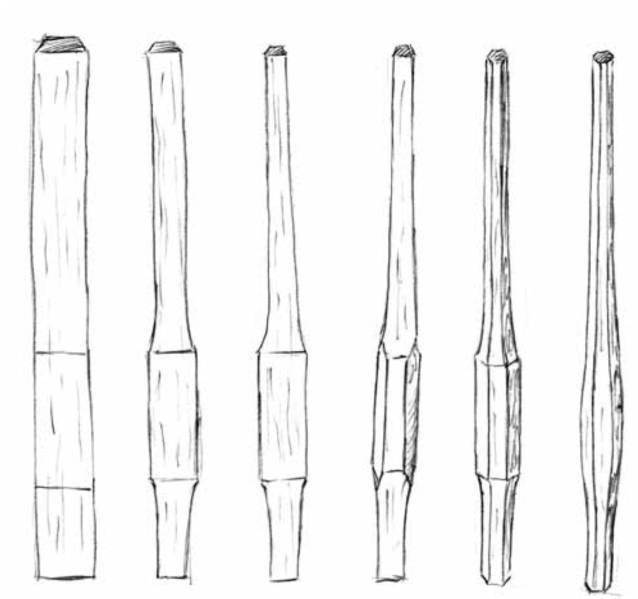


**FIG. 11.10** *Shape the spindles in stages.*

I start by marking two lines across the blank near the bottom of the spindle. One line is 3¾" from the bottom of the blank. The second line is 3½" above the first line. The area between the two lines will be the "swelling." For your first spindles, I suggest drawing the entire profile of the spindle on the first face as a guide so you can concentrate on cutting rather than on the dimensions.

The next step is to shave away material from two opposite faces from the lower mark all the way to the end of the piece. This requires that you carve down across the fibers, but once you reach the depth of the layout line, it's vital that you follow the fiber line as before. Slicing plays a great role in making this cut smoothly and with control.

Because of the small width of a spindle, it is easy to mistakenly carve down into the fibers. To ensure that you are following the fibers, pull up and out of the cut once you are shaving at the final depth. This is akin to creating a landing strip. There will be torn fibers left that you will shave off.

This makes the process clear and ensures that you follow the fiber line. Use this technique for all the parallel surfaces of the spindle. Repeat on the opposite face.

Then turn the piece and shave the other two faces on the lower section. If the first two faces are 5⁄8" apart, shave until the piece is square, knowing that it will be the correct size.

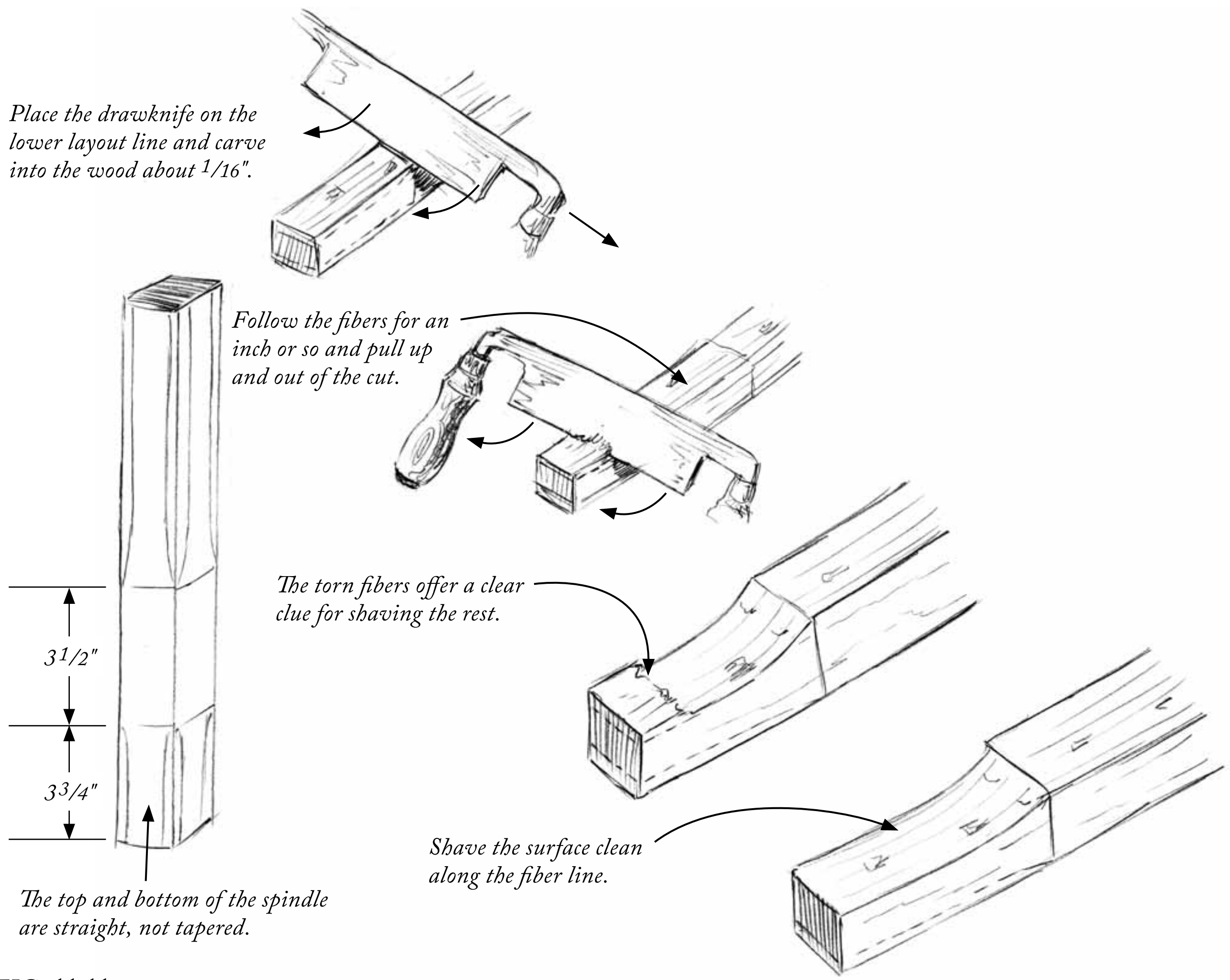



**FIG. 11.11** ***Shave the bottom of the spindle on two opposite faces.***

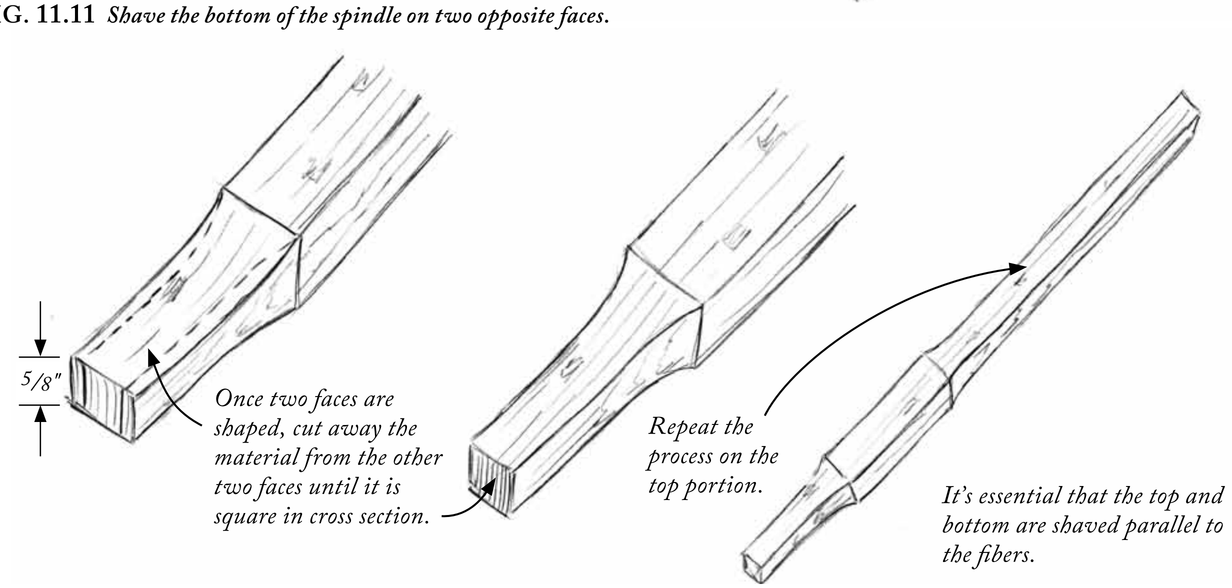



**FIG. 11.12** ***Shave the other two faces, then repeat the process on the upper portion.***

The final 2" should be straight and 5⁄8" in cross section. This allows enough room for shrinkage and final shaving to get a 1⁄2" tenon. Repeat the process for the top section of the spindle, again sizing the piece to 5⁄8" square.

## Tapering

The next step is to taper the top portion of the spindle by shaving material from all four sides. The dimension at the top end will be 7⁄16" in cross section. This will yield enough extra material to finish with a 3⁄8" tenon.

Focus on creating an even taper from the top line of the swelling all the way to the end.

To do this, I break the task into steps. Start two-thirds of the way down toward the swelling and take a light shaving off the surface all the way to the top end. Be sure to follow the fibers. Next, start another cut one-third of the way down and shave to the top. Repeat the process on the opposite face of the blank. Finally, use the drawknife to smooth the steps in the taper and ensure it is even and the correct size at the end. I work on both sides of the taper to ensure it is consistent. Be careful not to get carried away; this last cut is actually meant to remove very little material. Repeat this process on the other two faces.

Next comes the process of shaving the four-sided shape into an octagon. Start with the swelling. Place the spindle in the shavehorse, this time with one corner facing straight up. It's helpful to carve a V-notch in the dumbhead to grip the corner.

Take a light shaving along the corner of the swelling, as in Fig. 11.14, leaving a new facet that's about 3⁄16" wide. Be sure to follow the fibers. Rotate the spindle 90° and repeat. Do this for all four corners. Once complete, look at all of the new facets in relation to the original faces. They should be all the same width. If the new ones are narrower, take another light shaving to even them up.

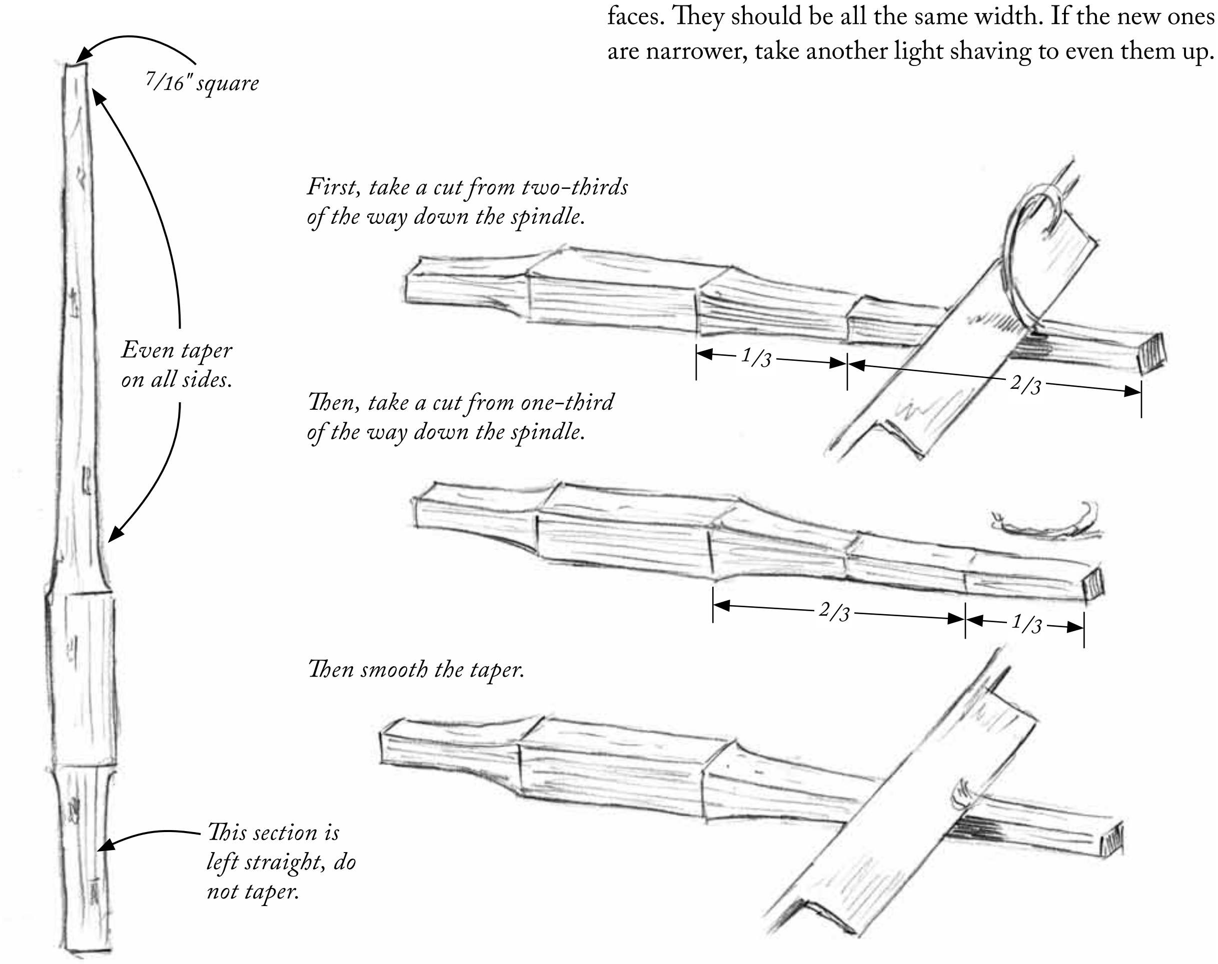



**FIG. 11.13** *Taper only the top portion of the spindle.*

The next step is to cut away the same facets above and below the swelling as in Fig. 11.15. Do this with the same type of cut that was used to reduce the two ends. This time, the tenons on the ends should look like stop signs, and the facets should all be even all the way down. If you were to crosscut the spindle at any spot along its length, you should see a perfectly formed octagon.

The final step before setting the spindles aside to dry is to shave off the hard transition on either end of the swelling, see Fig. 11.16. This will create the fluid shape of the spindle. Do this by taking light cuts from about 1" inside the swelling toward the tenons. Make sure to pull out of the cut before removing any material from the tenoned ends. Upon inspection, the facets should all be equal in width at any given location along the spindle.

Crisply defined facets will come in handy later after the drying, when the spindle will be taken to final size and rounded. Keeping the spindle in an octagonal cross section will make the sizing much easier. Adjusting an eight-sided spindle is much simpler than adjusting a round one with many tiny sides. I'll cover finishing the shape, surface and tenon sizing in the chapters on assembling the upper carriages.

## Shaping the Bow & the Crest

The bow for the balloon-back chair is simple compared to the spindles. The shaping begins exactly like the spindles,

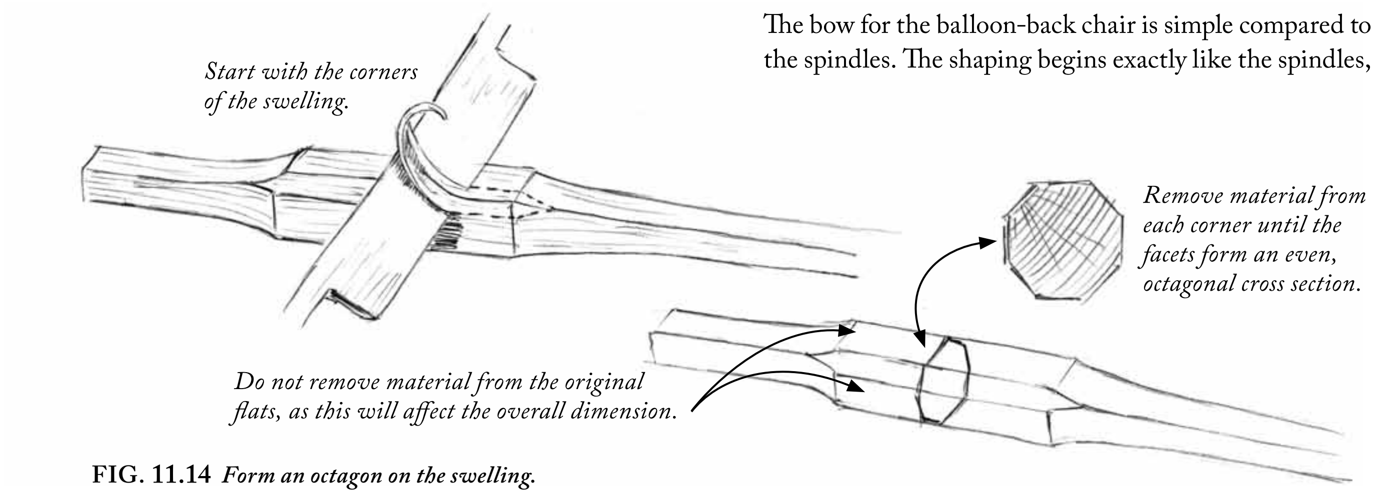



**FIG. 11.14** ***Form an octagon on the swelling.***

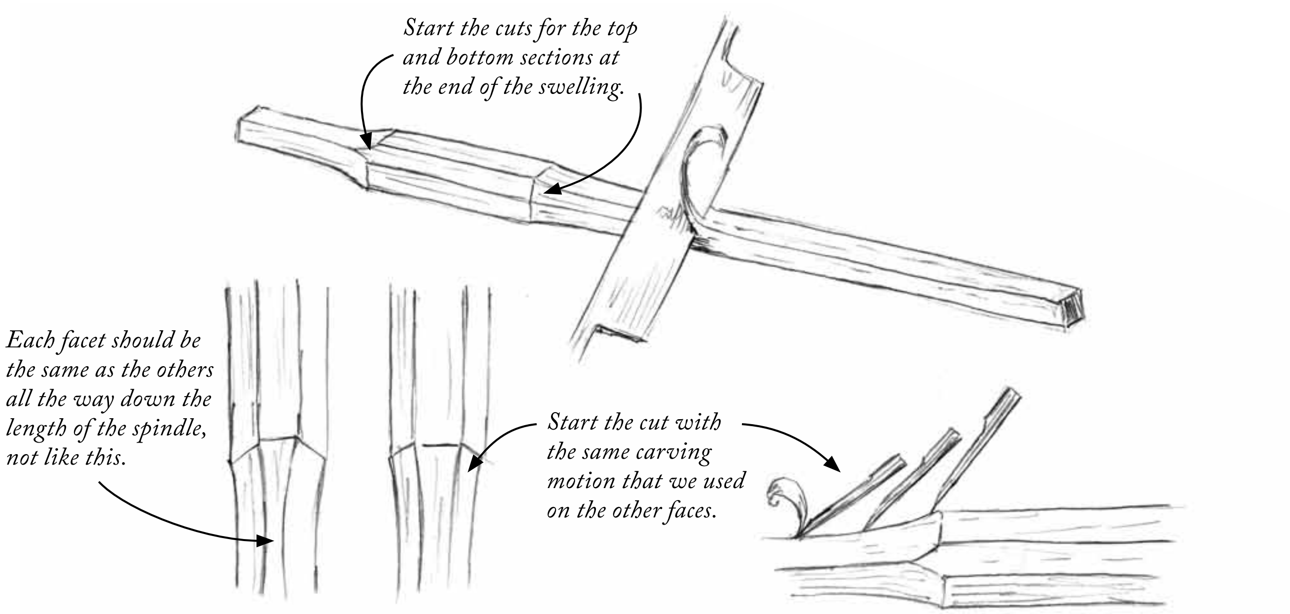



**FIG. 11.15** ***Shave the corners of the top and bottom of the spindle.***

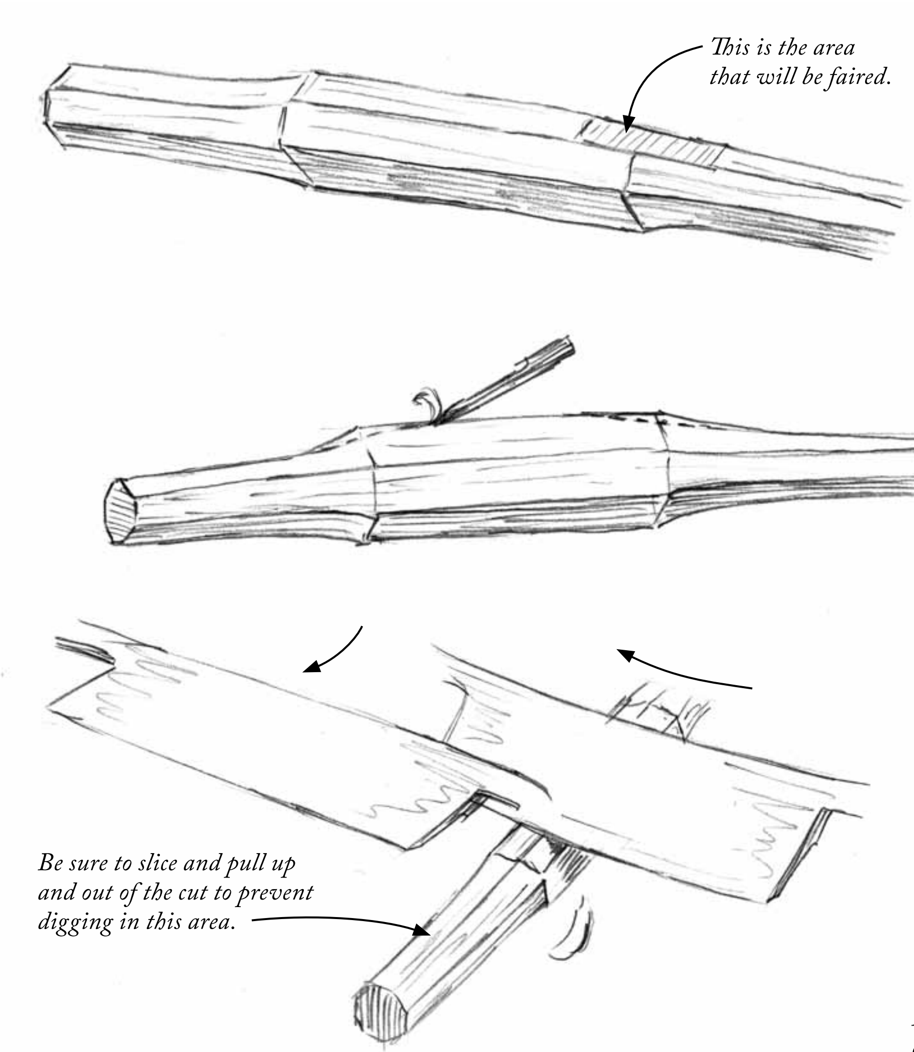
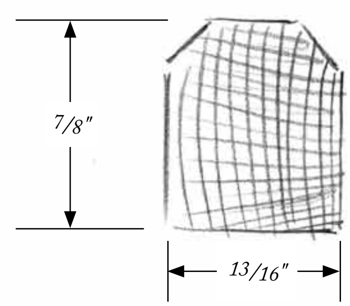




**FIG. 11.16** ***Smooth the transition from the swelling to the rest of the spindle.***

splitting the long blank so it is 1" square in cross section and shaving it along the fibers using the same method as the spindles. Once two faces follow the fiber line, use them as references to mark the width. The width of the tangential face is 7/8" and the width of the radial face is 13/16". The spindles pass through the tangential plane in the bow, so the extra material is helpful. Then shave to the line as if it were a long spindle.

Finally, chamfer two corners on one of the ray faces until there are three even facets. Mark a center point for bending and take note of any defects or thin spots that might be an issue. The piece is now ready to bend, with the tangential plane against the form.



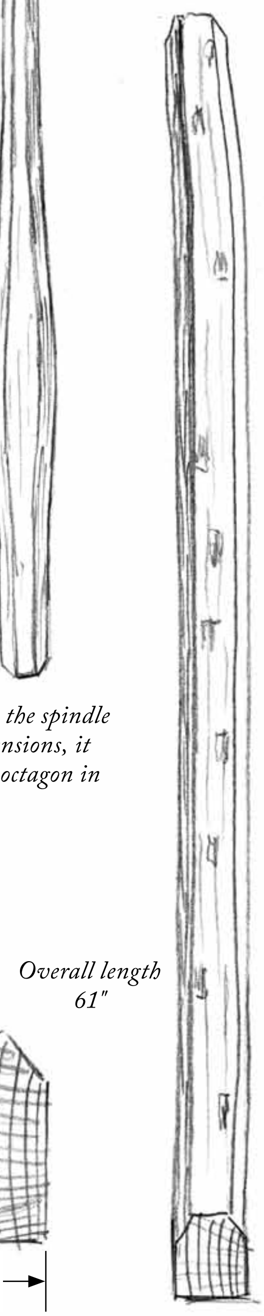




**FIG. 11.17** ***Shave the bow for the balloon-back chair.***

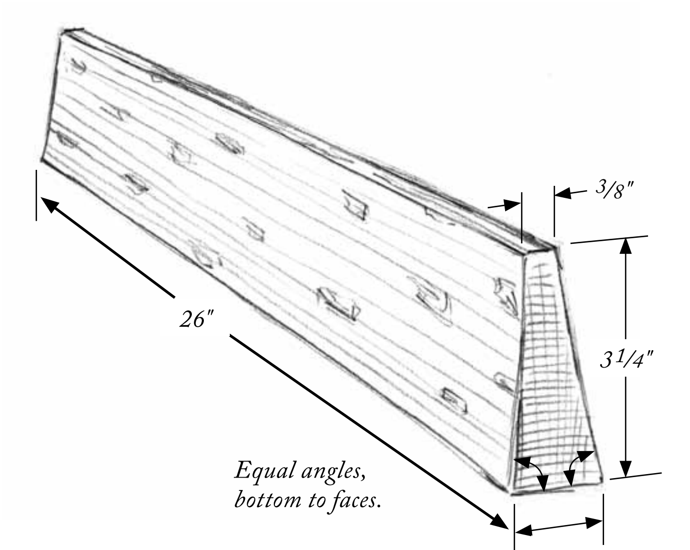



**FIG. 11.18** ***Dimensions of the crest.***

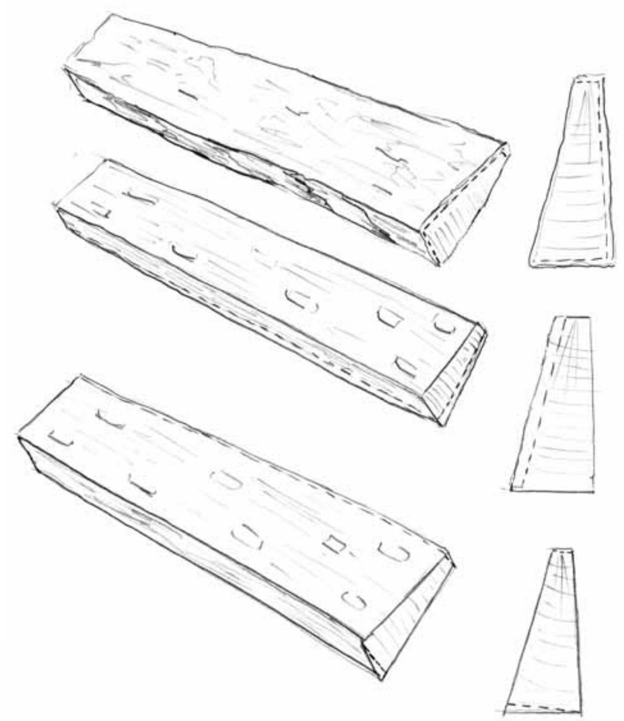


**FIG. 11.19** ***Shaping the crest of the fan-back chair.***

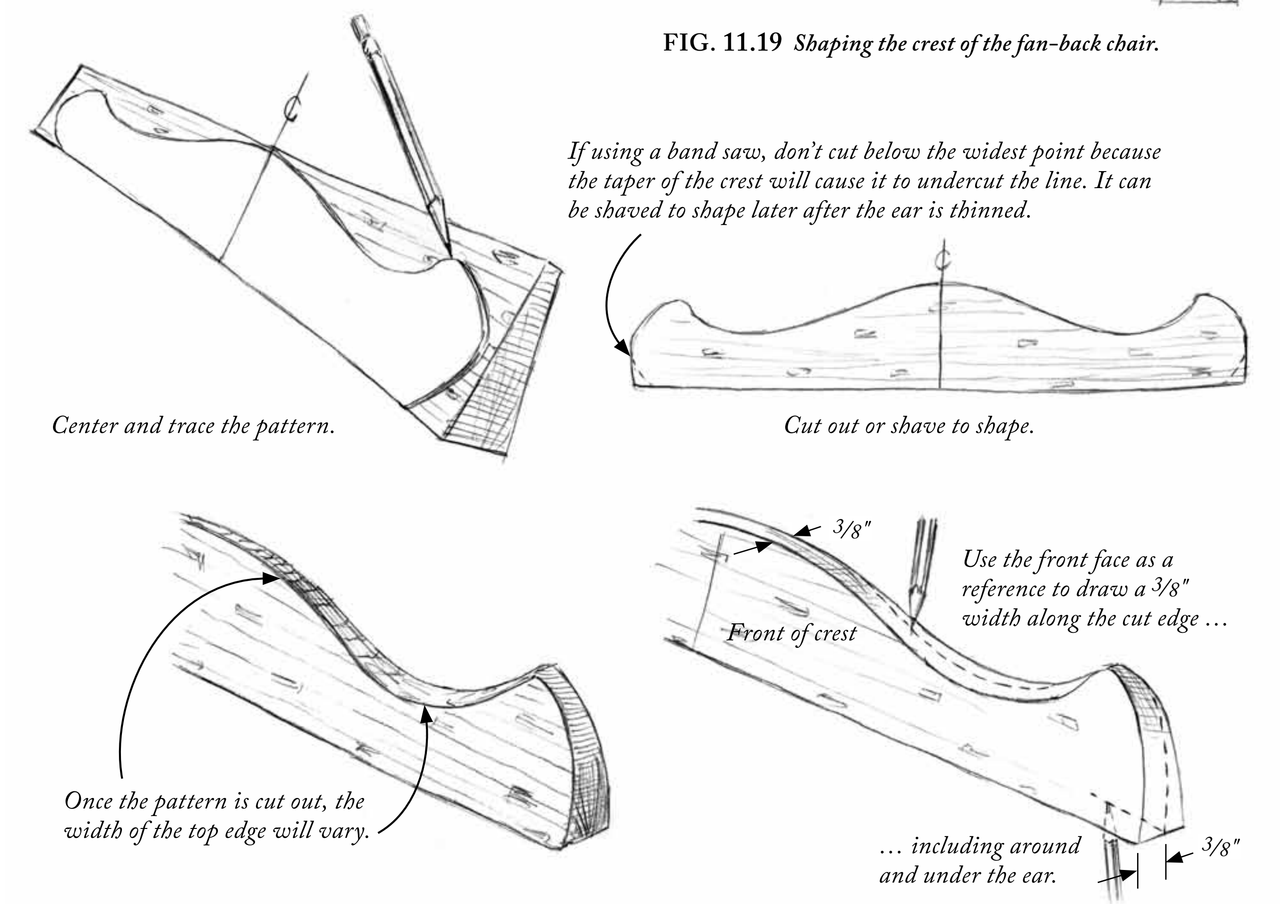



**FIG. 11.20** ***Cut the crest and scribe along the top edge and ears.***

## Shave & Shape the Fan-Back's Crest

Shaping the crest for the fan-back chair is one of my favorite woodworking tasks. By following a series of simple steps, you arrive at a complex shape that is consistent and has an apparent logic, plus it's fun. As with all previous shaping, the first steps call for following the fibers, which sets up all the other cuts to be predictable and easy. The first step is to shave the billet down to a piece with the geometry and dimensions shown.

Start by shaving one of the wide faces (ray plane) along the fiber line. Then, shave the wide tangential face at the bottom of the crest along the fibers and square to the shaved ray plane. This face will be where the mortises for the spindles and posts are drilled. Later, this tangential face will be shaved a bit so that it is the same angle to the front and the back of the crest, but at first, just make it square to the established face. Next, mark the width of the ray plane at 3 1/4" from the bottom of the crest and shave the top of the crest. Then, mark the width of the bottom at 13/16" and the top at 3/8" from the shaved ray face and shave the opposite ray face to the marks. Finally, shave the bottom face so that it is at an equal angle to the ray faces.

Once the piece is shaved along the fibers and shaped correctly, trace the pattern of the crest on the surface of the broad face and make a note on the surface that this is the front of the crest. I usually cut out the shape on my band saw, being careful not to remove the material on the lower side of the ear because the taper would cause the blade to undercut from the line. It's no big deal to remove the material later, especially after the ear has been carved to final thickness.

Cutting out the shape will cause the top edge of the crest to vary in thickness. The next step is to scribe a line 3/8" from the front face all the way around the top edge and around the ears.

Once the line is scribed 3/8" from the front face, turn the crest over and mark a curve to establish the ear shape. The curve starts 2 7/16" in from the widest point of the crest. Use a drawknife with the bevel down to carve out the material behind the ear. Because of the taper, there is more material to remove near the bottom than the top, and slicing will help create the shape.

Once the ears are thinned out, remove the last bit of the material from the lower portion of the ear with a drawknife.

The next step is to remove material from the back of the crest to make the dimension a consistent 3/8" at the top. The goal is to make the cross section of the back flat. Because you will remove more material from some areas than others, the plane will be twisted along the length of the crest. It's an interesting shape that I never tire of making.

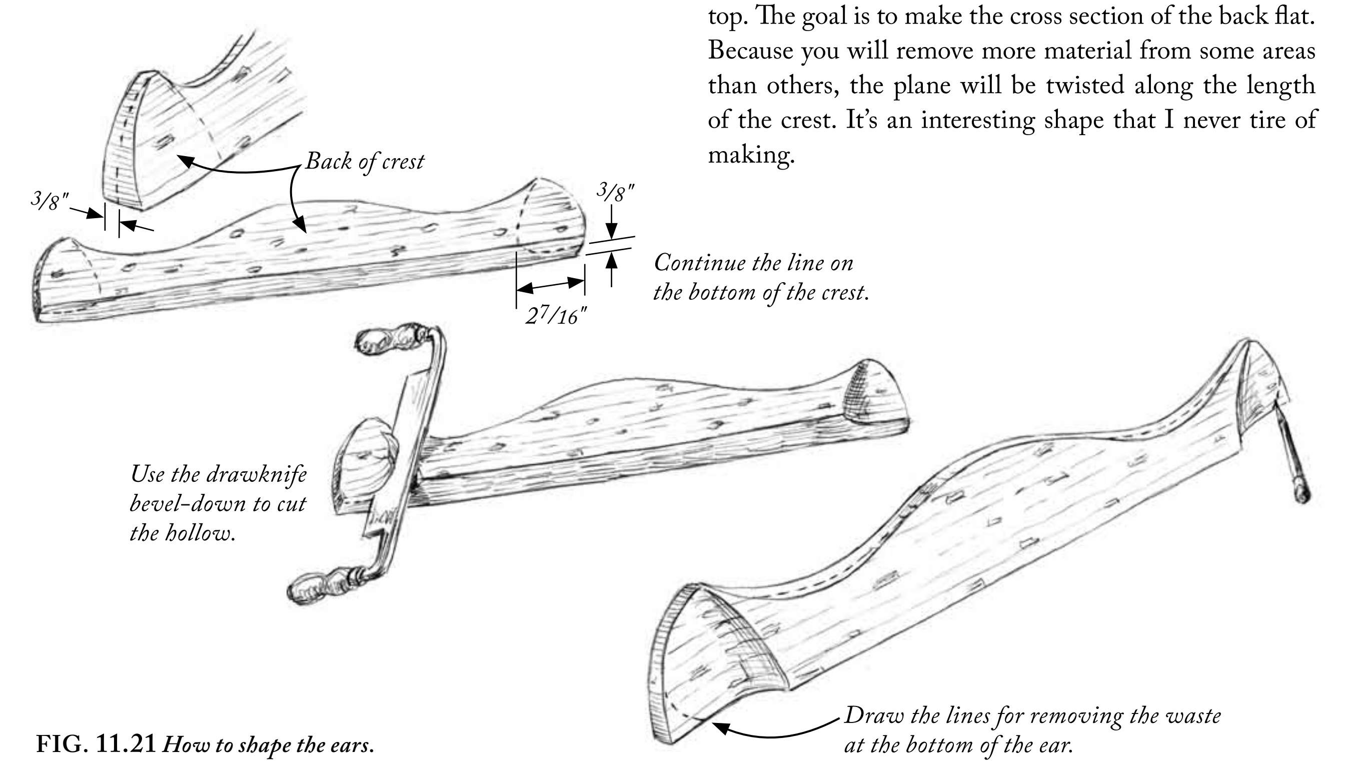



**FIG. 11.21** *How to shape the ears.*

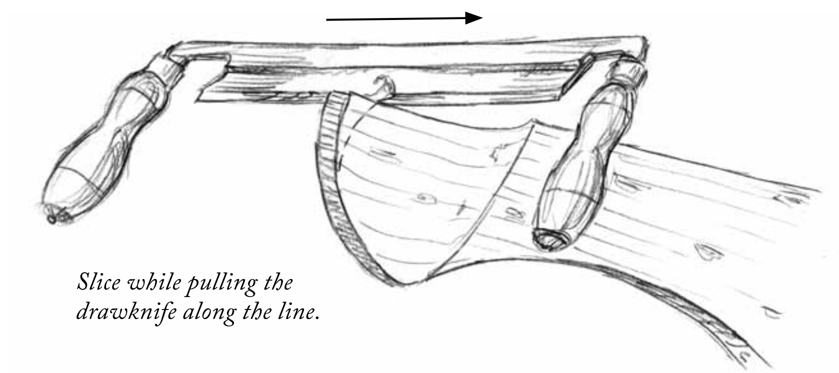



**FIG. 11.22** ***Then remove the lower portion of the ear.***

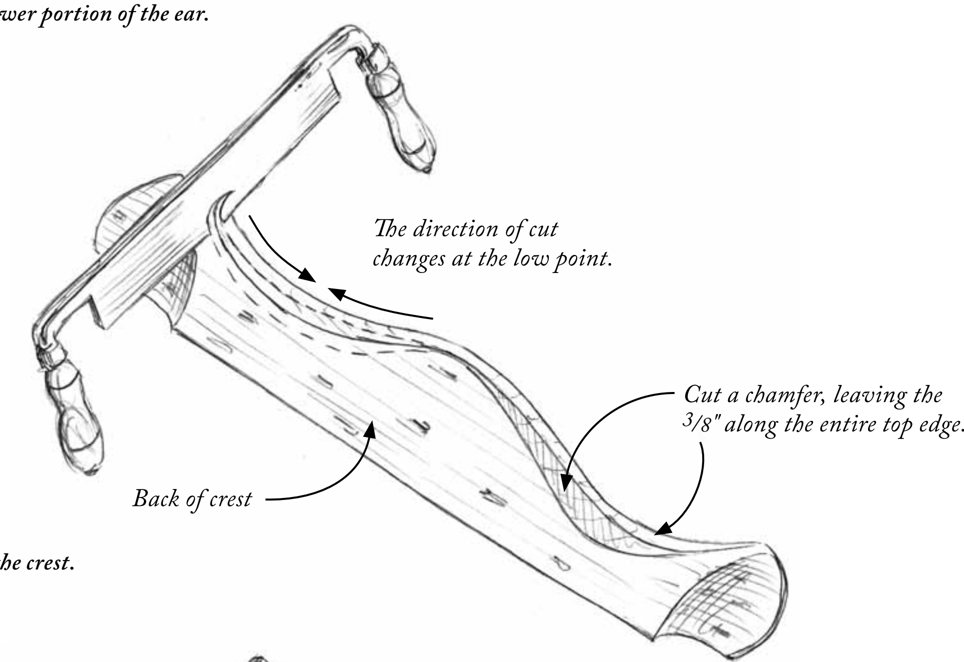



**FIG. 11.23** ***Shape the back of the crest.***

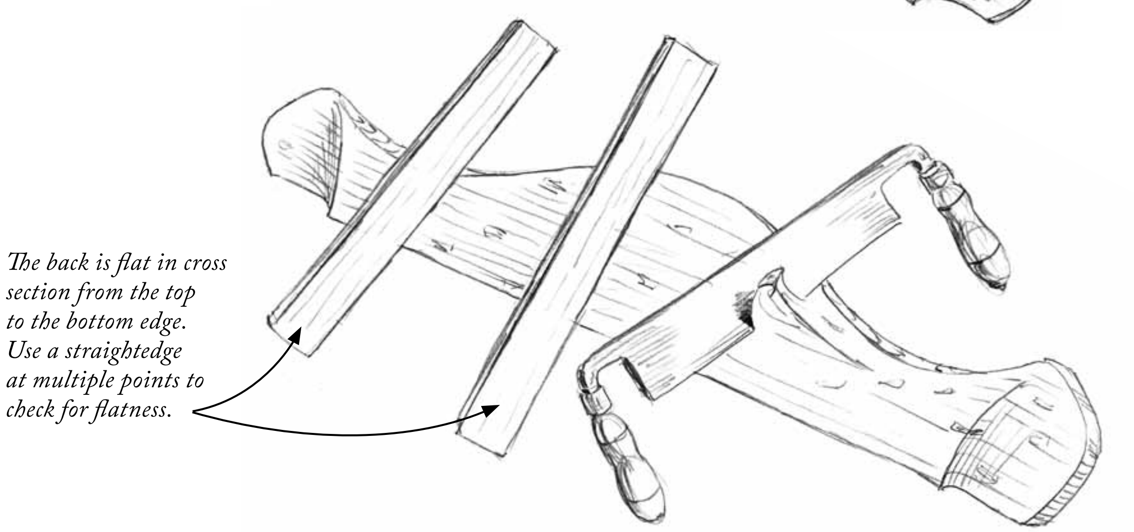



**FIG. 11.24** ***Continue to shape the back of the crest.***

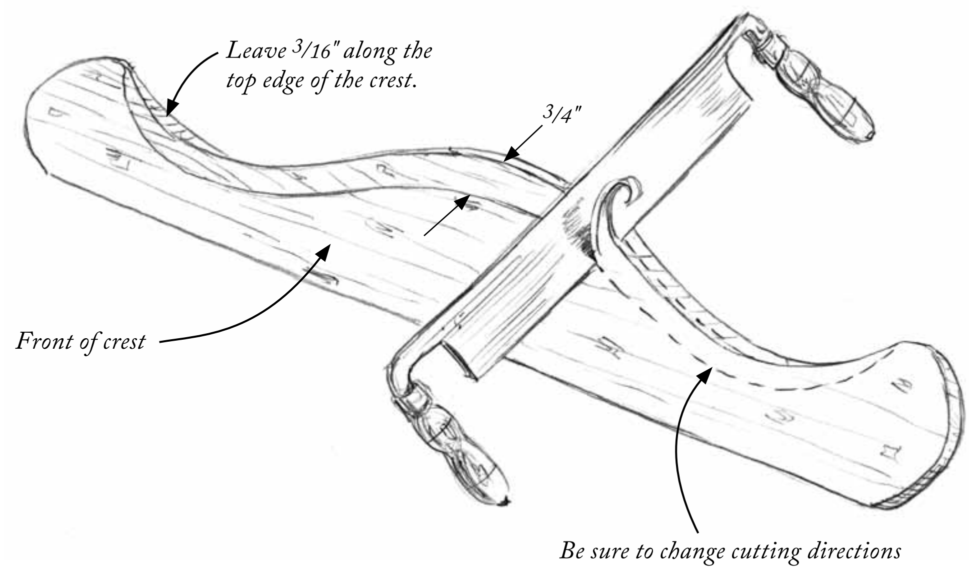



**FIG. 11.25** ***Chamfer the front face of the crest.***

I begin by cutting a chamfer off the corner of the back at the top, leaving the 3/8" width that I marked from the front face.

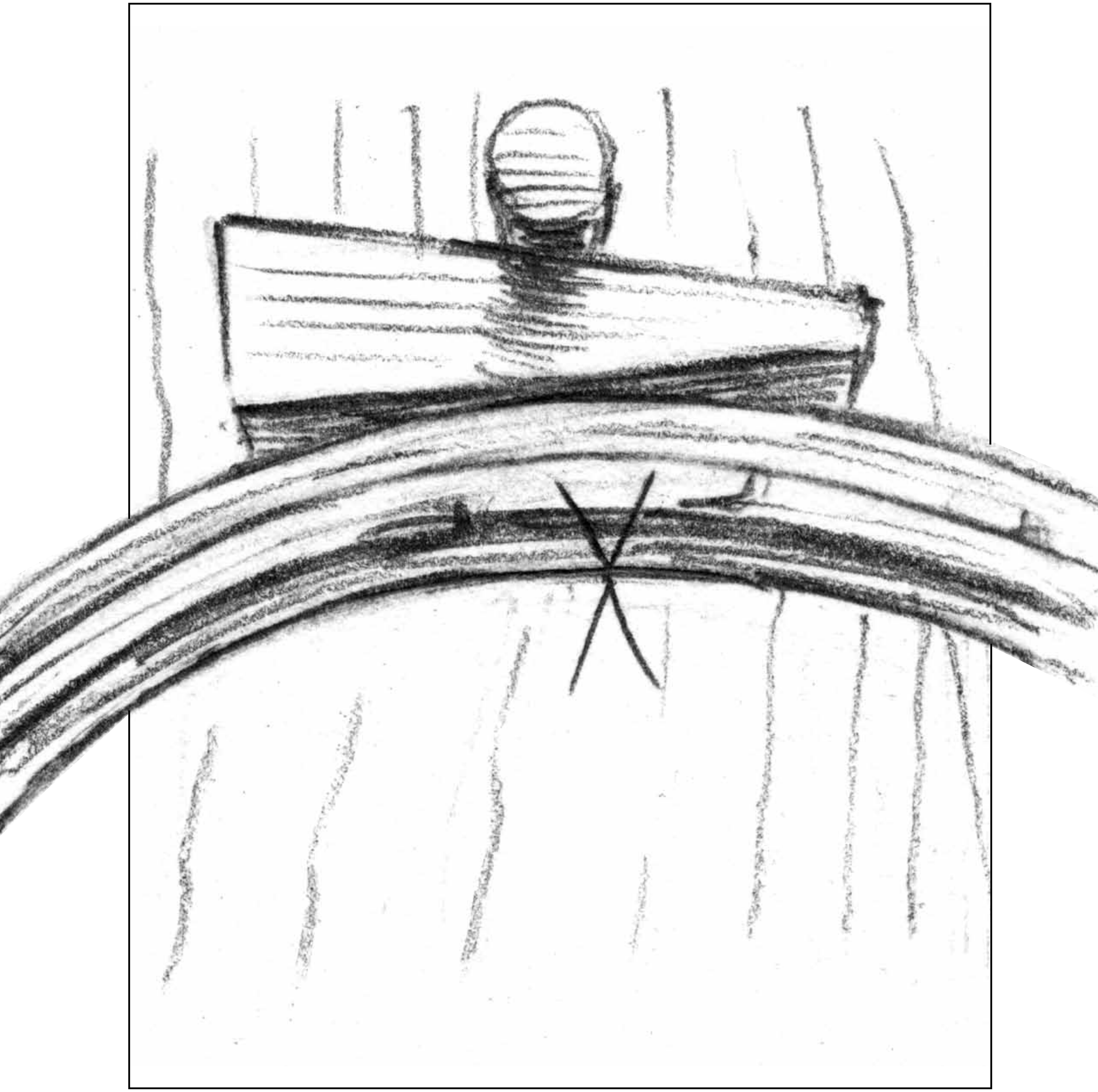
Then, I remove the excess material from the 3/8" top to the 13/16" bottom, being careful not to remove any wood from the edges, especially the bottom. It might be helpful to use a spokeshave to finish the job, especially in the hollow area near the ears.

The final shaping before bending is to remove a chamfer from the top of the front face of the crest.

All that's left is to mark a centerpoint on the crest for bending and put it in the steamer. If you can't bend it right away, store it for as long as you need and just add time in the steamer if it dries out.

## Conclusion

When shaping parts with a drawknife, the structure in the wood determines the reference surfaces. This is very different than the usual flat and square surfaces imparted by electric jointers and planers. It does take getting used to, and perhaps even a little leap of faith that following the course of the fibers will yield consistent parts. Usually, making one set of parts and seeing them through the process is enough to make sense of this way of working.



# 12

# Bending Wood

My first encounter with the topic of bending wood was a magazine article that featured pressurized ammonia and an elaborate piping rig. It made bending wood seem far from reach and delayed my first attempts by years. When I looked into steam-bending, I read another article where the bending apparatus included car jacks and steel straps, which also made bending solid wood seem out of reach. When I finally came across information on steam-bending split wood parts with nothing more than a small steam box and some gloves, I was chomping at the bit to explore the possibilities. So I cobbled a teapot and a hot plate to a box and started making chair parts.

Wood bends. Most trees rely on this to remain standing under the stress of wind and snow. So there should be nothing surprising when we steam a piece of wood and it wraps without complaint around a curve, right? But after seeing thousands of pieces bend, I am still amazed. Bending is one instance where the wood is generally capable of far more than we can imagine, and it usually takes seeing it to believe it.

Bending wood is a great way to imitate and manipulate nature to fit our needs. Throughout history, there are plenty of examples crooks and bent parts of trees used to serve a purpose; after all, what could be stronger than a natural curve with all the long fibers intact? One of my favorite activities is scouring the woods for a proper crook or branch for carving a spoon. The knee braces that were used on ships are good examples of harnessing extra strength from the natural shape of the tree.

But it isn't practical to find every curve that you need on a walk through the woods.

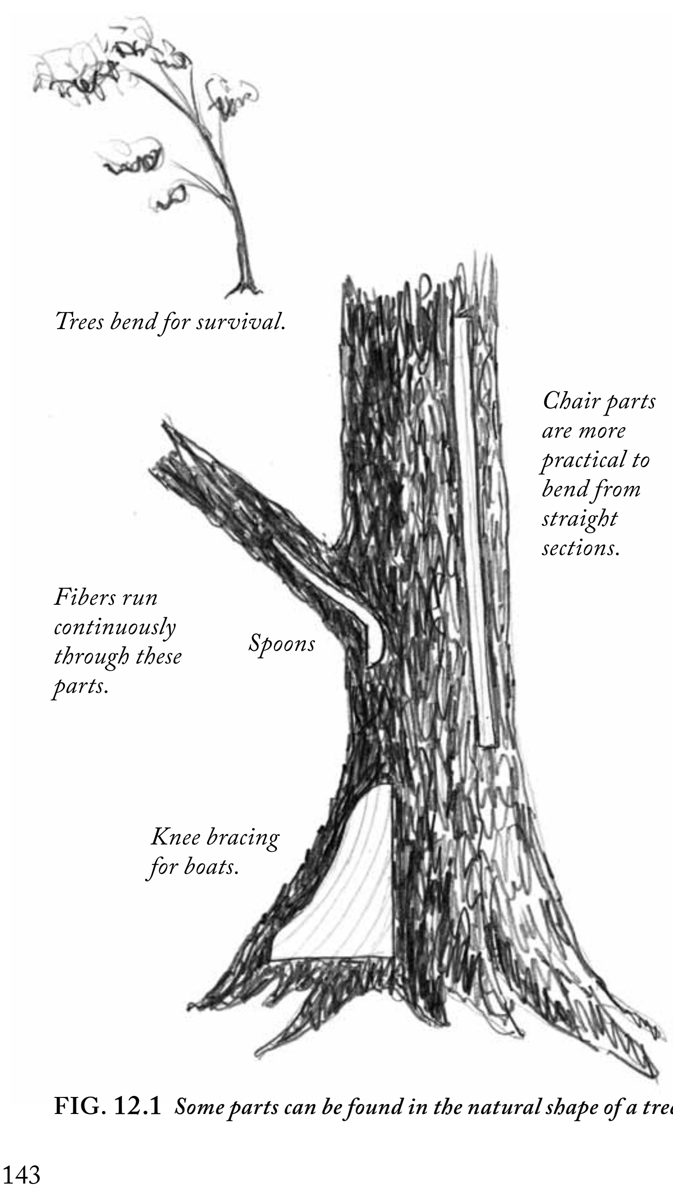



**FIG. 12.1** ***Some parts can be found in the natural shape of a tree.***

Wood with moisture in it bends more readily than

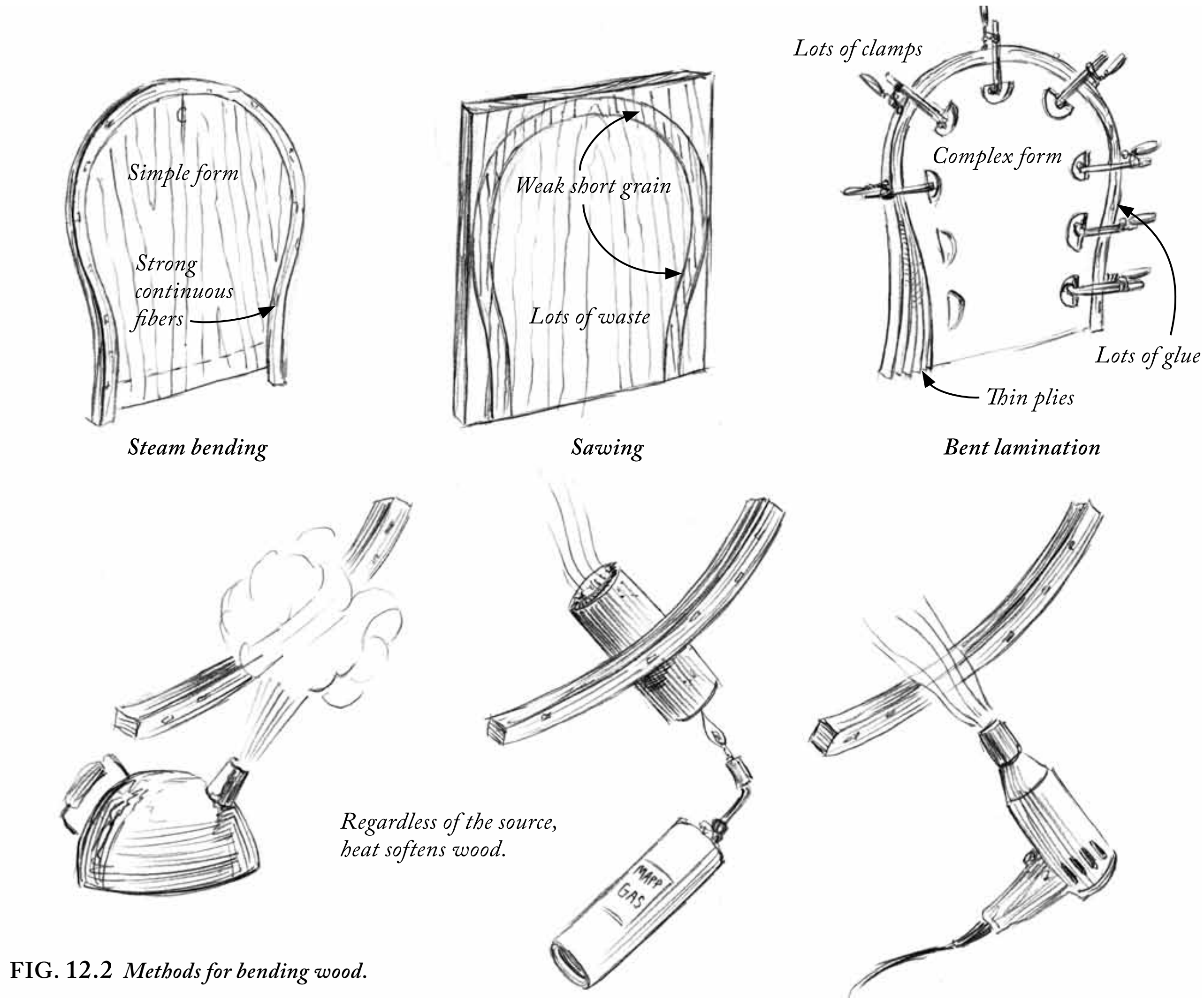



**FIG. 12.2** *Methods for bending wood.*

drier wood, and heated wood bends more readily than cold wood. If stressed into a shape, even cold, dry wood will retain at least some of the bend, especially if kept in that position for an extended period. Thin pieces, such as veneer, can be easily bent cold to a curvature, but they won't stay in that position because the tension created during the bending will cause them to return to their original shape. So bending is really about two things: getting the wood to take a shape then ensuring it stays that way.

Heat is the vital component to achieving both goals. It softens the cellulose and lignin in the wood so that it will distort; once it cools and dries, the lignin will set in the new position and resist the pull to return to the original shape.

The other component that enables more extreme bends is moisture. Moisture softens the material and acts as a conductor for the heat to reach the inner parts of the bend. Dry wood can be a good insulator, so the proper amount of moisture in the cell walls is helpful when it comes to transmitting heat.

You might be wondering, "Can't you just saw the curve from a board?"

There are other options for shaping curves from wood, but the simplest – cutting the curve from sawn lumber – usually results in too much short grain. Short grain lacks the strength necessary for chairs, especially when extra mass is unwelcome. Sawing also makes the rest of the shaping process slow and laborious because of the constant change in cutting direction, not to mention the large amount of waste. Other techniques tend to use effort, time and materials in a way that is impractical, expensive or just downright tedious, especially when solid wood can be easily bent. I'll illustrate these options because I think they help convey the concepts involved in bending wood, and benefits of steam-bending solid wood.

Parts that are split and then shaved to follow the fibers are the best for bending. Besides the ease of bending split parts, the workability before and after bending is essential to using hand tools. When shaping and surfacing split parts, the direction of the cut is always from the thick areas to the thin, which allows you to cut without having to change directions. If the pieces are sawn and are not parallel to the fibers, you need to be on the lookout for tear-out and change your direction of cut accordingly – not a recipe for speed or fun.

Through any process of bending wood with heat, it's as though you are rewriting the history of the wood, from being a straight tree to one with the perfect curve to fit your chair. It's much simpler than finding a tree in the shape of a balloon-back chair.

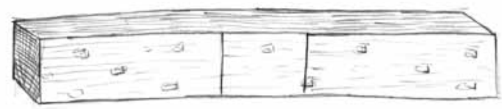
Steam-bending requires only a simple form to wrap the piece around and minimal clamping because the piece hugs tight to the form as you bend it to shape. The process invites change and exploration.

While this topic has concrete science behind it, which I'll describe as best as I can, I rely mostly on simple time-tested principles and the generous nature of the wood. Seeing a material that's prized for its rigidity and stability turn downright rubbery has forever changed the way I approach woodworking.

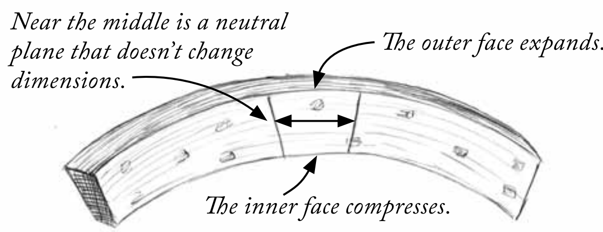
## What Happens to the Wood: Expansion & Compression

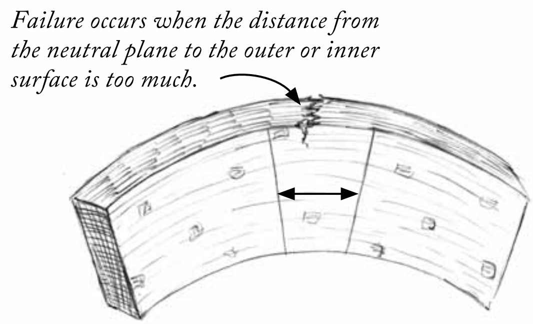
When bending wood, or any material, there is expansion (tension) on the outer surface of the workpiece and compression on the inner surface. The expansion surface is growing in length while the compression surface is forced to shrink. Depending on the wood's natural ability to expand and compress, somewhere near the middle of the piece there is a neutral plane that stays the same length, neither expanding or compressing. The farther the outer or inner surface is from the neutral plane, the more stress and force it must endure. This is why thicker bends not only take more force to achieve, but also suffer from greater risk of failure.

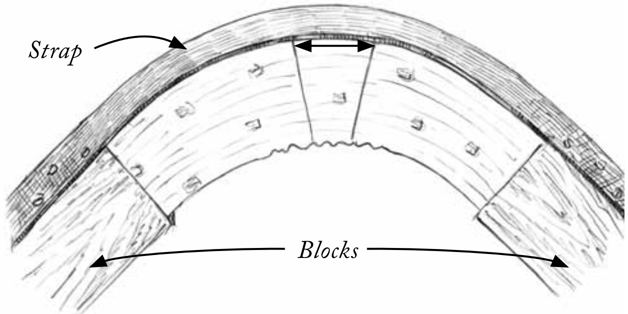
Much to my surprise, wood is much better at compressing than stretching. Wood is only capable of expanding a small percent of its length (1 to 3 percent) on the outer surface, while the compression side of the bend has far more potential for distorting without failing. There are ways to influence the ratio of wood in tension and compression. Increasing the portion of the wood in compression improves both the success rate and the radius that a piece can bend. But at some point, compression force will cause the piece to buckle and fail.



*Two parallel lines drawn on a bending blank tell the story.*



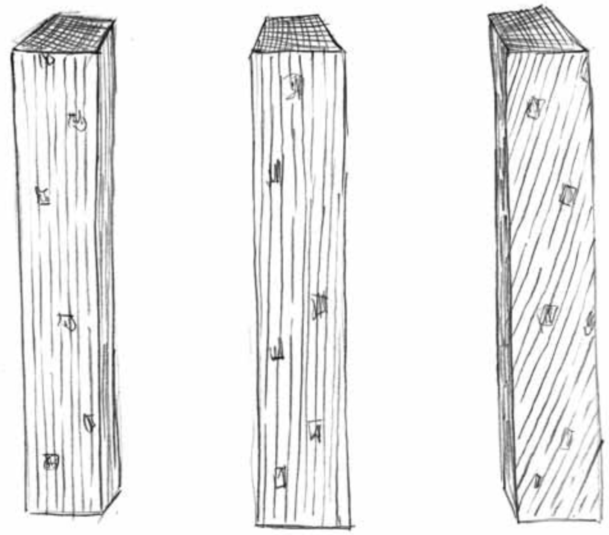




*A strap and blocks restrain the expansion of the outer face, which moves the neutral plane outward and puts the entire piece into compression.*

**FIG. 12.3** ***Stresses during bending.***

While we can theorize about what is happening inside a piece of wood as it bends, wood is an unpredictable material and can vary from tree to tree in its ability to bend. Besides the normal qualities of straightness and defect-free wood that I look for, there can be inexplicable differences. I never declare a log as "good bending" until it has made tough bends. While an occasional lifted fiber is not unusual, a catastrophic shear failure, where the wood shears off (leaving you staring at the broken piece in your hand) is a sign that your log is simply not good for bending, or that it might require an extra step or two to succeed. There are many variables in the process; luckily there is also a great deal of forgiveness.



*Split and shaved stock is best.*

*Moderate runout on sawn wood can succeed depending on the bend.*

*Pieces with distinct runout are not suitable for bending.*

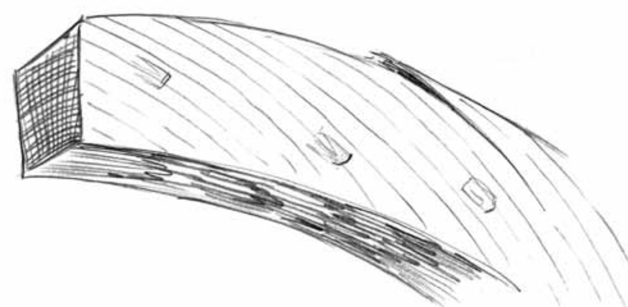


**FIG. 12.4** ***Stock for bending should follow the fibers.***

## Moisture in Wood, Bending Green

I have had great success bending green wood, which I attribute to its soft cellulose and the easy transfer of heat throughout the piece. Green wood is the most predictable to time in the steamer, usually requiring about 30 minutes to fully plasticize.

## Bending Air-dried & Kiln-dried Wood

Moisture is merely the conductor that delivers heat throughout the piece. Wood from freshly cut or well-preserved logs will render the easiest bending wood, but air-dried wood and even kiln-dried wood can also make subtle bends with a little longer steaming times and extra consideration.

Air- or kiln-dried wood is most likely going to be in the form of sawn boards. The process that you use to extract the parts should follow the fibers as closely as if it were split stock. If you must saw parts for bending, your success will depend largely on how straight the fibers are and how closely you followed them while sawing. Problems with sawn stock are likely to happen in areas where the fibers run out the side of a piece.

I often split a board down the middle to help identify the course that the fibers follow down its length then saw the parts parallel to that line. I can't stress enough the importance of following the fibers. There are lots of variables in play when bending wood and while wood with moderate grain run-out might bend fine, it is one variable that is usually best to eliminate.

Once you have your parts, there are other issues to account for. Kiln-dried wood does not steam-bend easily because the wood has been transformed through a heating process that removes the heat-conducting moisture, but more detrimentally, it also hardens the cellulose and sets the lignin. It is akin to making toasted bread: Once you've cooked it, you can soften it somewhat with moisture, but it will never be bread again.

It's helpful to restore as much of the moisture to the wood as you can before and during the steaming process. I have had success making bends with kiln-dried wood by soaking it before bending and using straps and "overbending." Overbending is when you push a bend in a piece to a tighter radius than the desired curve, then let it cool in the form for a period before moving it to a form that "unbends" the piece to the correct shape. This not only helps with some ornery woods, it can also give more consistent results and manage springback.

When it comes to soaking the wood, the absorption of moisture is limited to the outer surfaces; but these are the regions that conduct the heat inward and distort the most during bending. If I were limited to kiln-dried wood, I would soak it for about three days, with the end grain sealed with a waterproof glue, before steaming and bending it. I'd seal the end grain because it absorbs the moisture more quickly than the other surfaces.

Even if you saw and shave kiln-dried wood to follow the fibers in a workpiece, I do not recommend attempting to make a tight bend such as a balloon-back with it. It will most likely be difficult and leave you with the wrong impression about the bending process.

Air-dried wood is easier to deal with, especially if it has been stored outdoors or in an unheated area. I've read that the moisture content should be between 12 and 25 percent, but depending on the species and preparation, I've had no problems with bending drier wood with a little extra time in the steamer. One distinct advantage to bending air-dried wood is that it "sets" very quickly and holds the shape with less time in the form. I think this might have something to do with the lack of moisture in the cells, which means that there is less hydrostatic pressure to resist the bend on the compression side. Also, air-dried wood doesn't lose as much moisture in the setting process, which means it suffers less distortion when it dries.

If your air-dried stock gives you trouble, especially if it's sawn, try soaking it for a couple of days before steaming. If your air-dried stock is sawn and shaved parallel to the fibers, you could consider bending a balloon-back, especially if you soak it first and steam it for an hour or more.

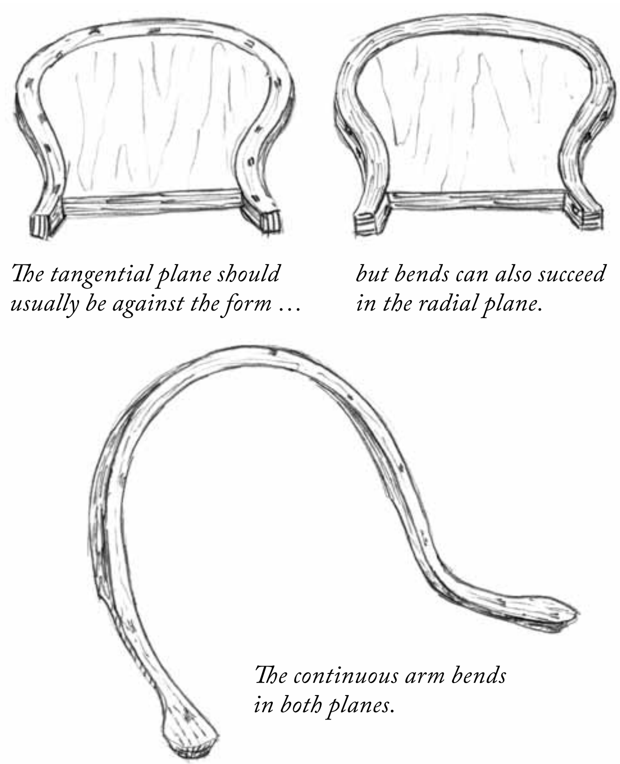
## Springback

Springback occurs when the piece is removed from the form and, upon the release of pressure, the curve opens up. The amount is predictable and calculable with bent laminations and the form can be made to compensate. With green wood, when the piece is allowed to fully dry in the kiln while in the form, there is virtually no springback. As a matter of fact, it's not uncommon for a piece to close tighter after being removed from the form. I attribute this to a variation in moisture content between the inner and outer surface of the bend. The outer surface will lose moisture more rapidly in the kiln while the moisture near the inner surface is blocked from evaporating by contact with the form. Once the piece is removed from the form, the outer surface is "set," but the inner surface continues to lose moisture and shrinks, which pulls the curve tighter.

Another surprising issue with bending is that mild bends tend to spring back more than more extreme ones. I attribute this to the fact that the mild bends don't suffer extreme distortion, so the original tension of the flat piece still holds sway. It's usually a good idea to overbend a mildly curved piece a bit so that it springs back to the desired radius, either naturally or by placing it in another form with the desired radius. Pieces bent with straps tend to have less springback, perhaps because there is less tension on the outer surface.

## Orientation of Bends

The orientation of the bend is a topic of some controversy in chairmaking circles. Some folks, including me, adhere to the notion that the growth rings are like laminates and should be flat against the form when bending. Others maintain that the fibers bend regardless of direction and the growth rings may have a weak layer between them



*The tangential plane should usually be against the form …*

*but bends can also succeed in the radial plane.*

*The continuous arm bends in both planes.*

**FIG. 12.5** ***The orientation of the wood while bending.***

that can delaminate, if not at the time of bend, then later on in the life of the piece. There are other factors that can also play into the bending direction. The tangential plane (parallel to the growth rings) shrinks more during drying and can distort carvings or the width of the chair's hands, etc. And the less-dense surface of the ray plane (a.k.a. quartersawn) might make scraping beads or shaving out compression areas more difficult.

One chair that demonstrates that both orientations are valid is the continuous-arm chair.

The arm in a continuous-arm chair must bend in both planes, so obviously, it's going to be a compromise. I prefer the more dense surface of the tangential plane to be on the surface of the hands and the front of the bow where the bead is scraped; others may want the opposite.

I sometimes allow the orientation of bends to be decided by the most practical way for splitting and shaving parts from the log.

## Producing Steam

Steam is the invisible, gaseous form of water. The white cloud of vapor that we associate with steam is actually the light refracting through water molecules as they fall out of the gaseous phase upon contact with cooler air. If you look closely at a teapot or steamer, you will see a small clear area just beyond the spout before the plume begins. That is true steam.

Steam can be produced in many ways, as long as the temperature in the box is high enough. My goal is to have the box at least above 200°F. Opening the door to a steamer can reduce the heat to below a viable level and should be held to a minimum.

If you already have a hot plate and a teapot or a propane-fired range that you use, that's fine. But I'm pleased to say that the wallpaper steamer industry has finally caught up with woodworkers and now offers cheap, safe steamer units that have long boil times, easy-to-see reservoirs and automatic cut-offs, and they are easy to refill. Unlike cumbersome propane-fired boilers, these units can be used indoors, which makes bending in January more fun. I've been using these for years and am sold on their price and reliability. I like to have two steamers hooked up to my box, but one is fine, depending on the volume of the box. The piping that comes with the units is usually far longer than necessary, so I cut it to appropriate lengths and use pipe insulation to help ensure that the heat stays within the system. It's important to have an easy means of adding water to the pot. Most steamers recommend that you should cool them before refilling with cold water. I use a teapot to prepare boiling water to add to the steamer reservoir if it gets low to avoid any delays in the process. Extra care must be taken when refilling the steamer. Never position your hands directly above the orifice of the steamer or teapot. Long-sleeved shirts and gloves are also helpful in avoiding steam-related burns.

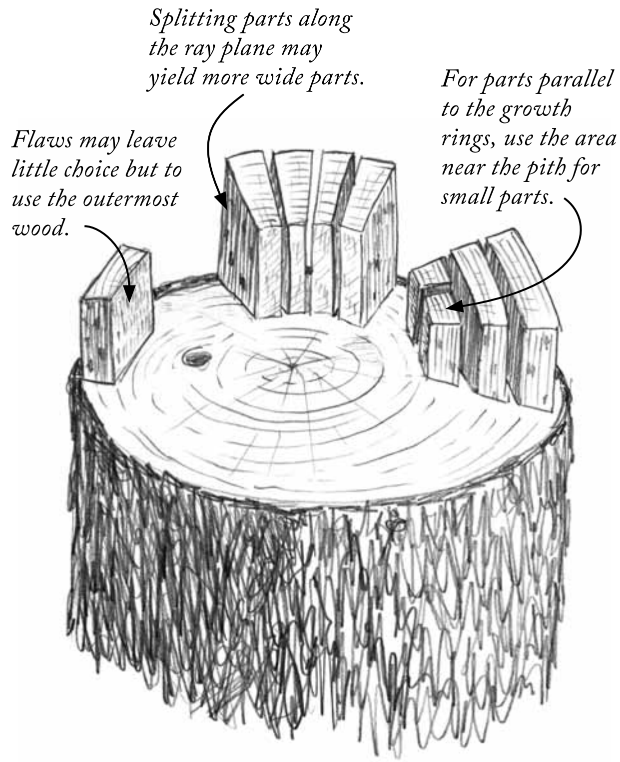



**FIG. 12.6** ***The log can influence the orientation of your parts.***

## Steaming Time

I like to let the steamer heat up to its highest temperature before introducing the piece to be bent; that gives me a more accurate accounting of the time to steam. Use a good thermometer to test the temperature and note how long it takes to plateau for future reference. Steaming time varies with the moisture in the wood, the thickness of the wood and the radius of the curve.

A general rule of thumb is about 25-40 minutes for green pieces that are the thickness of the project parts for this book, and 1-2 hours for air-dried stock. There is probably a point where over-steaming is an issue, but I

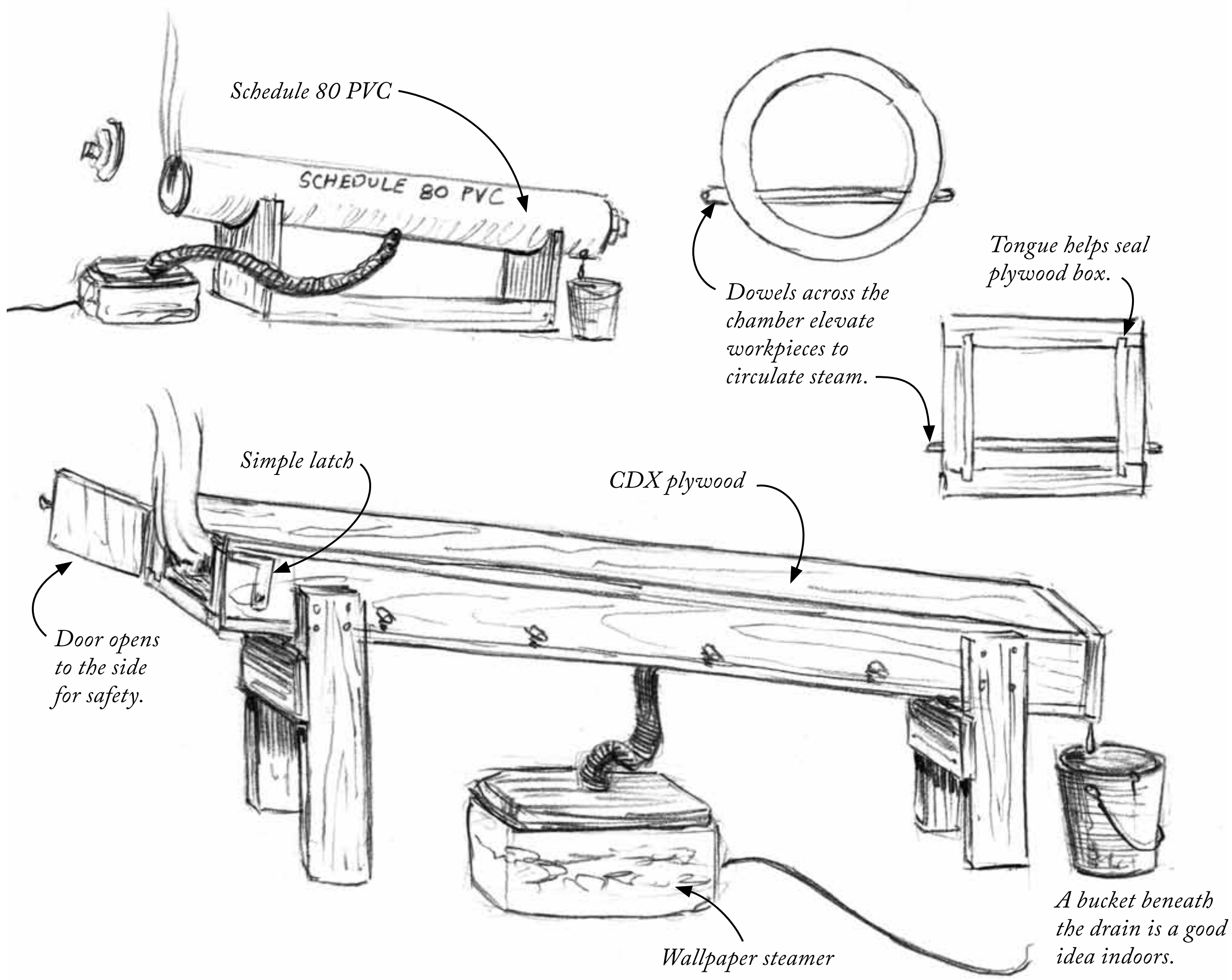



**FIG. 12.7** *Two common types of steamers.*

doubt that it's shorter than two hours, especially if the steam is moisture-laden.

Sometimes, you may get the feeling that the bend will fail if the wood is too stiff in the beginning of the bend. You can return the bend to the steamer to soak up heat for a while longer and try again. If you have problems and the bend can't be completed on the first attempt, return the piece to the steamer immediately for another 20 minutes then try again.

## The Box

There are many options for the box that traps the steam and holds the parts to be bent. Schedule 80 PVC pipe works fine, but I think it's expensive overkill. I've seen schedule 40 pipe melt when hooked up to a powerful steamer.

I prefer a CDX plywood box that is barely large enough for the bend at hand. I've found that a box with an interior of 4" x 3" x 62" is large enough for almost all of my needs. Don't bother to paint or seal the wood; you'll simply be trapping the moisture and inviting mold growth. To function, the box shouldn't be NASA airtight; as a matter of fact, you should see steam leaking out, which lets fresh hot steam circulate to all regions of the box. If the steam can't circulate, then you are relying on conduction, which doesn't transfer heat as well as convection. I keep a thermometer in the top of my box and with this sort of box, the temperature climbs to 210°F. Standard woodworking glues won't hold up to the heat and moisture so I rely on polyurethane glue, tongue-and-groove construction and screws to hold my box together.

To allow the cooled condensed vapor to drain, the whole box should be at an angle and have a drain hole at its lower end. I usually put the port for the steam hose in the center of the box near the most extreme part of the bend. To prevent steam burns, the door of the steamer should hinge on the side so that your hand is never above the open door. Steam burns come on fast and can do plenty of damage. I usually put the end of the steamer with the drain port on a lid from a plastic tub to collect the liquid that drains out.

## Bending Forms

Forms for solid-wood bending are simple jigs. I usually cut mine from two pieces of plywood sized for the backer board or, in the case of crest rails, with two pieces of 2"-thick pine glued up. Once you have the bend laid out on the plywood, cut out the shape and take the remaining waste piece and screw it to the back of the jig. Then attach the cut-out shape to the front of the board. This arrangement gives you the double thickness you'll need for 5⁄8" pegs to hold the wedges. I've found it important that the form should be as smooth and fluid as possible. Any bumps or saw kerfs could kink the wood and start a compression failure.

I typically use clamps to hold the wood to the forms. I like quick-release clamps that have 550 lbs. of pressure. These eliminate a lot of fussing with wedges during the bend, and they pull the piece tight to the form with little fanfare. I especially like them for bending crest rails, which require more force and offer little opportunity for leverage.

## Straps

I rarely need to use straps, but they can help to ensure successful bends and provide a little extra leverage. Referring to them as straps, however, is a bit misleading. While

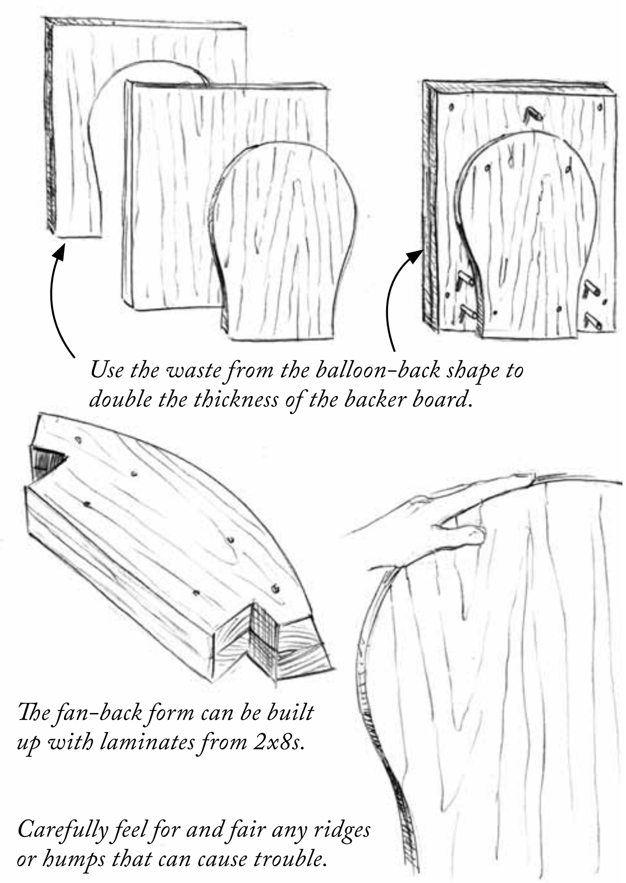



**FIG. 12.8** ***Construct a bending form.***

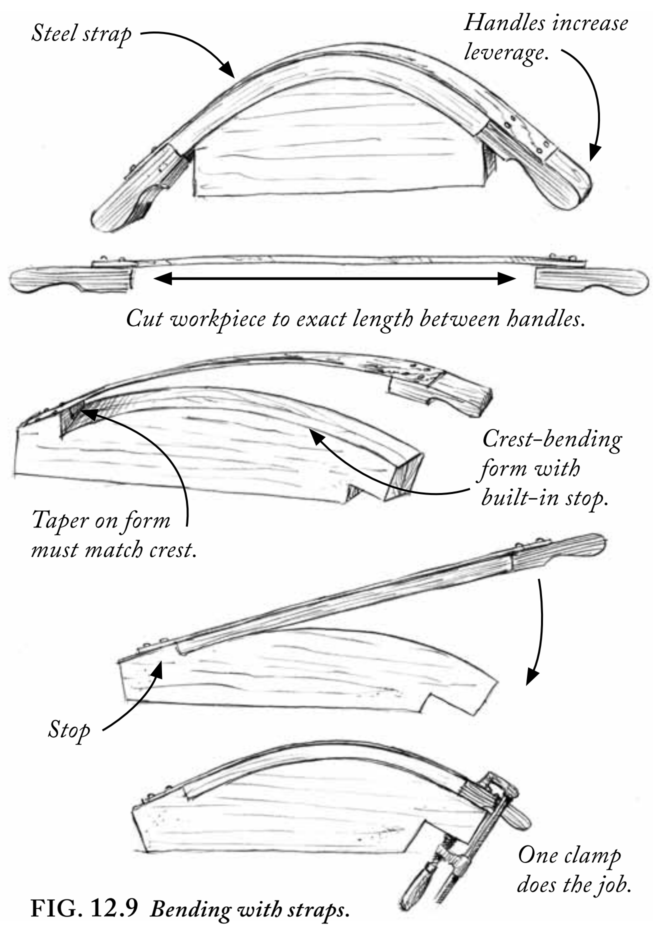



**FIG. 12.9** ***Bending with straps.***

the strap itself offers some lateral support that keeps the fibers from lifting, it's the pressure provided by the blocks at the end of the straps that plays the greatest role in aiding the bend. The concept is simple: Restrain the length of the fibers on the outer face of the workpiece to put more of the piece into compression. This effectively moves the neutral plane closer to the outer surface, which relieves the outer surface of stress.

If the blocks could be 100 percent effective at restraining the expansion of the outer face, the entire piece would be in compression. Of course, there is a potential cost of increasing the stress on the compression side of the piece to the point where the cells collapse and the bend fails. If I were using a strap to bend the fan-back crest, I would bend it before cutting out the pattern and final shaping.

For my straps, I use sheet metal or thin strips of spring steel. It's essential that the strap is securely connected. The end blocks can also be sized to provide extra leverage during the bending process.

I find straps/blocks most appealing when using woods that must be sawn, such as walnut, or when the bending radius and thickness is pushing the limits of the material. If you dry the bend while it is still in the strap, it will take longer because the strap blocks the moisture from leaving the surface. Be aware that a reaction between the wood and the metal in the straps might result in staining. Oaks are especially corrosive, so use a stainless steel strapping material (or coat the inside of the metal) to avoid surface discoloration.

## Limbering

It can be helpful to "limber" pieces before bending by taking them out of the steamer and pre-bending them to stretch the fibers and break the lignin bonds. Then return the parts to the steamer to get back up to heat (another 20 minutes or so) before bending them around the final form. I don't usually do this because the white oak that I usually use doesn't have much difficulty bending. When I use species I'm less confident in or wood that has shown a tendency to break, I limber the wood and have found it to help. Take care to limber the wood only in the plane that it will be bent. I've found that wood will do anything that it can to avoid bending, including twisting and bulging; when the fibers are pre-stretched in a plane other than the desired one, the bends tend to show waviness and inconsistencies. At right is a simple limbering form that helps to control the plane of the bend.

## Stock Prep

The success of steam-bending has everything to do with the selection and preparation of the piece. When I first examine a newly split log, I look for the smoothest, straightest, clearest wood, which I reserve for bending. Most other parts can come from the areas around the bending stock. Not only must the bending stock be longer in some cases, but it should always be as free from defects as possible.

When shaving bending stock, the fibers must run the entire length of the piece. If the fibers are crosscut anywhere, especially on the outer surface, the expansion force can cause the end to lift and a split to begin. The surface quality should be smooth and regular; any sawmarks, dips or knicks will give the opening for a split to begin.

You may wonder, "Doesn't the grain raise all over the piece from the steaming?" Nope. When a piece of wood is shaved with a sharp blade, there is no grain compression. And when there is no compressed grain, there is nothing for the moisture to raise. This is also the reason that I save any scraping until after the bend is done. But I find that I can make final cuts, such as chamfers on the hands of an armchair bow, before I bend a piece.

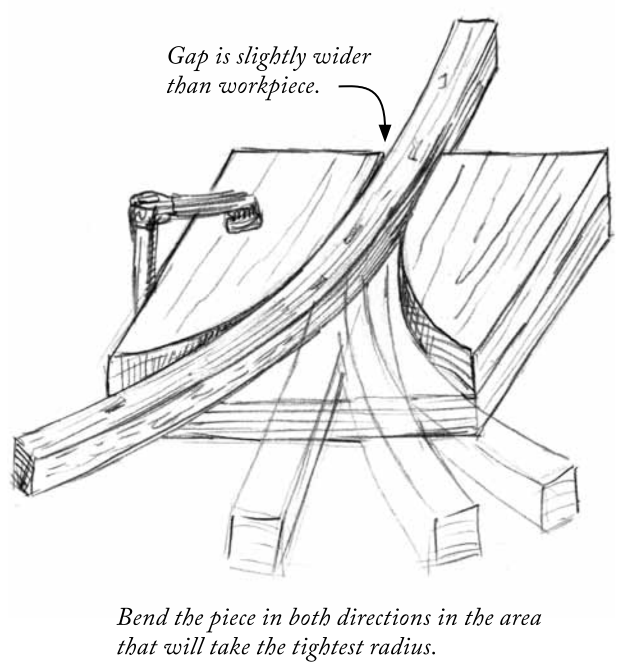



**FIG. 12.10** *A simple form to limber parts for bending.*

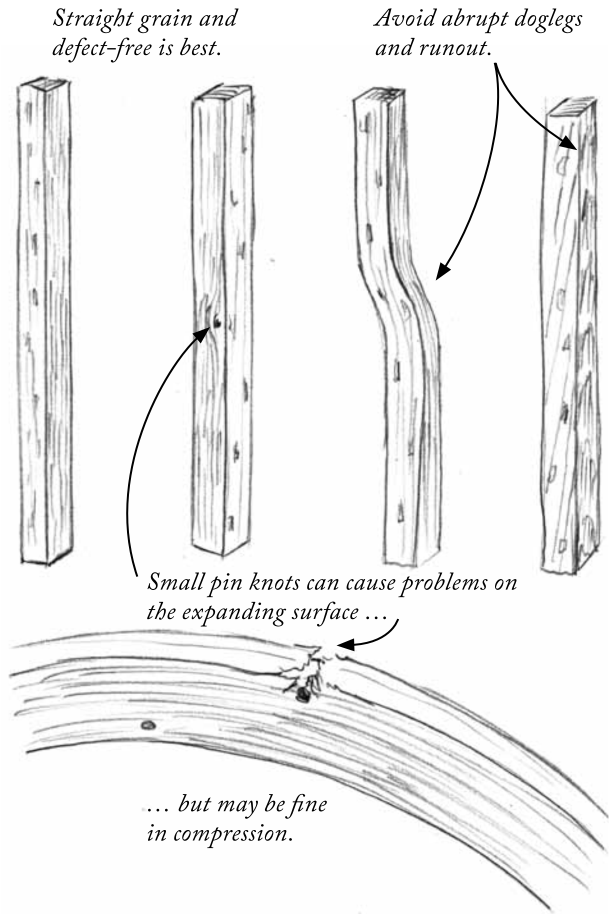



**FIG. 12.11** ***Successful bending comes from selecting good wood.***

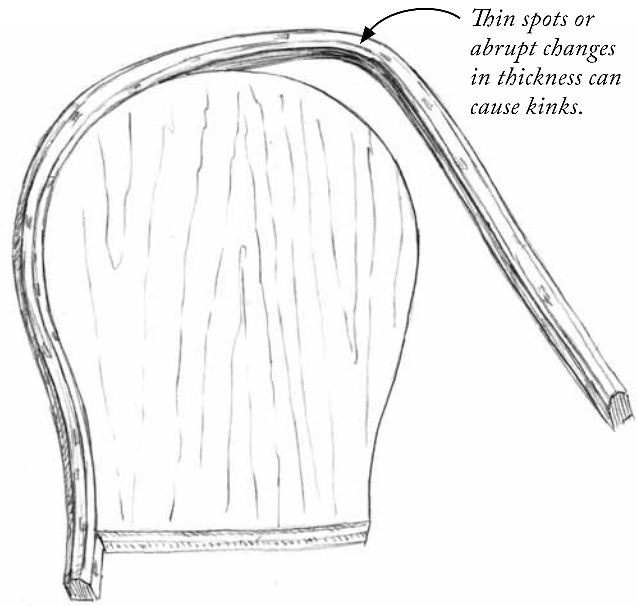



**FIG. 12.12** ***Why you should avoid thin spots in your bending material.***

It's just as important to note that the thickness of the piece and radius of the bend create some limits. The thinner bends tend to work out, but the impact on the joinery must be taken into account as well.

Newcomers to shaving and bending tend to shy away from exact thicknessing of the parts, which usually means that the pieces are too thick to bend easily. Not only should a part be shaved to follow the fibers, but it should be as thin as possible, accounting only for the little extra material needed to clean up the surface after the bend is set.

Uniform thickness is also vital to successful bending. When a piece is evenly thicknessed, the applied force will spread evenly across the piece. If there is a thin spot, the force will concentrate there and create a kink and possibly break.

Some thin spots can be kept from kinking by supporting them with your hand or a wedge while bending until the main stress of the pressure moves to another part.

Careful shaving along the fibers to an exact thickness can avoid these issues. Sometimes a design will call for thinning out an area where a tighter radius bend will be, which can satisfy the design requirements for the bend, but leave other areas large enough for the joinery. Usually, the change in thickness occurs just before the bend to avoid splitting.

## The Bending Process

Planning is key to successful bending, as is rehearsal and marking, because time is of the essence. I always mark the center of my symmetrical bends as well as drawing an arrow that shows me the orientation of the piece in the form. It's important to use a marker that will endure the steamer, such as a soft lead pencil (4B works well). I tie a piece of kite string to the workpiece that hangs out of the steamer door, and that makes it easier to pull the piece out. Clamping the form to a solid workbench in such a way that the pegs, wedges and clamps aren't impeded is important. It's a drag to discover these things during the actual process of bending.

Once the piece is up to heat and you remove it from the steamer, you should move with purpose to get it into the form – but don't panic. I do a rehearsal for my bends and lay out all of my tools and wedges so I know exactly where they are. I figure that I have about 45 seconds to get the major bends done. I say major bends because minor tightening and tweaking can go on for minutes, but the most extreme bends must be done quickly. If you fuss around with a wedge trying to make sure that it's absolutely perfectly seated while the other side of the bend remains straight and cooling, you are not doing yourself any favors. While 45 seconds might not seem like much time, take a look at your watch and sit still for 45 seconds and you'll see that it is plenty.

I pull the bend around at a constant rate to give the fibers a chance to conform to the bend while supporting

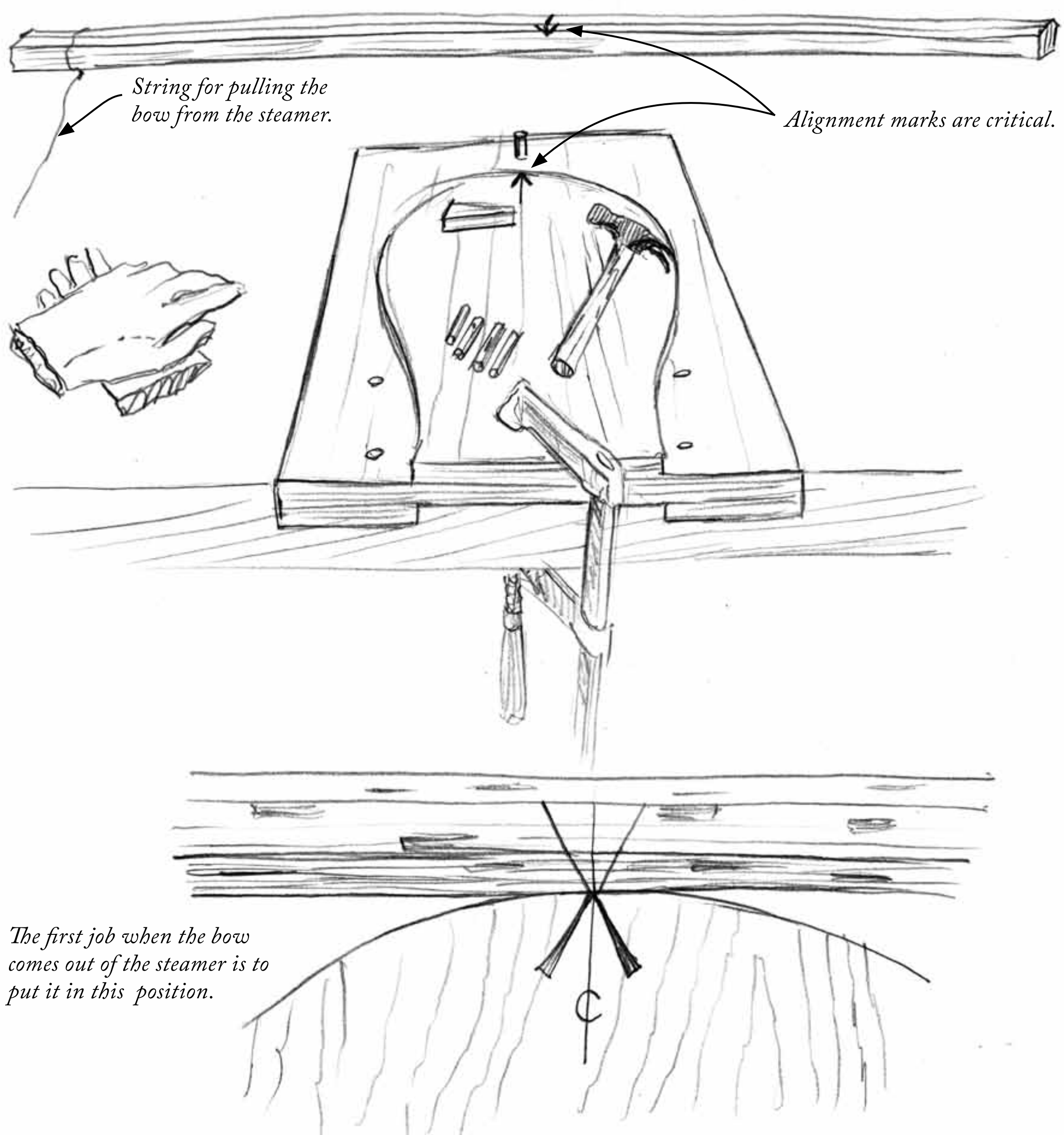



**FIG. 12.13** ***Preparation is important for bending.***

the bending moment. I try not to be jerky or so slow that the piece cools too fast. It might sound silly, but when assessing the correct rate to bend a piece, I think of Superman bending a steel bar. If he moved too fast it would looks unimpressively easy, and if he moved too slow it would seem like it was too tough for him. The proper rate for pulling the bend looks the same. Bending wood is probably the only time most of us get to look like Superman. Relish the moment.

I try to support the spot that is suffering the most distortion at any given time – this is called the "bending moment" and it is usually where trouble will start. I also

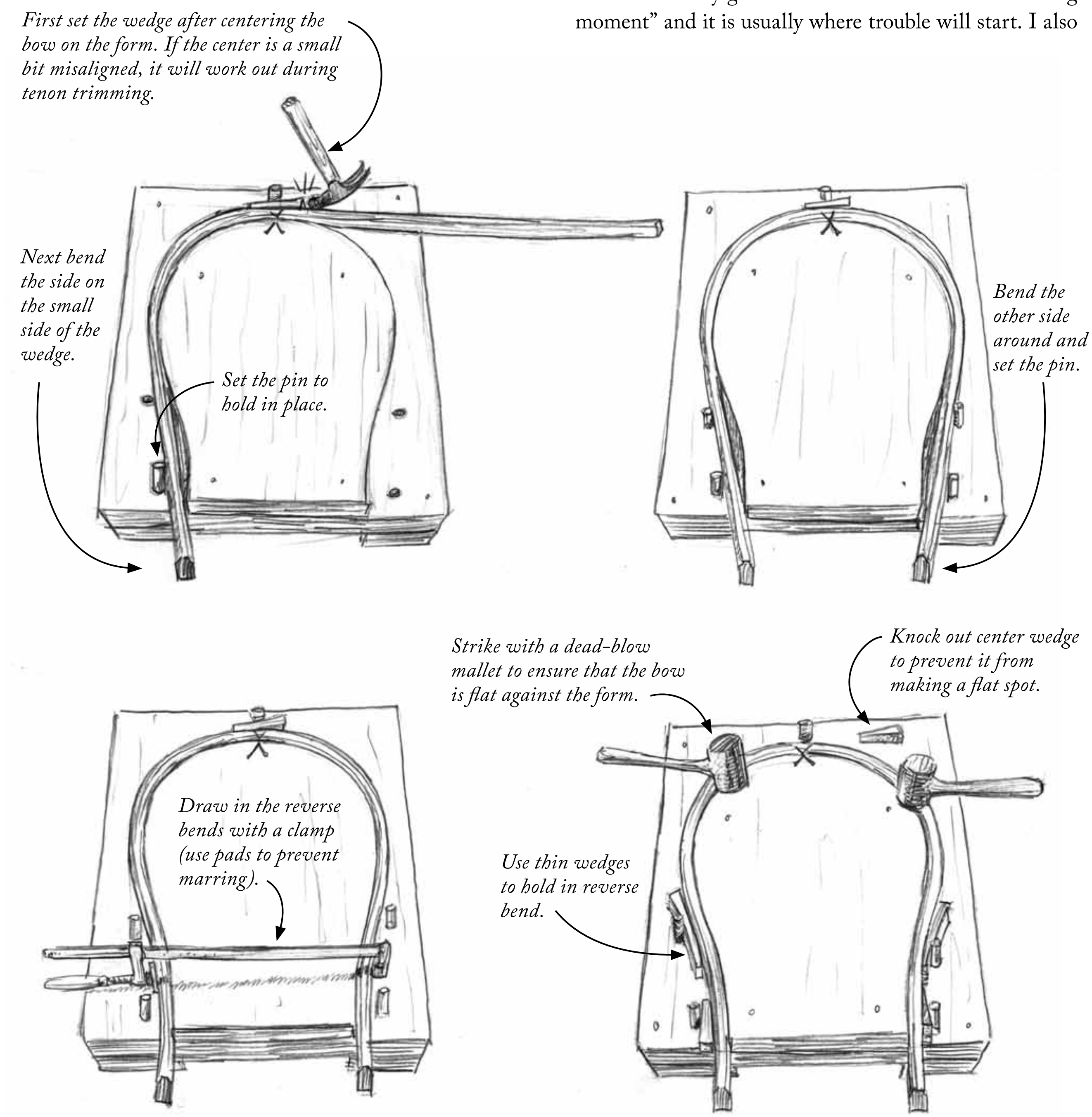
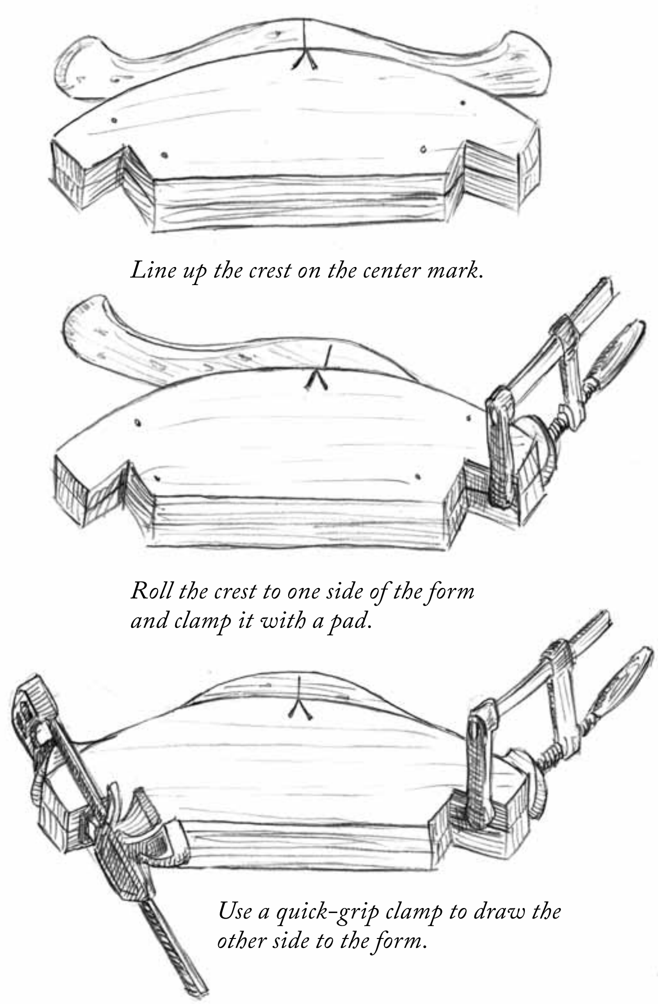



**FIG. 12.14** ***Steps for bending the bow.***

try to keep the piece from twisting or lifting out of the plane that I am bending it in. No matter how agreeable the wood is to bending, it will still try to relieve the stress in any way that it can.

I begin the bending process by centering the bow on the form and driving a wedge in the top position to hold it. Then, I bend the side opposite of the fat side of the wedge, so that the pulling action of the bend doesn't pop the wedge out. Once the bow makes contact with the bottom corner, I set a pin to keep it in place while I bend the opposite side. With both sides bent, I use a quick-release clamp to draw the bow into the reverse bend. Then I use long thin wedges to hold the reverse bend in place.



*Line up the crest on the center mark.*

*Roll the crest to one side of the form and clamp it with a pad.*

*Use a quick-grip clamp to draw the other side to the form.*

**FIG. 12.15** ***Steps for bending the fan-back crest.***

Once the piece is fully wrapped around the form, I use a dead-blow mallet to make sure that it is also pressed evenly down to the board that backs the bending form. On occasion, I clamp a board across the form afterward to encourage the workpiece to sit flat.

Bending the fan-back crest is simple, and usually rather anticlimactic, especially if you have a solid quick-release-style bar clamp. Before starting, make sure that the form has the correct surface on top. It should be the wider of the two faces, which will make the angle cut on the form an undercut to match the taper on the crest. I first center the crest on the bending form, making sure that it is the front face of the crest that is making contact with the form, and then roll it to one side where I clamp it. The arris (corner) between the back of the ear and the back of the crest is the best pressure point to use when clamping. I use hard felt clamp pads that take the impression of the hot piece to prevent damaging the arris. Rubber, foam or even blocks carved with the negative impression of the arris can be used as well. Once one side is secure, I draw the other side to the form using a high pressure quick-release clamp. Be sure that the clamp is not applying pressure on the end of the thin ear, which can split or break. Screw-type clamps work well here too, but are a bit more cumbersome because you may need more than one when the screw is fully extended. Again, check to make sure that the bottom of the form and the bottom of the crest are in line. If you don't have a strong quick-release clamp, you can pull the crest around and use regular bar clamps to draw it to the form.

## Dealing with Problems During Bending

Dealing with lifting fibers during bending is not difficult if caught early enough, but if a split is allowed to run, it can quickly rage out of control. When you see fibers begin to lift, apply pressure to the area and use a thumbtack to temporarily pin them back down. By keeping the end compressed, the lifted fibers won't get a chance to gain mass and run deeper into the workpiece – you hope. Once the bend is complete, glue down the lifted piece with moisture-actuated polyurethane glue, which expands into the crevice and can later be shaved to become invisible. To secure and compress the glued fibers, I use clear packing tape stretched around the bend. Resist the urge to make your bending pieces oversized; it will simply increase the chance that a split will begin in the first place.

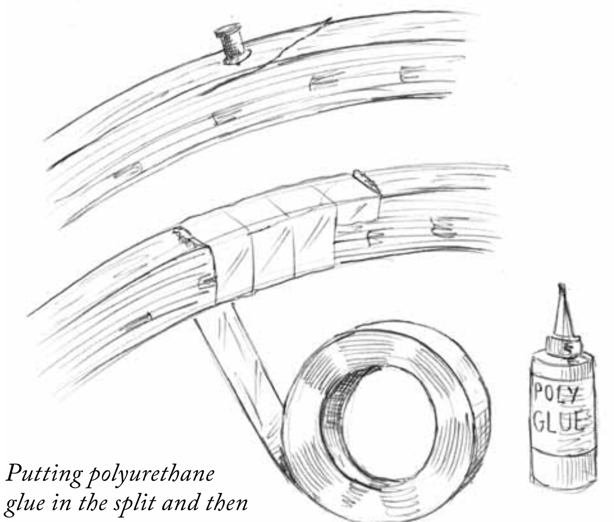



**FIG. 12.16** ***How to fix small splits.***

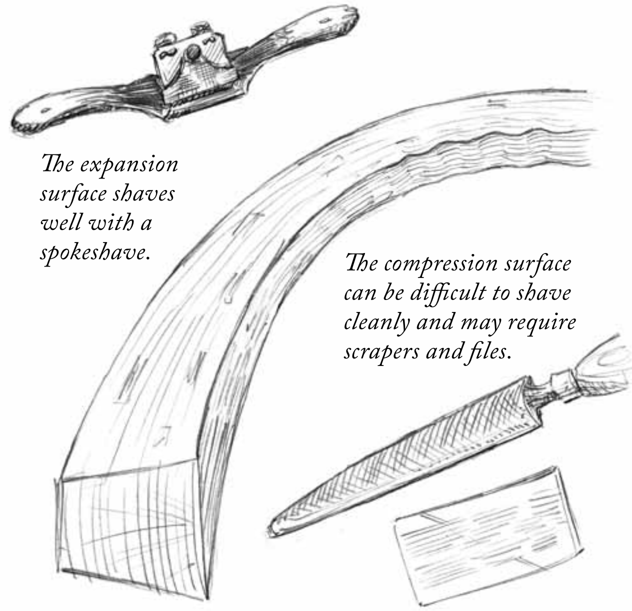



**FIG. 12.17** ***Clean up bent parts.***

## Dimension Changes when Bending

One interesting result of bending solid wood is its change in thickness. When bending around a form, the compressed portion becomes thicker and the expanded portion becomes thinner. Consider this when you decide the rough dimension of the bend so you leave enough material to remove for final surfacing. The thinner expanding area also tends to twist out of plane when bending, and I apply pressure on it to resist this tendency when bending wide pieces.

I usually take some time after the piece is fully dried to shave the thicker side down and even up the surfaces for aesthetic reasons. The change in dimension is more easily seen and corrected if the workpiece is bent when it is square, rectangular or octagonal in cross section.

There will be some difference in the way that the expansion and compression surfaces shave. Expansion surfaces tend to shave cleanly because the fibers are taut and well-supported; compression surfaces, on the other hand, tend to have a wavy stress that makes it tough to shave smooth. If this is the case, I use a scraper and alternate the skew of the tool from one cut to the next to avoid following the waves. Any surface that is scraped or filed will suffer some grain compression and have to be sanded later, so avoid scraping any areas that don't require it.

## Drying the Bends

Do you put pieces straight from the steamer into the kiln on the same day? I don't; however, the length of time that you should leave the wood to first air-dry depends on the species. Some woods, such as hickory, are so dense that they will most likely check if stressed in the kiln, whereas red oak, with its open fibers, is more forgiving. I like to leave my bends out of the kiln for a day or two if possible.

Perhaps you've seen or heard of folks taking the bend off the form soon after bending and tying it with a string to keep the bend. This works OK, but the tension of the bend might run toward any thin areas, causing the piece to distort from the desired shape. I leave the bend in the form until it is fully set to the shape.

So, how long do you need to kiln-dry the bend before it can come off of the form? Usually, just a couple of days. But the real test will most likely be when the wedges fall out due to shrinkage and lack of stress. You should check the forms daily to make sure that the wedges themselves don't shrink and allow the bend to open up. Once dry, a piece will hold the bend almost perfectly and will not lose weight regardless of how long you leave it in the kiln. It's important to remember that if you put wet wood in the kiln, you will be increasing the ambient moisture level and delay the drying times of the pieces that are already inside. If you are drying the bend without a kiln, expect to leave it in the form for a couple of weeks or more, depending on the season.

One more detail: Bends, especially ones that are not placed in the kiln to dry, will open with seasonal moisture cycling unless restrained in place.

## Adjusting Parts with a Heat Gun

A heat gun comes into play on almost every chair that I build – not for the major bending, but for subtle adjustments of bent or straight parts. The heat gun is proof-positive that heat is the main factor in bending wood. Once bent to shape with heat alone, the piece will hold the shape.

I use a heat gun to adjust bends after they have been taken off of the form or to straighten spindles that develop

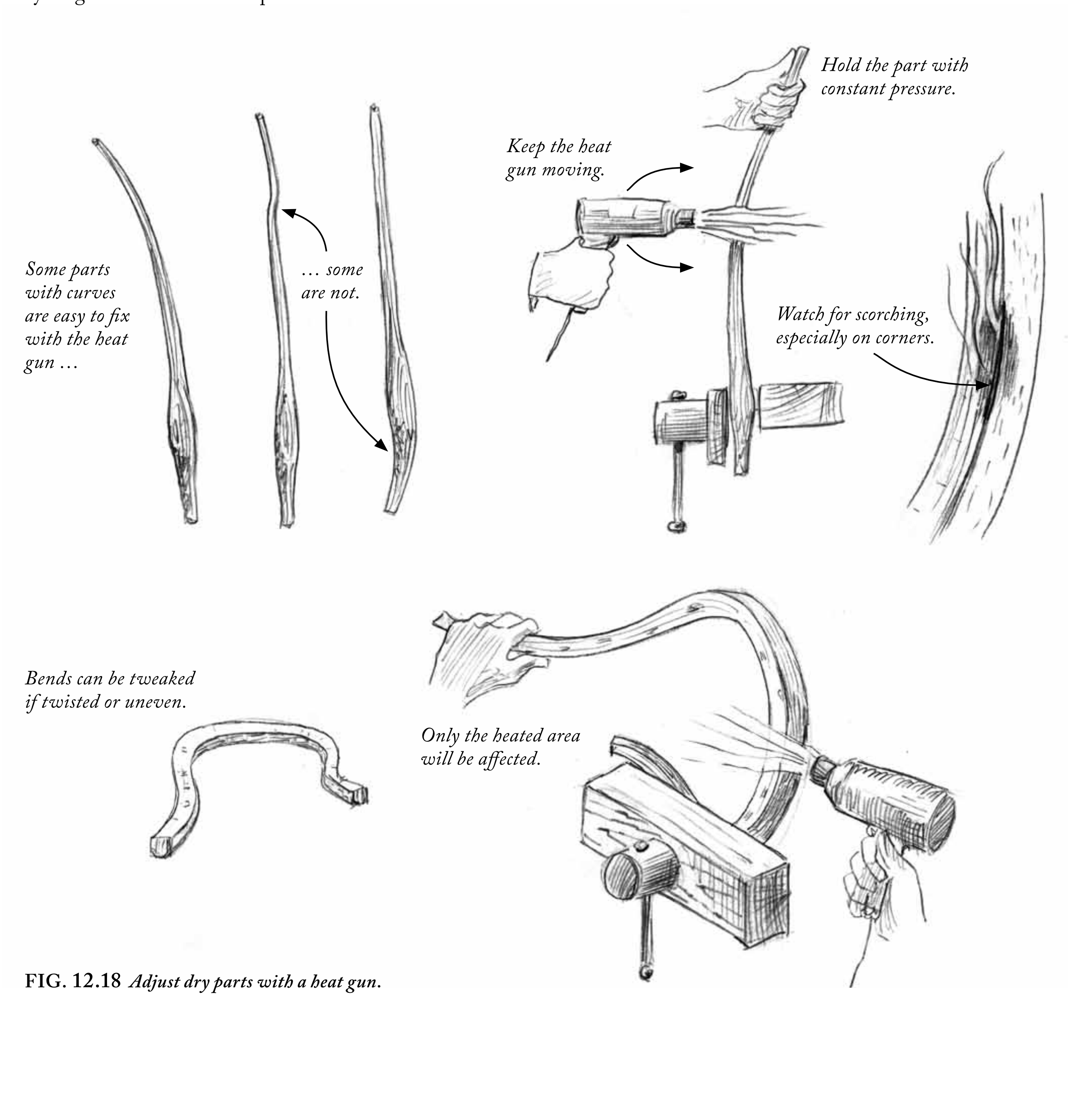



**FIG. 12.18** *Adjust dry parts with a heat gun.*

a bow. The best way to do this is to place one part of the piece in a vise then heat the area that you wish to bend. Heat guns are deceptively hot, so keep the gun moving. Avoid staying in one place or pointing it at the corners, which can scorch the piece and cause a break to start. Once the area is warm, apply pressure in the direction that you wish the bend to take then heat it some more. Once the area is up to temperature (hot to the touch, but not enough to burn you), you will feel the piece "relax" a bit. Keep the piece slightly over-bent in the direction you want while it cools. You can usually tweak it back to get the final results once it is cool. Using a heat gun multiple times in the same area is not a good idea because the wood will begin to get dry and brittle. While it may be tempting to try to fix kinks, or dog legs in a spindle, I've had little success marshalling the forces to correct these problems. It's much easier to relegate these parts to the fireplace earlier in the process.

And most important, be careful not to burn yourself on the heat gun and be sure to set it down in a safe place, away from combustibles. This is no hair dryer.

## An Alternative to Steam Bending: Bent Lamination

Before I began making chairs, and was still deterred by the ammonia-bending solution, I used bent laminations for all of my bends. Bent lamination consists of using a stack of thin layers that are clamped around a form with glue between them. Once dry, the bend holds the curve, giving a stable and strong result. But this always was a lot of extra work to saw up the laminates, plus lots of nasty glue and clean-up, neither of which I adore. Also, the forms and clamping strategy require a greater investment in planning and effort because the pressure must be equal at each point on the workpiece. For some bends, mating forms that enclose the bend from both sides can be used to achieve even pressure, but for the shapely parts of chairs, this can be difficult.

Dealing with parts that change dimensions in cross section, such as tapers, also requires extra steps to taper each ply or cutting to shape after bending, which exposes the glue lines. This seems like a huge hassle once you've simply shaved a taper in green wood with a drawknife.

It's important to use glue that is formulated for the task because of "cold creep." Cold creep is when glue shifts under the pressure of the laminates trying to straighten out, which may not be apparent for some time after bending. White and yellow glues are prone to this problem. Bent lamination is a process well-suited to shops equipped with milling equipment because the consistency required when sizing the laminates is exacting and most easily achieved with a machine. I've had good results using vacuum bags to create the even pressure when dealing with panels.

Lamination bending has its place, such as when the materials or curves are beyond the ability of solid bending. But in the chairs that I make, steam-bending easily handles the curves and achieves the same basic result as laminate bending, without all the sawing and glue. Applied heat can soften the cellulose and lignin between the fibers, allowing them to stretch and compress enough to bend. Once the piece cools and the moisture is driven from it, the bend holds just the same as a laminate. As a matter of fact, if you look at the end grain of the woods that are most appropriate for bending, the ring-porous hardwoods, they look as though they are made up of layers, just like laminates. But instead of having to arrange and glue the laminates, they are already connected and usually quite willing to contort into the shape you want.

With bent laminations, the thickness of each laminate determines the radius of the curve that's possible;

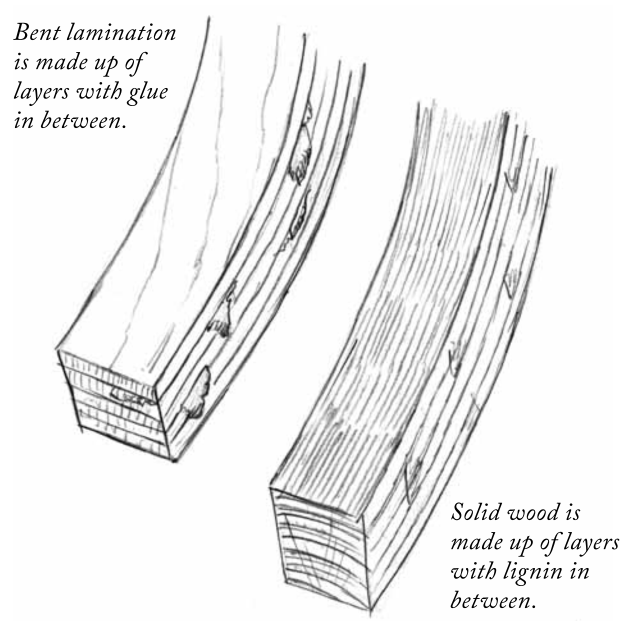
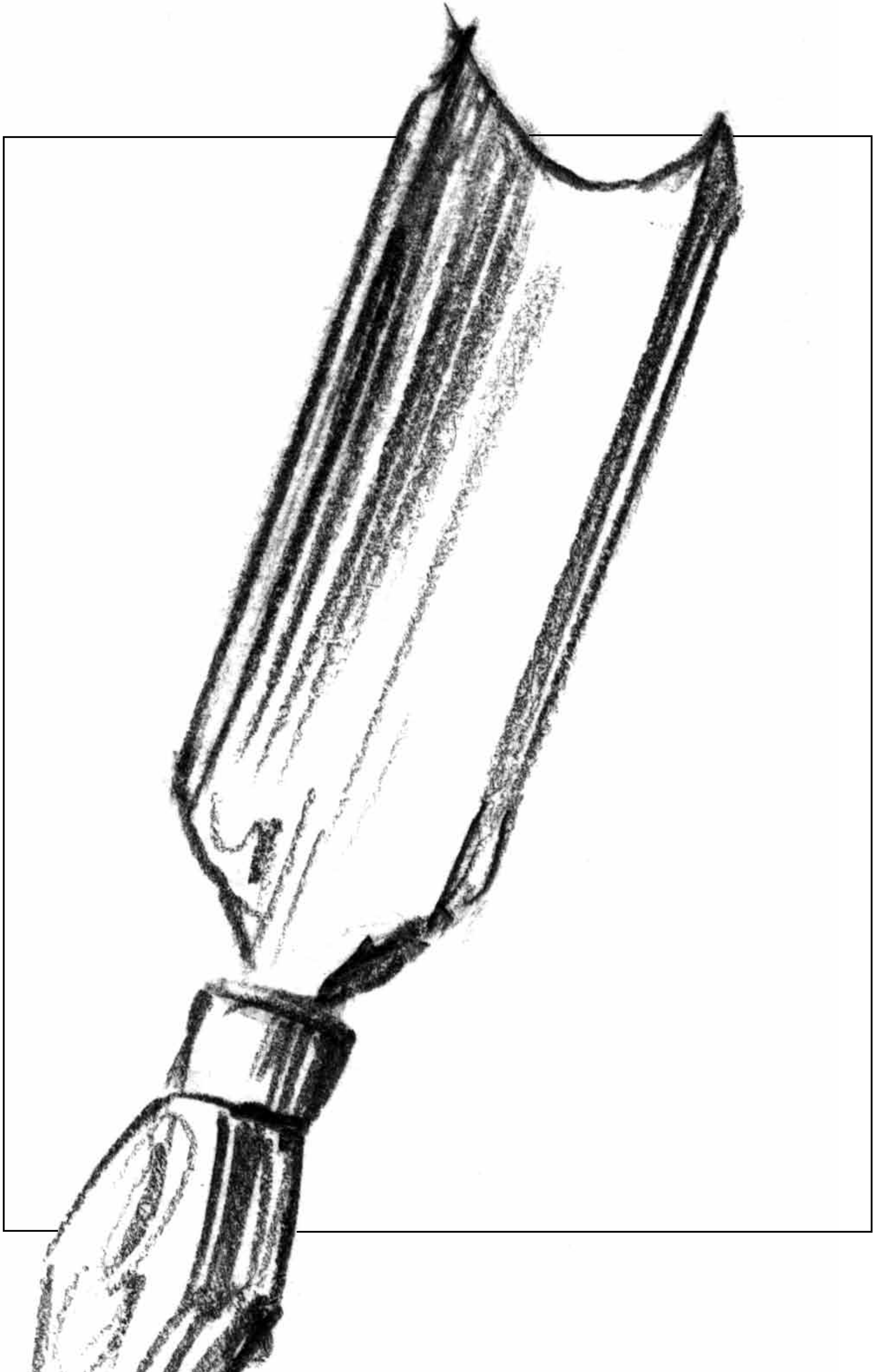



**FIG. 12.19** ***Bent laminations and solid wood have similar structures.***

thinner laminates can make tight radii with ease. Because the layers have no physical connection to each other, until the glue dries, this allows them to slide past each other as they curve without creating stress that might cause a solid piece of wood to fail. Plus, the outermost laminate actually expands less than the inner ones which, in turn, benefit from its support.

## Conclusion

The simplicity and strength of a bend made from solid wood, as well as the ease in forming joints with it and through it, transformed my entire woodworking experience. I've been able to eliminate materials, tools, jigs and a huge amount of preparation while creating more complex and interesting pieces. I always think, "If I can draw a curve on a piece of plywood, I can make the part." Once I experienced the directness and freedom of this technique, I've never since been fazed by the few challenges that it presents.



# 13

# Turning Tools

Turning is a form of carving, and as such, there are many similarities to the tools you might use in standard carving, although the sharpening geometry is different. Whenever my turning skills seem to let me down, I often look to the shape and condition of my tools. The correlation between well-tuned tools and turning success cannot be overstated. I usually see this when I hand a well-tuned tool to a student who has been struggling with a poorly tuned one. The improvement is usually immediate.

This chapter covers the tools that I find most helpful in turning and the way I maintain and use them.

## Tool Condition

New turners often underestimate the dulling effect that cutting will have on the tools. Turning tools show a distinct change in their usefulness as they dull. The dull tool will resist taking a light cut. The extra pressure required will tend to increase vibration while limiting the range and fluidity of motion. This is a recipe for a bad experience.

Most modern turning tools are made from high-speed steel. High-speed steel retains an edge longer and is less prone to losing its hardness during grinding. The downside is that high-speed steel is more difficult to get as sharp as regular high-carbon steel. But for me, the extra edge life is worth it. High-speed steel encourages grinding because it isn't damaged by overheating until it reaches red-hot. If it does get red-hot, take that as a sign that you are being too aggressive. Let the tool cool (don't quench it in water because this stresses high-speed steel) and, as remedies, lighten your grinding pressure and perhaps dress the wheel.

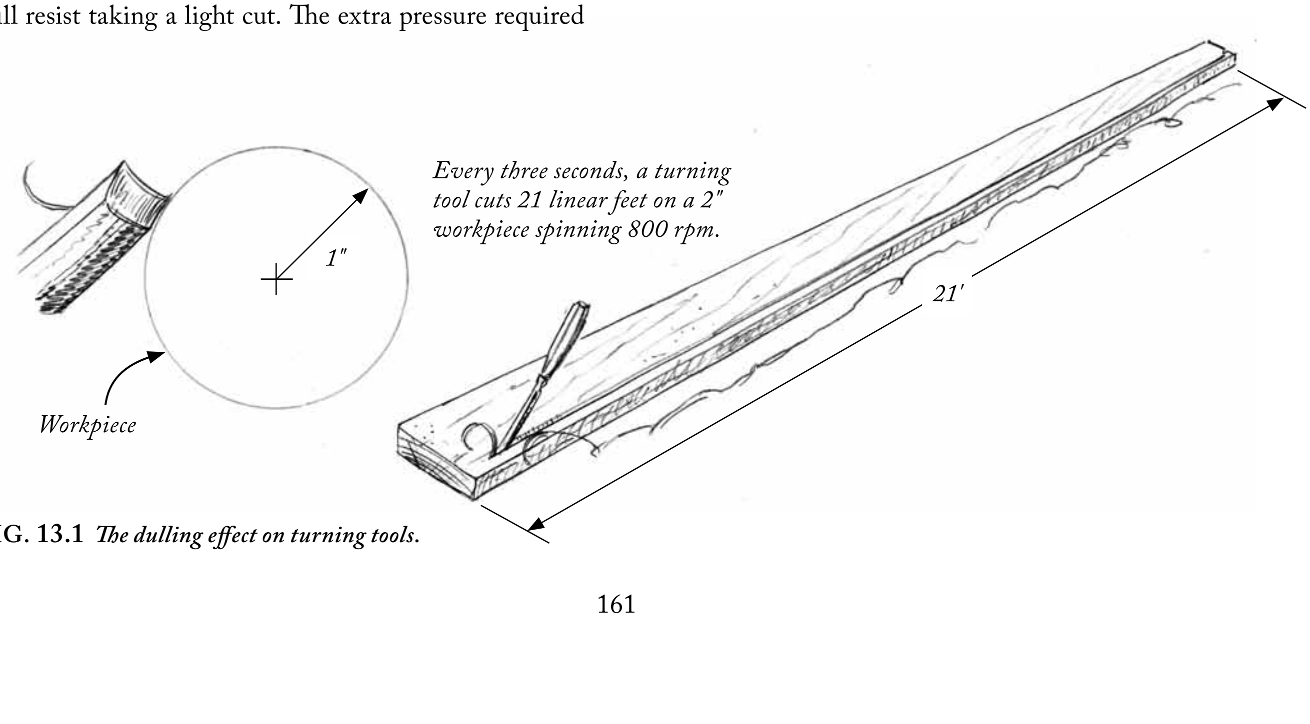
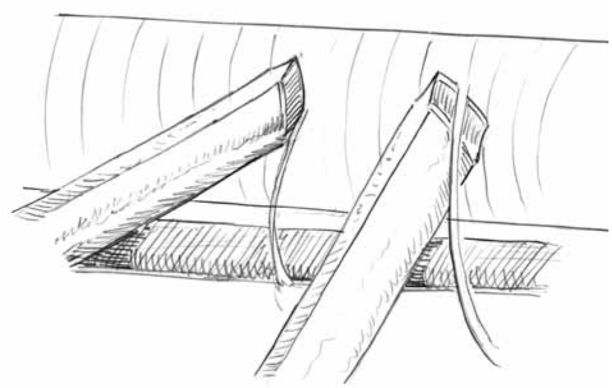



**FIG. 13.1** ***The dulling effect on turning tools.***

Many production turners conclude their sharpening process at the grinder. They use a light touch and frequent grinding to keep a sharp edge. I like the idea of this because it encourages grinding and sharpening in general. It stresses getting back to work instead of fussing with honing. But I hone most of my tools after grinding to get the edge as smooth as I can to leave a scratch-free surface on the work.

The dulling effect can be difficult to imagine; after all, sometimes you use the tool for only a minute or two.



*Dull tools cut better when presented at an extreme angle, but this shifts the fulcrum on the tool rest too far to the side of the cutting action.*

*Presenting the tool straighter makes it easier to resist the force of the spinning piece.*

**FIG. 13.2** ***The position of the skew is important in order to maintain control.***

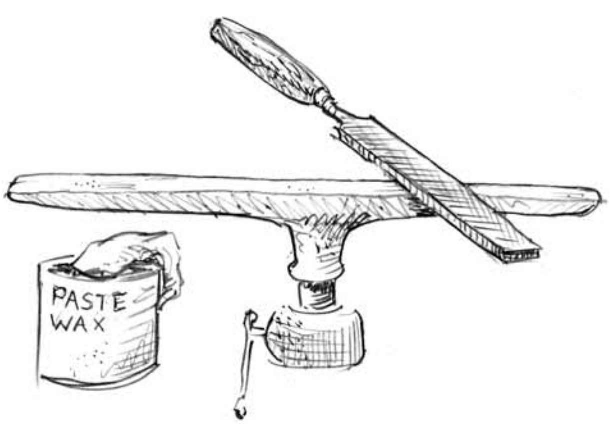



**FIG. 13.3** ***A smooth and polished tool rest is essential.***

That's hardly a problem with a plane or a chisel. But would you ever consider carving hundreds of linear feet with a carving gouge between sharpenings? Many turners ignore the length of their cuts and do just that. Imagine a 2"-diameter round spinning at 800 rpm; after 30 seconds of cutting, more than 210 linear feet have passed against the edge! Of course, by using different parts of the cutting edge, the tool can go longer between sharpenings. But for the new turner, focusing on getting one part of the tool to cut is usually tough enough. So tool maintenance becomes even more imperative.

Oftentimes a slight burr or a damaged edge on a tool won't just leave a dull spot, it will send the tool skittering down the work or chew it up. This is especially evident when using the skew. When entering a V-notch or any cut where the skew starts cutting immediately upon contact, the slightest deformity on the edge will prevent the tool from taking a bite.

Also, when the skew gets dull, taking a cut when the tool is presented straight on to the work becomes more difficult, so the turner usually shifts the handle far to the side to get more of a slicing cut. This makes it tougher to resist the force of the turning piece. Because the support for the tool is too far to the side, the skew is easily dragged down the work, resulting in a catch.

One essential tool that is most often neglected is the tool rest. A pitted or dinged-up tool rest will make smooth turning nearly impossible, and most new turners assume the problem is with their technique. A well-polished, smooth and waxed tool rest is essential to good turning. I take a smooth file to my tool rest and hold it perpendicularly as I draw it along, taking a fluid cut. After the surface is level and free of defects, I polish it with stones or fine sandpaper. Then I wax and buff it. The tool should glide easily. Any tools that have sharp corners, such as parting tools and skews with rectangular cross sections, should be eased with a buffer or sandpaper.

## Turning Tools

As with most woodworking, it is easy to confuse having more tools with having more ability. More important than having lots of tools is knowing when and how to use them. Talking about tool choice and shape can be contentious in turning circles, much like discussing politics at a holiday dinner, but here is my take.

My basic turning kit contains a 3/4" roughing gouge, which does most of the heavy shaping; a 1/8" diamond

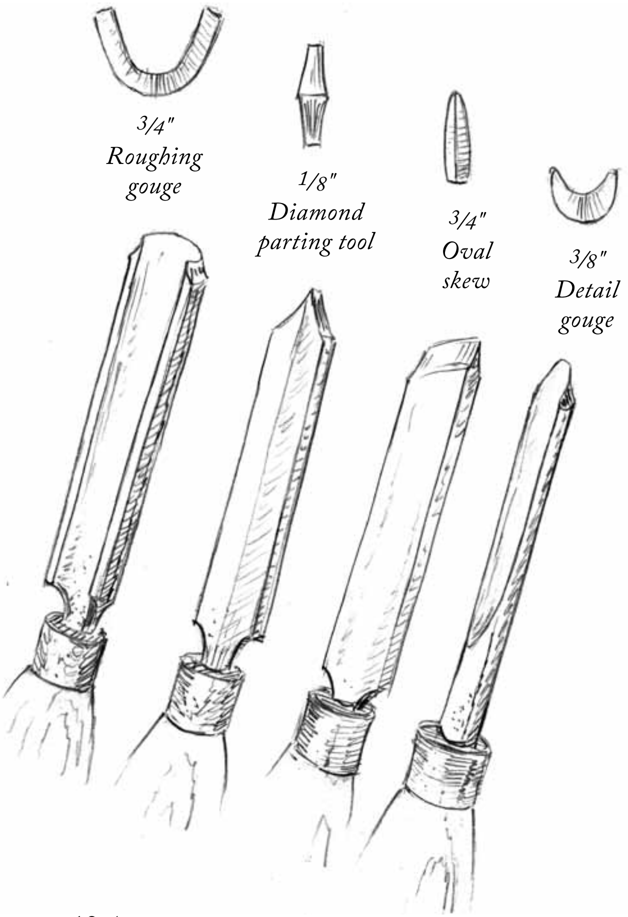



**FIG. 13.4** ***Basic turning tool kit.***

parting tool for sizing diameters; a 3⁄4" oval skew for finishing all of the surfaces except the coves; and a 3⁄8" detail gouge for getting into coves and roughing out beads. The size of these tools can vary with personal preference and the scale of turnings that you are making. Getting the most out of each one and limiting the number of times that you switch tools helps to achieve consistent results.

With these four tools I can perform all of my turning tasks; more importantly, by limiting my collection, I keep all my tools in top condition with ease and know exactly which tool to turn to at each step.

I also use a couple of other tools that make my life easier (I'll mention those as we go), but to make these chairs, the four core tools more than suffice.

The techniques you use at the lathe will dictate the shape of your tools' edges. Every turner has favorite shapes; I am no exception. I'll share my angles and shapes below, but keep in mind that the key to turning tools is the degree of sharpness and maintaining flat bevels. Any rounding over of the bevel will encourage you to over-rotate the tool to engage the cutter, which makes the tool difficult to control. To aid with the flat bevels, I use hollow grinds on all of my turning tools. The only exception is on the inside of the gouges, where a slight rounding can be tolerated.

For all of my sharpening, I like to keep the process fast and simple to encourage me to do it. Ensuring that sharpening is fast and easy is vital to actually stepping away from the lathe to do it.

Further information on the techniques in using these tools is in the Turning Practice chapter and information on the lathe and its accessories can be found in The Chairmaker's Workshop chapter.

### THE ROUGHING GOUGE

I use a 2" gouge for turning blanks to round and a 3⁄4" gouge for roughing out my shapes. The larger gouge isn't necessary, but it does make roughing more comfortable.

Before I reshape a new gouge, I polish the inside to remove any milling marks. I use a diamond cone-shaped hone, sandpaper on a dowel and diamond paste on a dowel to polish the flute. I grind a 35° bevel (or so) on my gouge. Just as important as the angle and condition of the edge is that the profile is straight. This keeps the cuts fluid and predictable. If the edge is crowned, rotating the tool during cutting will advance or retract the cutting edge, which adds another variable.

While grinding the gouge is possible to do freehand and with a simple tool rest, I use a jig to get consistent results. The set-up time with the jig is quick and doesn't deter me from grinding.

Once the bevel is ground, I use small diamond-impregnated paddles to hone the bevel, then I remove the burr with the diamond hone. Sometimes I turn the burr from the inside of the flute with a leather strop.

This isn't a finishing tool, so I don't go too far with the honing. I always like to keep the flat at the edge small to prevent rounding during honing. I hone only three or four times before going back to grinding.

### THE DIAMOND PARTING TOOL

I like a diamond-profile 1⁄8"-wide parting tool. The tool is widest at its cutting edge, which reduces binding, and the tool's small kerf reduces vibration. I don't hone this tool because I use it only for sizing diameters, and I grind it too often for honing to be practical. To grind it, I don't even set up a tool rest. I shoot for about a 50° inclusive angle. First, I set the tool on the top edge of the tool rest and lower it until I make contact with the heel of the bevel, then I lower the tool on the wheel until it makes full contact. I repeat this for both sides, taking care to keep the edge at the widest part of the tool's spine and straight across. When I have turned a burr, I stop grinding and tap the edge into a softwood block to knock the burr off and get back to turning.

**THE OVAL SKEW**

I prefer an oval skew, which seems to move more fluidly and doesn't ding up my lathe's tool rest. It's a personal choice. I sharpen it at 30° inclusive (15° on each side) using a standard tool rest on my grinder. I don't have any trouble grinding it this way, even though the shaft of the tool is an oval. I simply focus on keeping the edge horizontal; once it is hollow-ground, it registers on the wheel. I also shape the edge to a subtle curve. I like the exceptionally light cut that this curve allows, plus the toe and heel of the edge are somewhat pulled back, making

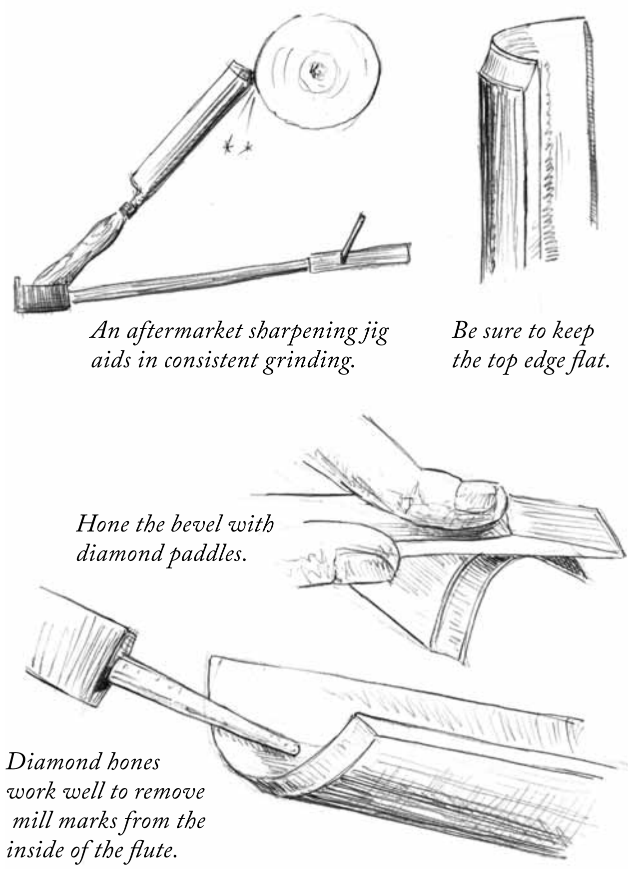



**FIG. 13.5** *Sharpen a roughing gouge.*

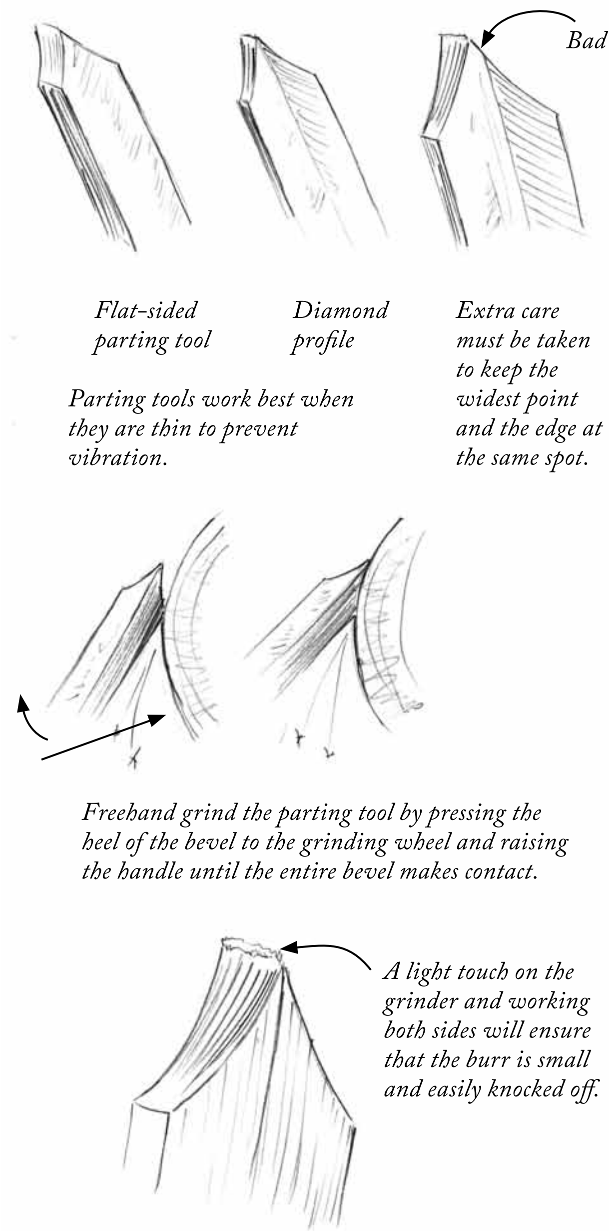



**FIG. 13.6** *How to grind a diamond parting tool.*

catches less likely. I achieve this curve by pivoting on the tool rest while grinding.

It's important to keep the two bevels ground equally. Once I'm satisfied with the grind, I hone the tool by pulling it on my stones just as I would a chisel. If the edge is curved or you are using an oval skew, you will roll the tool slightly to make sure that the entire edge is honed. Don't confuse this with lifting the tool so that the

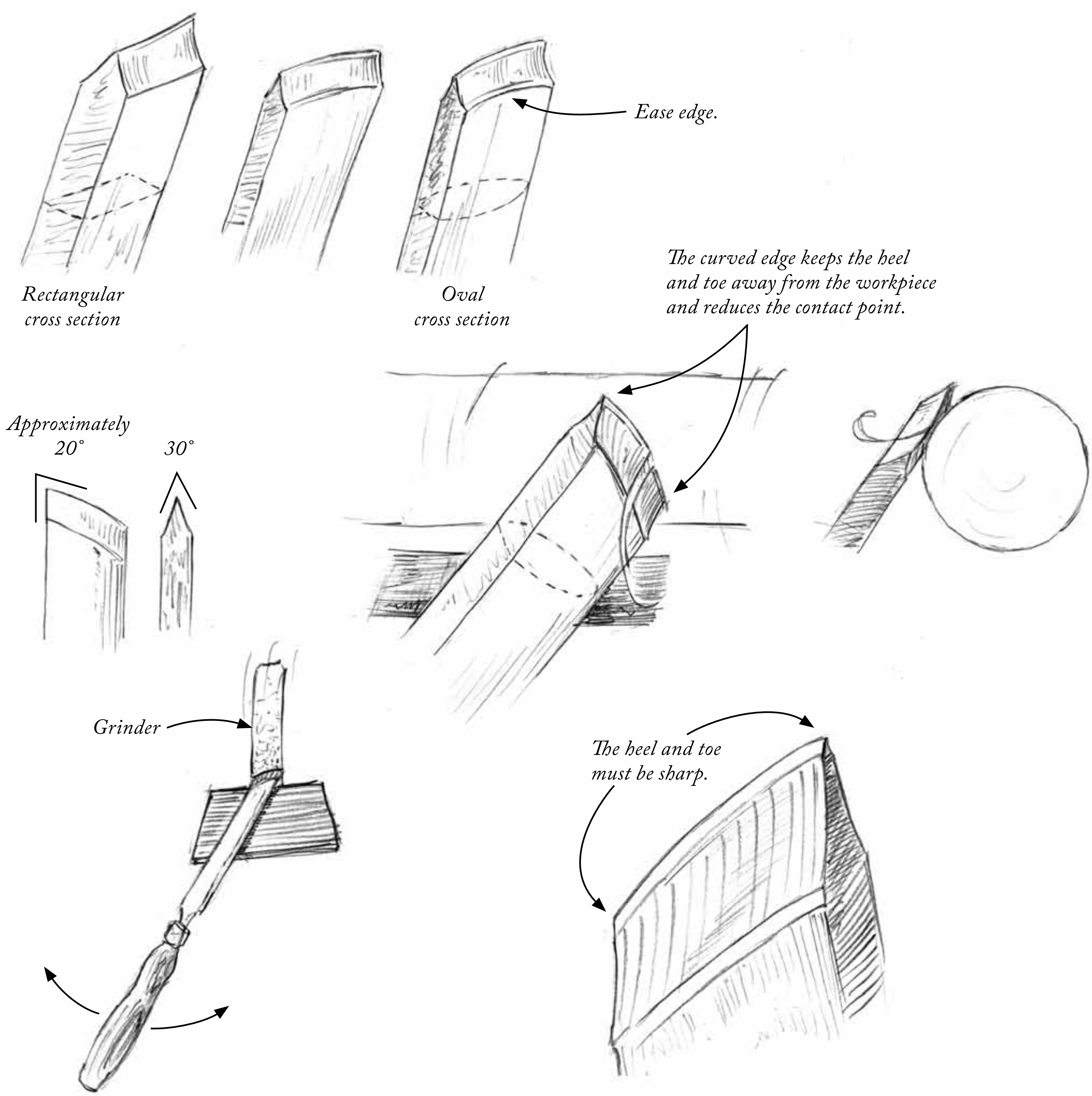



**FIG. 13.7** ***Grind and shape the oval skew.***

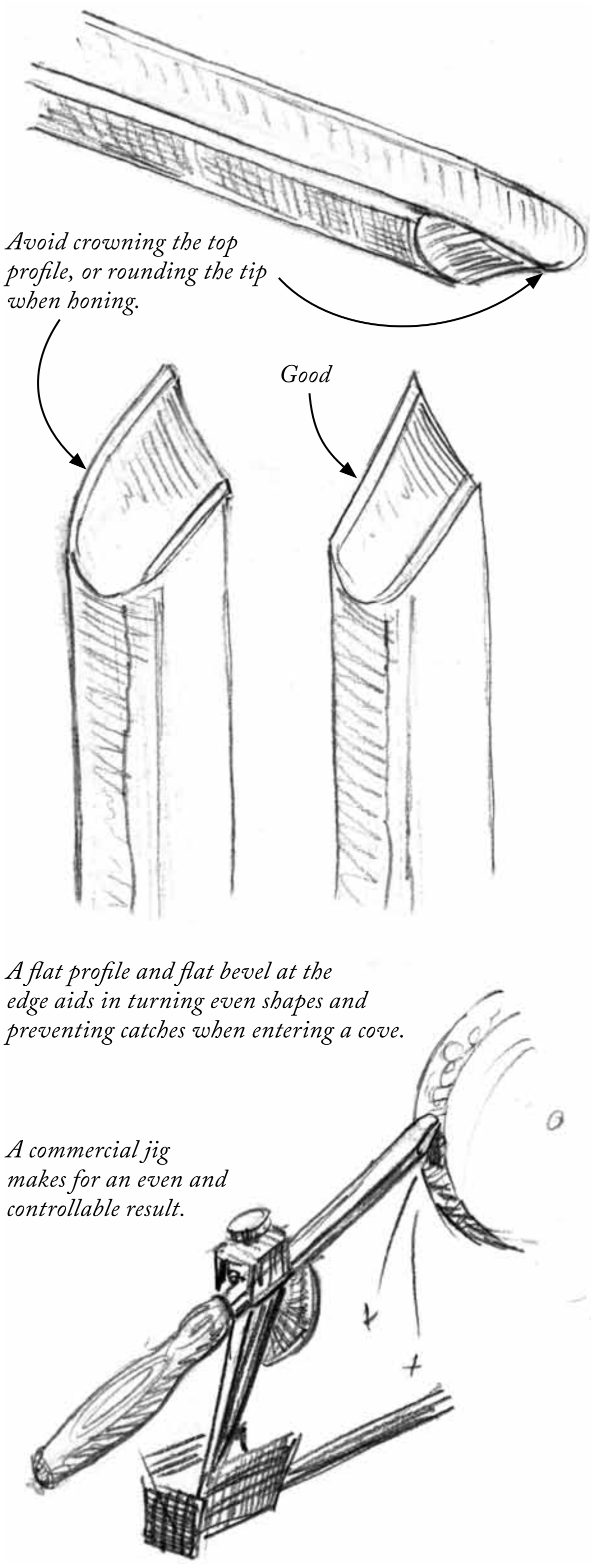



**FIG. 13.8** *Sharpen a detail gouge.*

back edge of the hollow grind loses contact. This is the worst result and will round the cutting edge over, dubbing it like a drawknife. Having a flat facet behind the cutting edge is essential to good skew technique. I never strop this tool, and I hone it on my finest stone in between turning each chair leg to keep it at peak sharpness.

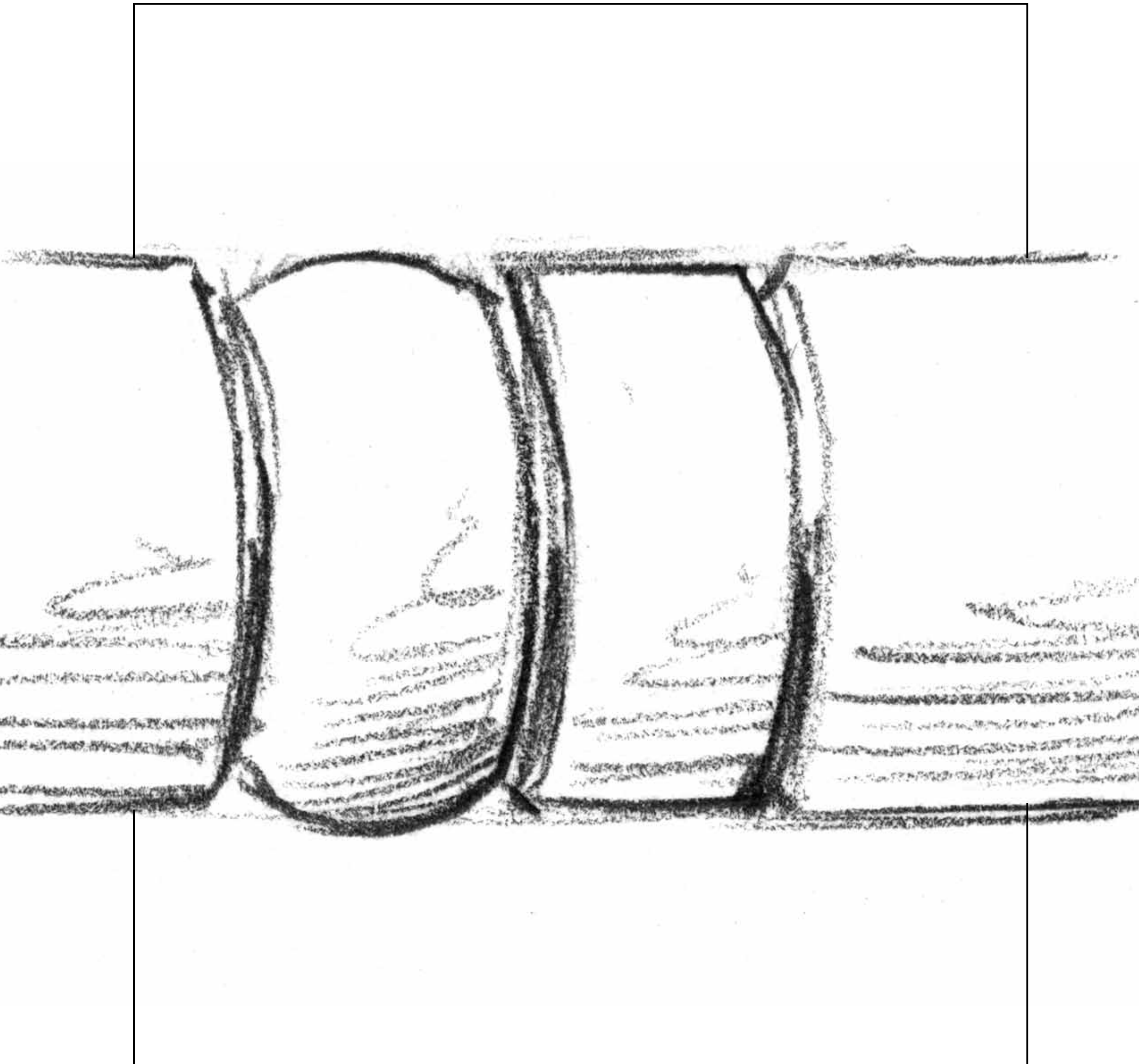
When the facet behind the cutting edge gets wider than 1/16", I hollow grind again.

**THE DETAIL GOUGE**

I first polish the inside flute of the detail gouge (as I mentioned above) before regrinding it to a fingernail profile with a commercial jig. The jig comes with instructions for grinding the correct shape. For a long time, I avoided investing in a jig to make this grind, but after using one, I realized that my results doing it by simply rolling the tool on the tool rest while swinging the handle side-to-side did not give as consistent a result. I usually resist sharpening jigs, but I've found the consistent results worth it in this case.

The shape of the curve at the end of the flute should be even. I grind the detail gouge at 35° and finish the honing the same as with the roughing gouge. I keep this tool in top shape to reduce chatter and the chance of catches. Like the skew, this tool performs best when most of the bevel is made up of the hollow grind, so I grind again after only a few honing sessions.

To those new to turning, there are many details to consider, such as the speed of rotation, the size of the workpiece, the heft of the lathe and the details to be turned. Tool condition is one variable that you can always control. To achieve this, you must become proficient at the grinder. In the last 15 years, I've had the same iron in one of my favorite spokeshaves, but I've replaced most of my turning tools at least once. While they aren't cheap enough to think of as disposable, I never confuse their cost with the value of a pleasant turning experience.



# 14

# Turning Practice

For new turners, and some experienced turners, many problems can be predicted and solved before the lathe is ever plugged in.

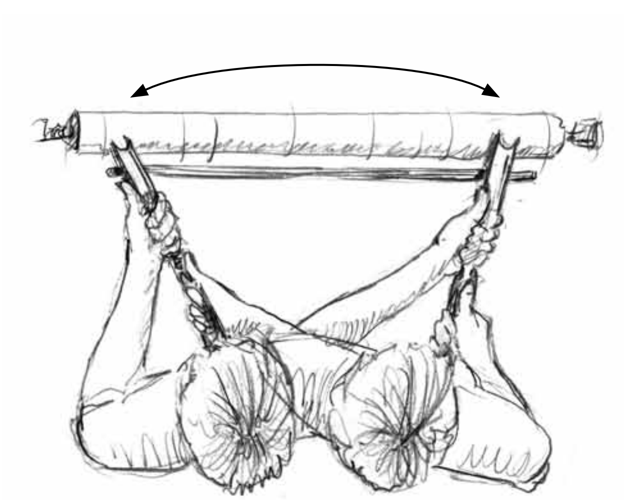
There are some basic tendencies that we all share, such as gripping a tool too tightly as well as an aversion to sharpening our tools. With some focus on the precursors to good turning, success with the spinning wood can be more easily achieved.

While new turners are generally anxious to make some shavings, I've found a few tips that usually make their experience more successful. Good turning technique has a lot to do with moving the tool correctly. But the tool is in your hands, so correct movement starts with you.

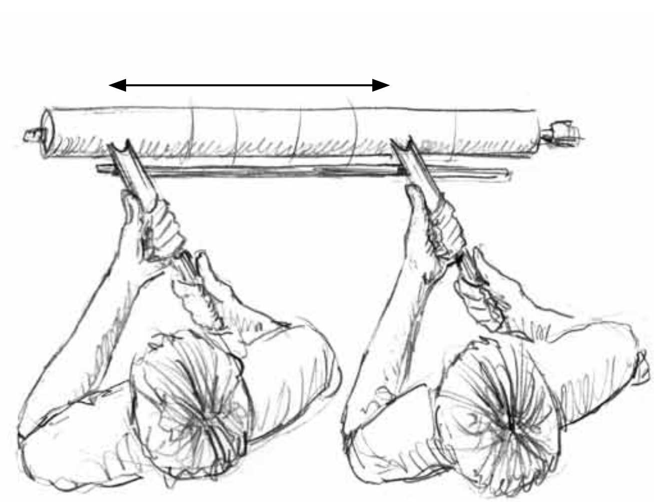
Often, trouble with turning a piece starts at the waist. It's natural to use your hips and waist as a pivot, which causes the tool to travel in an arc.

This means that you have to adjust constantly the position of the tool to compensate for its curved path. It makes creating consistent shapes very difficult. It's also common to see a student start with knees bent and move by straightening them. This means the turner is rising and once again must compensate by shifting the tool.

The proper movement is similar to what you might see on a machine lathe, where the cutter is held in a constant position while moved along a slot parallel to the lathe's axis. The key is to learn to move your body to achieve this result.



*Pivoting at the hips cause the tool to travel in an arc, which requires constant adjustment to make a fluid cut.*



*Moving the whole body while keeping the tool in a fixed position allows for fluid cuts and subtle adjustments.*

**FIG. 14.1** ***Pivoting at the waist can make turning difficult.***

Imagine if the turning was not only spinning, but slowly moving sideways. Then you would need to focus only on holding the tool in a single position as the turning slid by. This is exactly the way it feels when you get used to moving correctly.

To move smoothly, I focus on two types of movement. Just like your hand moves along a page as it writes a sentence, the position of your body must coordinate with the movement of your hands to produce fluid results.

The first movement I'll describe is "location movement," which directs the tool from one part of the turning to the other; the second is "detail movement," which forms and follows the shapes.

Location movement is focused in the feet, ankles, knees and leg joints.

When working on a specific task, I make sure I am comfortable moving from one end of the detail to the other while keeping my waist and everything above it locked. This throws most folks for a loop. It's most natural for the beginning turner to assume that it's the arms that do the moving, and it takes a surprising amount of muscle strength to keep your legs bent while shifting your weight.

A few back-and-forth movements from one side of the detail to the other is all that it takes to begin getting the correct stance and feel.

The second type of movement is detail movement. This is when the tool, hands and arms shift positions to form or follow the shapes of the turning. For most turnings, detail movement will allow the details to be cut without widely swinging the arms. Keeping the arms and elbows close to the body gives stability and control while cutting. For much of my cutting, I keep the back of the tool handle braced against my hip so that I can control the movement from my legs.

A great deal of the movement that folks tend to make as detail movement is actually compensating for a lack of location movement. Sometimes this is accompanied by a rising motion or turning motion originating in the knees and hips. By considering these movements as separate and practicing them this way, you can start to spot which one is the problem.

Hopefully some solace for troubled turning can be found in the simple notion that you are usually just standing in the wrong place to do the job.


*Take a wide stance, bend your knees and shift your weight as you move from one position to the other.*

**FIG. 14.2** ***Location movement on a lathe.***

## Moving Toward Balance

When confronted with a whirring piece of wood, most beginners take a comfortable stance and start cutting. This is a mistake. Most shapes require the turner to shift position during the process, and if you start out in the most natural and comfortable position, you will become more unnatural and awkward as the cut proceeds. This limits your dexterity, requiring you to constantly compensate while cutting.

Instead, position the body in a natural state as it will be at the end of the cut, then shift to the beginning the cut. This way you will move toward comfort and balance as the cut proceeds.

At first, this is awkward and takes planning and practice. It also requires a great deal of energy, muscle and discipline. I like to start with a rehearsal of the cut, and when I find myself at the end, I shift my balance and grip to the most comfortable position. Then, retaining this grip and keeping one foot in position, I move the other

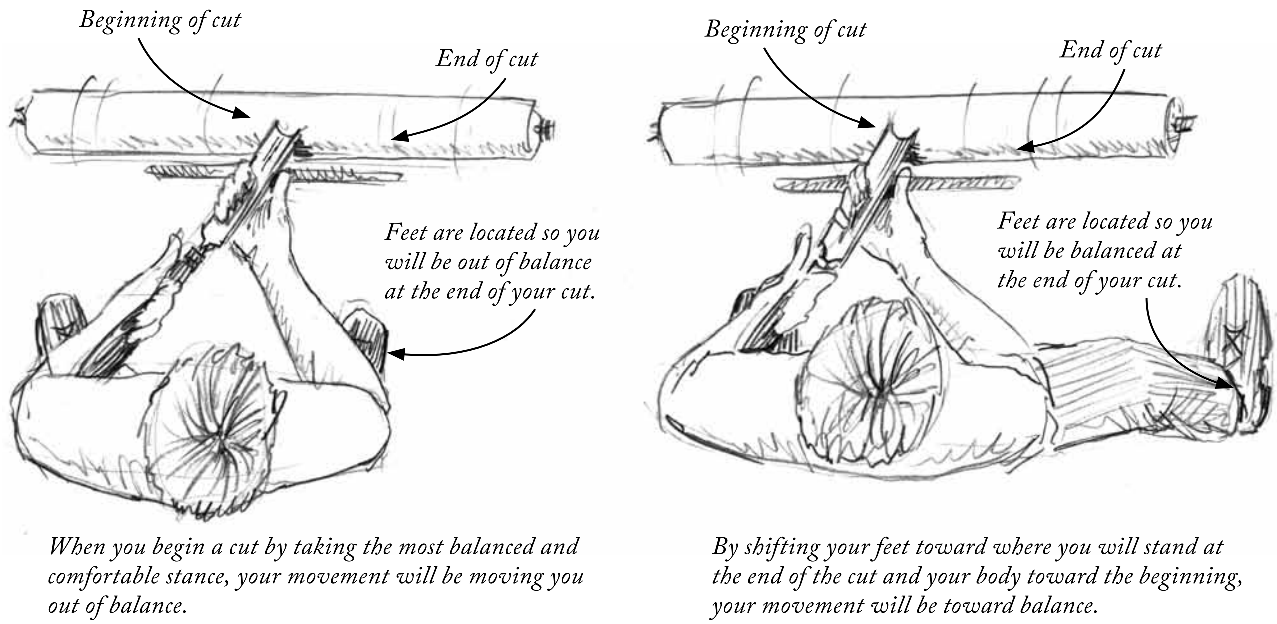



**FIG. 14.3** ***How to "move toward balance" when turning.***

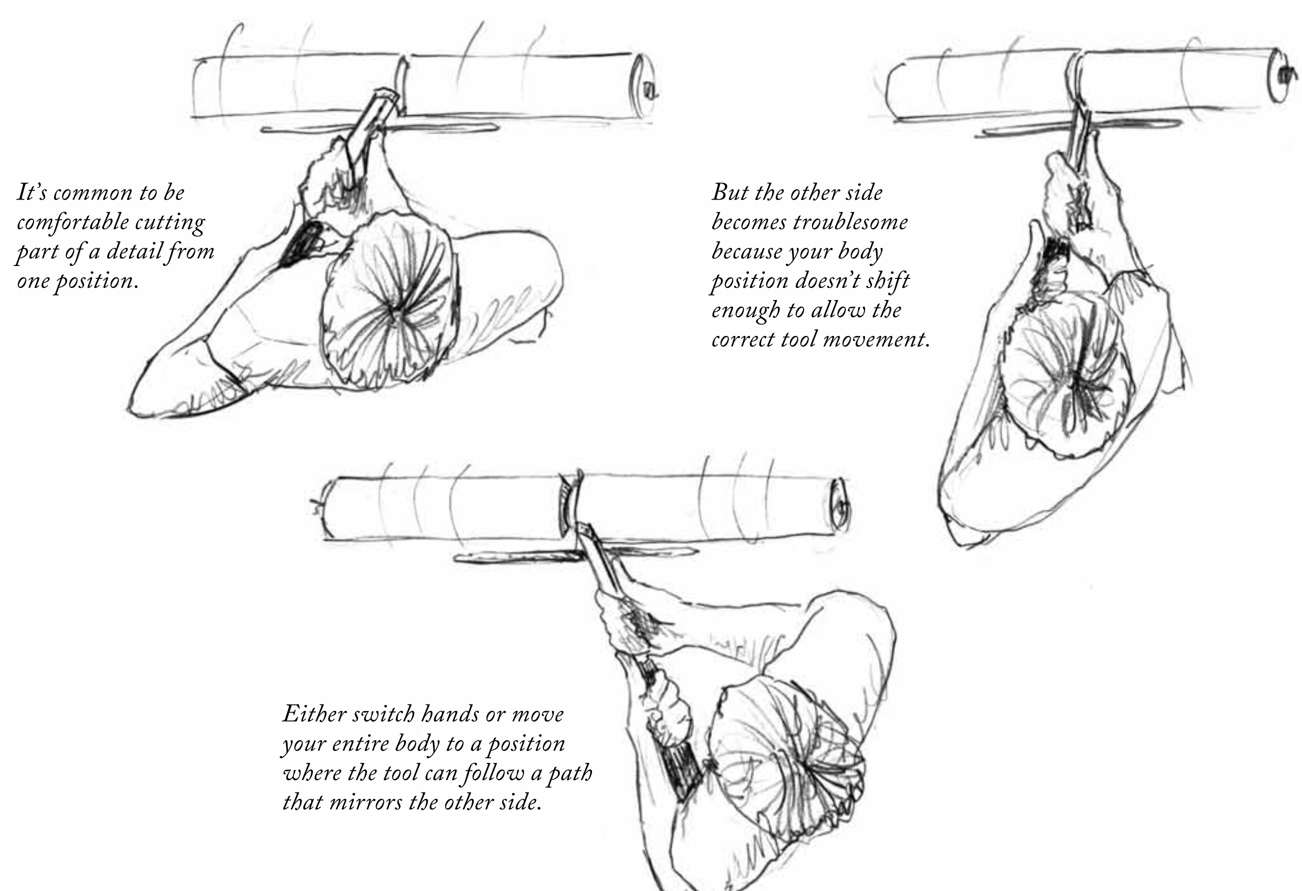



**FIG. 14.4** ***How to get out of the way of the tool when turning.***

foot back to the starting position and practice shifting my weight along the length of the cut. This movement is the location movement that takes place in the hips, knees and ankles. Often it requires starting on the ball of one foot. Be prepared to feel awkward and tired; these are new muscles you are using.

## Get Out of the Way

Folks often report that they can turn one side of a bead or cove with ease and the other is difficult or consistently misshapen. The reason for this is often that the body is in the path that the tool needs to follow.

The solution is always the same: Get out of the way.

When turning a detail where the handle moves away from the body, the turning often goes smoothly. When the path of the handle must travel where the turner's body is positioned, it's natural to adjust the path of the tool to compensate for the impending collision, rather than moving the torso out of the way so that the tool can move properly. It's also wise to practice by simply switching to your non-dominant hand to resolve this, especially if you are new to turning and not set in your ways.

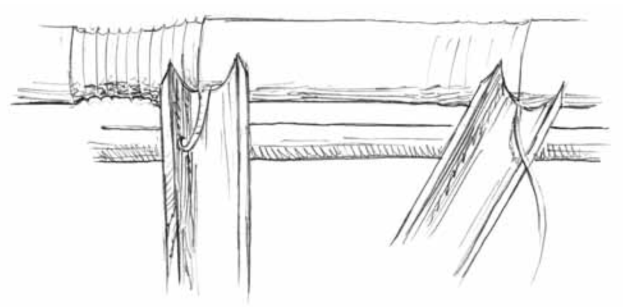
Once again, a little rehearsal and positioning practice can help. So position yourself at the end of the cut then shift your weight to the beginning while keeping the same foot and tool position. If standing in the way of the tools is uncomfortable, you will be more likely to move when the time comes.

## Tool Position

It's instinctual to hold the cutting tool perfectly perpendicular to the spinning workpiece. For most turning, however, this isn't the best position. To the new turner, nothing is more disconcerting than the idea that the tool will be ripped from the hands, so presenting the tool at an angle is not natural.

The problem is that when you present the tool to the workpiece in a perpendicular fashion, the bevel rides on the same spot that the tool is cutting. It's a bit like sawing off a limb you are standing on. Once the tool takes a light cut, the bevel is no longer in solid contact with the workpiece and must be adjusted quickly to compensate. This leads to jerky cutting and a lack of control. (The parting tool is one exception to this.)

The solution is to present the tool at a slight angle, which allows the bevel to ride on the surface that was just cut while supporting the cutting edge ahead of it.



*When the tool is presented perpendicular to the axis of the workpiece, it is making contact at the same point that it's cutting, which leads to uneven results.*

*Angling the tool slightly allows the contact point to follow the cutter on the smooth surface just created, giving better control and surface quality.*

**FIG. 14.5** ***How angling the tool slightly results in smooth cuts.***

On the other end of the spectrum is the tendency of new turners to finish a pass by angling the tool farther away, rather than moving their body position. This not only requires the position of the tool to change as the angle increases, but also puts the cutter farther away from the fulcrum, which decreases control.

## Leverage & White Knuckles

One of the eye-opening moments is when I demonstrate turning with two fingers. With just two fingers on the back of a gouge, I take a light shearing cut, demonstrating

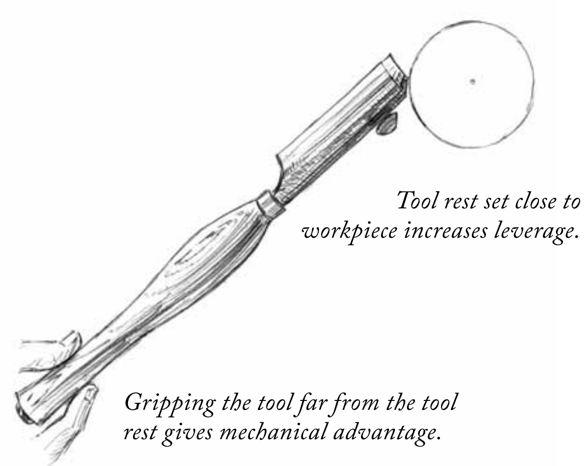


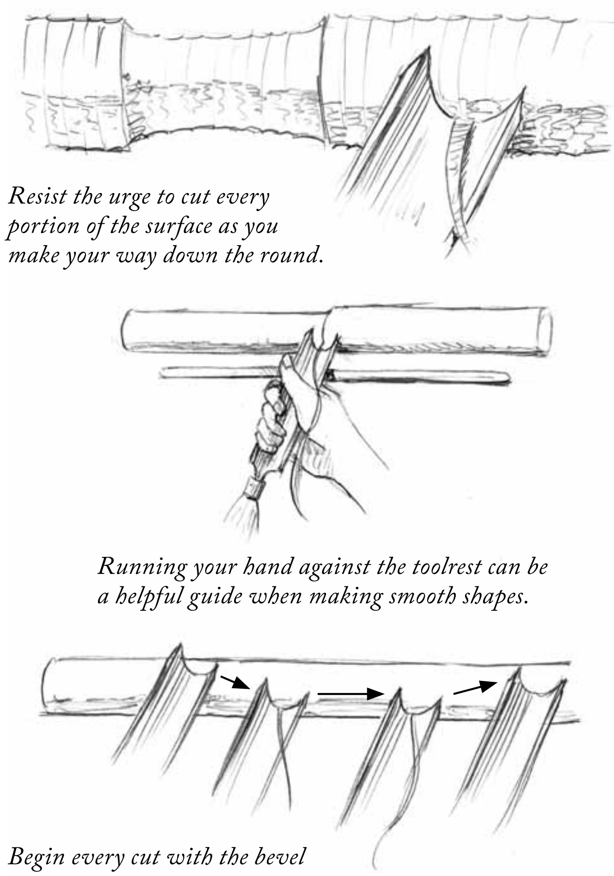

**FIG. 14.6** ***The "two-finger" turning demonstration.***

that leverage, bevel contact and tool position are the crucial elements in turning.

By keeping the tool cutting high on the round, I can take light cuts with a fully supported bevel. And by holding the end of the gouge, I can take advantage of the leverage available by using the tool rest as a fulcrum. This both discourages the habit of scraping, which has no bevel support, and the white-knuckle grip that most new turners engage. A heavy grip is exhausting and limits the range of movement and sensitivity to feedback that are essential to good turning technique.

With a sharp tool and good position, the grip on the tool should be like holding a bird: not enough to crush it, but just enough that it can't fly away. While I don't encourage the two-finger showboating, try this with a very loose grip on the tool:

Hold the handle of the tool between the thumb and forefinger and the shank of the tool with the other thumb and forefinger. Slide the tool along the tool rest while riding the bevel on the workpiece, but not cutting. Raise the handle slightly and allow the bevel to slide down the round until it takes a light cut. Resist the urge to tighten your grip; this will give you the feel and feedback that is essential to controlled cutting. This cut will also help you recognize the force that the shaving exerts as it flows over the edge. It is usually minor, but on some deeper cuts it does alter the balance of forces at play.



*Resist the urge to cut every portion of the surface as you make your way down the round.*

*Running your hand against the toolrest can be a helpful guide when making smooth shapes.*

*Begin every cut with the bevel rubbing on the workpiece and lower the tool until the cutter engages. Keep the tool in cutting position until the end of the cut, then feed the tool forward to ride back up onto the bevel again.*

**FIG. 14.7** ***"Planing" with a gouge.***

## Digging for the Cut

The desire to see a tool cut a shaving runs deep. Watching the shavings fly can rival the resulting condition of the workpiece, even though the shavings get swept up and discarded.

When using a handplane to joint an edge or flatten a board, it will initially cut only the high spots while the low areas remain untouched. The job is done when the incremental progression of the cuts reaches the level of the low spots and the flat surface is complete.

The same goes for turning. For a new turner, a tool that isn't cutting is a source of stress and nothing calms the nerves like a lovely shaving. So new turners often shift the tool while making a pass to ensure that there are no gaps in cutting and shaving-making. This, of course, leads to misshapen details and, even worse, serious digs as the turner finds that pulling out of an adjustment isn't as easy as starting it.

I encourage turners to practice by intentionally not cutting. Get used to sliding a tool along the spinning workpiece and trying to bring the edge as close to cutting as possible without taking a shaving.

This exercise allows turners to get used to their body position and movement, the feeling of "not cutting" and also taking a light cut. At some point the tool will take a cut from a high spot before coming out of the cut as the tool moves along. Then, with a subtle adjustment of position, begin another pass and the tool will cut again at the high spot, only for a wider area. Much like the handplane, a series of light shavings and multiple passes will yield a uniform shape. I also find that running my forward hand along the tool rest can give a solid reference for keeping my tool position constant and moving fluidly.

Soon, you will learn to match the pace and smoothness of the sideways movement with the depth of cut and desired condition. This is when the most controlled cuts start to happen.

It's also important to avoid starting from the "stabbing" position, where the tool is presented at such an angle that the cutting edge engages first, usually with a good grab. As a first impression of cutting on the lathe, this sets the tone of being out of control and hanging on for dear life.

A better solution is to begin and end every cut with the bevel riding the work and the edge disengaged from the work. From this starting point, you can move along the round and slowly shift to a cutting position. When the pass is near completion, slide the tool back up the round and onto the bevel for a safe exit. The safe zone is high on the round and should always be the default direction when starting or finishing a cut.

## Practicing Mistakes

While learning techniques for turning specific details is important, I've found that having a process to practice and improve them is critical to mastering them. I remember learning to turn and feeling like mistakes and catches came out of nowhere, like a mugger in the night. But turning is simple physics, and the combination of tool, wood and movement will yield absolutely predictable results. Just like driving a car, the key is learning what the controls are and how to combine them to keep out of harm's way. The problem almost always lies with you and your tool, and while this sounds like condemnation, I take it as encouragement. If the technique you are using gives poor results, you have the ability to choose a different technique, but first you must identify the problem.

Because the occasional turner usually needs to make a only few pieces when a project calls for them, it's natural to assume that carefully turning a good bead on a scrap piece of wood is the way to bone up before chucking up a furniture part. The problem with this assumption is that it implies that squeaking out one good bead is proof positive that you can repeat the feat.

I've found it's more productive to turn 10 poor-looking beads quickly. This gives the turner the chance to rehearse the movements and isolate the problem areas. I encourage consciously repeating mistakes, as long as they aren't unsafe, until you can do so consistently. That way, you will learn to investigate the mechanics of the trouble, and avoiding it becomes easy. Plus, like a boxer learning to take a punch, you won't become overly rattled by a simple catch or mistake.

## Cutting Techniques

The following sections explain how to use each of the turning tools common to chairmaking.

### USING THE PARTING TOOL

The main job of the parting tool is sizing the diameters of the various details. Correctly sizing diameters requires good cutting technique, as well as a means to measure the results. Parting tools come in a variety of widths. I use a narrow one (1⁄8") with a diamond cross section, but parting tools that are wider or straight-sided work fine as long as they are sharpened and used correctly.

The cutting action of the parting tool starts the same as other tools in that you ride on the bevel just behind the cutting edge and retract the handle as you introduce the cutter. But from that first moment of cutting, you must feed the cutter forward at a rate that corresponds to the material that you are removing so the bevel stays firmly in contact with the wood.

Otherwise you will be scraping, which leaves a rougher surface, gives poor feedback and introduces vibration. If you feed the handle too far forward, the edge will simply disengage and stop cutting. This is preferred to raising the handle too much and scraping. In a short time, you will be able to judge and feel the contact of the bevel on the wood as the guide to correct cutting.

As I've gained turning experience, I've also gained respect for the role that parting-tool technique has not only on the size of the parts, but for the rest of the process. The vibration that begins with the parting tool may not be a problem while cutting the diameters on a full-round blank, but it can show up later and cause problems.

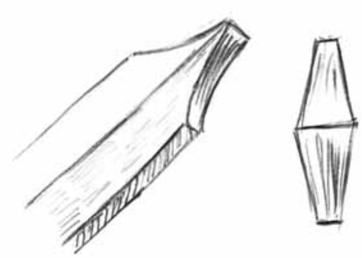
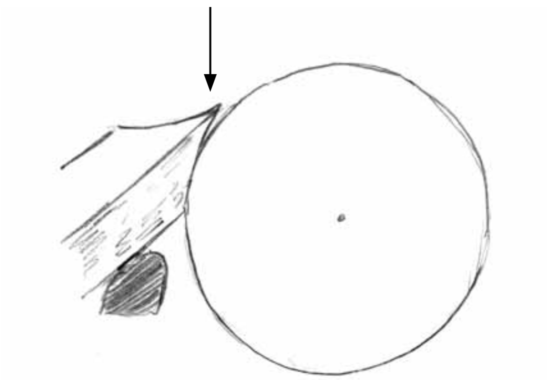
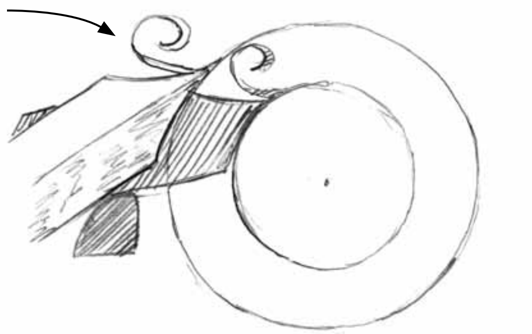


**FIG. 14.8** *The diamond parting tool.*

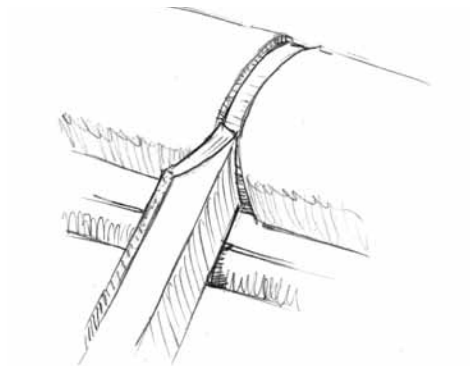


*This is the motion that I use for introducing the tool for grinding …*

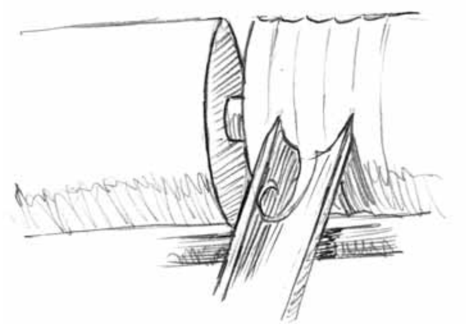


*… and cutting.*

**FIG. 14.9** ***Correct parting tool technique.***



*Shallow parting tool cuts are best and require a good plan for the sequence.*



*Deep cuts invite vibration.*

**FIG. 14.10** ***Shallow cuts are best with the parting tool.***

When making deep cuts, it's wise to wiggle the blade a bit to increase the width of the kerf to keep the blade from binding. This is most useful with straight-sided parting tools, which can bind in deep kerfs. That said, I try to avoid making sizing cuts that go too deep into the round. Later, in the layout section, I will show how planning and sequencing can eliminate cutting more than 1/2" or so per cut.

**THE SKEW**

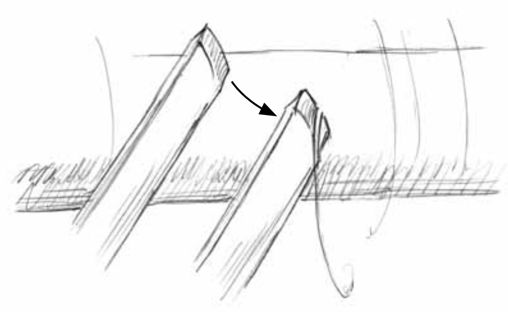
There's no need to introduce the skew as a potential workshop villain. In my experience, there are only a few times that the skew actually becomes troublesome.

***The Planing Technique.*** When talking about the skew, it's common to address the cause of a catch as being the "toe" (the long point) or the "heel" (short point) of the skew contacting the workpiece and catching. While learning to avoid these areas is helpful, it doesn't solve all skew issues. For that, I've learned to focus on the one aspect of skew use that lies at the root of many of the problems: The skew is a tool with no reverse.

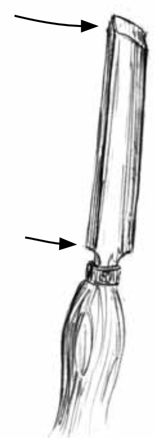
It is vital that you always slightly angle the skew to the workpiece and always be moving the tool forward. Any backward motion, or even holding it still while shifting the handle, can cause the wide edge to take a deep cut that overpowers your leverage, sending the skew out of control. Focusing on keeping the skew moving forward eliminates a lot of problems when learning to plane and form shapes.

Yes, it is a bit of a cruel joke that the hesitance, caused by fear of a catch, can actually cause the catch. This is all the more reason to rehearse the entire motion that you plan to execute to make sure that you don't feel the need to stall the forward motion of the tool.

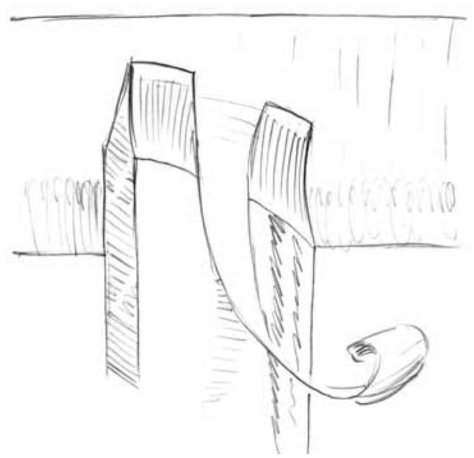
Another problem that can derail smooth skewing is allowing the handle to move ahead of the cutter. This will almost always lead to a catch. When planing along a round, it's obvious when the cutter is leading the way;



*The skew must always be moving forward, even when beginning a cut.*



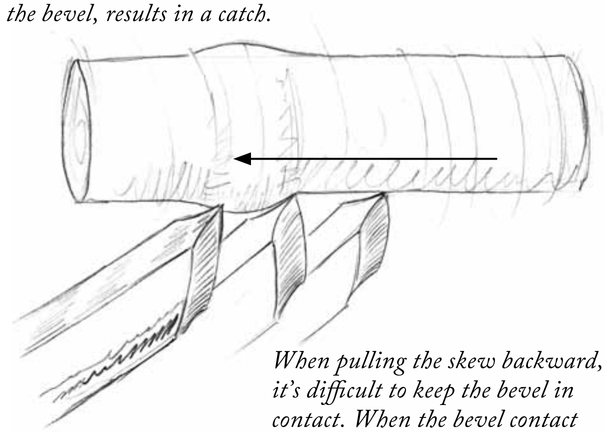
*The cutting edge must always be ahead of the handle when moving through a cut.*



*If the skew is presented perpendicular to the workpiece, it will take a wide shaving and the toe and heel will be dangerously close to contacting.*

**FIG. 14.11** ***Skews must always move forward.***

*Edge contact, unsupported by the bevel, results in a catch.*



*When pulling the skew backward, it's difficult to keep the bevel in contact. When the bevel contact ends, the catch begins.*

**FIG. 14.12** ***A recipe for a catch.***

when turning beads, it can be difficult to notice, but every bit as troublesome.

Cutting with the skew held in a constant position will only shave the high spots. This is good because it helps level the surface. But it does go against our innate desire to see the tool cut, so folks tend to "back up" to get a missed area. In this reverse motion, it's difficult to keep the bevel in contact, and when the cutting edge makes unsupported contact, it grabs and overpowers the tool. So moving forward, regardless of the shavings, is the key. You can always return to the beginning of the movement and, with subsequent passes, the surface will get more fluid and the shavings more uniform.

The other time this is a problem is when you try to hold the skew in a fixed spot while trying to find the best way to engage the cutter. While the subtle movements might seem harmless, the tool can engage too quickly, causing a catch. Instead, always move forward, even just a little, when engaging the cutter. Besides keeping the tool moving forward, there are a couple of motions that control the skew. One is the rotation of the tool, and the other is the position to the left or right that you swing the handle. These two motions work together to position the cutter for cutting. Learning the effect of coupling and adjusting these motions is the key to getting the tool in the position to cut safely.

To safely bring the skew to the work, it must be introduced high enough on the round so that the edge is not in contact, or it will grab immediately, pulling the point of the tool downward until it catches in a dramatic fashion. To start safely, place the shank of the tool on the tool rest and workpiece. Then retract the handle slowly as you move the tool down the length of the workpiece to the level where it can cut.

I like to hold the tool so that the edge of the blade is at around 45° to the axis of the workpiece and rotated so that the cutting is taking place just below the midpoint of the blade. If the tool is presented perpendicularly to the workpiece, the toe and heel are both dangerously close to wood, so when cutting begins, it's tough to manage because it quickly takes a wide shaving. On the other end

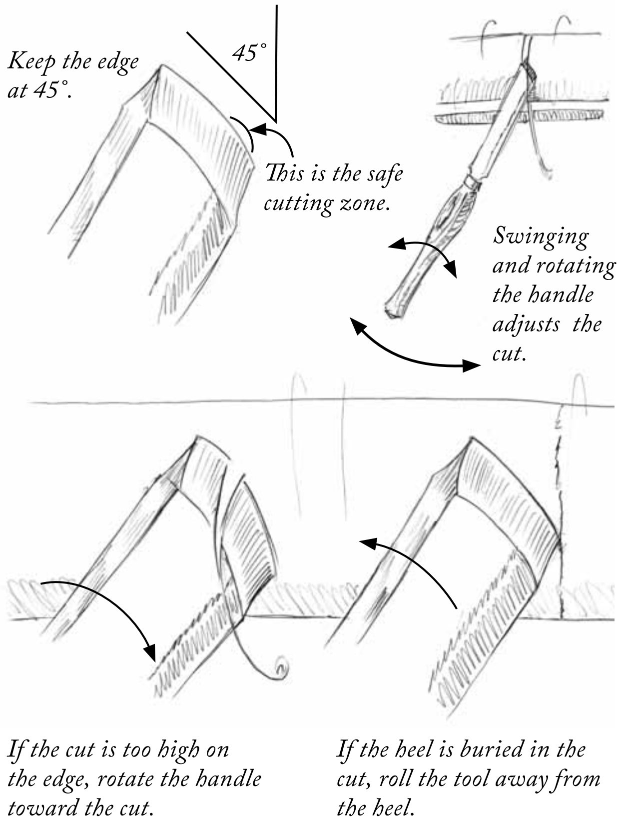



**FIG. 14.13** ***The basics of skew control.***

of the spectrum, if the tool is presented at too much of an angle to the workpiece, the toe and heel are safe from contact but the contact point on the tool rest is far out of line with your support and it's easy to become overpowered.

The best solution is somewhere between, but a few moments trying the extremes will give you a feel for the benefits of the correct angle. If you have a friend in the shop, have him or her turn the workpiece by hand so that you can get used to the cutting action of the skew, or set the pressure from the tailstock light enough that any misstep will cause the drive center to disengage so that the piece stops spinning.

This is best done when using a steb center, which is shown in The Chairmaker's Workshop chapter.

Another problem when cutting with the skew is resolved through body movement. It's easy to tense up with this tool and rely on a death grip. This grip encourages everything below the waist to lock so the motion of the body no longer follows the axis of the turning, but

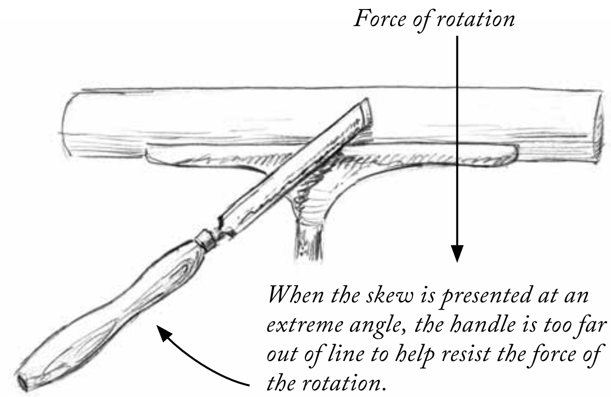



**FIG. 14.14** ***When the skew is angled too far, you can lose control.***

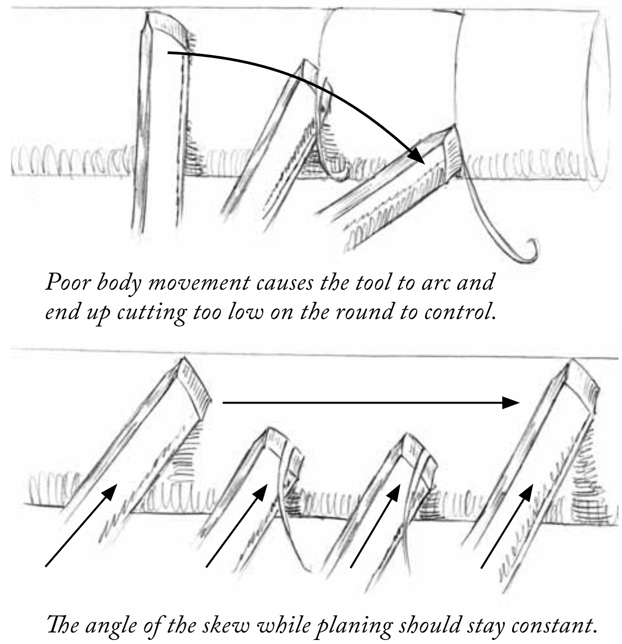



**FIG. 14.15** ***The angle of the skew should remain constant through the cut.***

pivots at the waist. To remedy this, folks usually present the tool nearly perpendicular to the workpiece and end the cut with it far too parallel to the workpiece.

This motion means that the presentation of the tool is always shifting. And as the cut progresses, the tool drops down the round and becomes difficult to control until you finally rotate it enough to come up off the bevel and again, it catches. To remedy this, practice holding the back of the handle against your hip while moving the tool along the cylinder at a constant angle. It requires a lot of body movement to keep the angle of the tool constant.

The final issue with planing with the skew is safely ending a cut. This entails a movement that feels unnatural at first, which is to push the tool back up the workpiece, taking a lighter cut, until the edge no longer contacts. The problem is that the natural tendency is to pull the tool; that acts to lower the cutting edge, which takes a deeper cut! It takes time to change these habits, but they can all be practiced with the lathe turned off until you are comfortable with them.

***The V-Notch Technique.*** One of my favorite techniques is the V-notch because there are very predictable results to doing it wrong, and finding the zone of success in between wrong and right is a real eye-opener. Even though it isn't going to be in every turning you do, the techniques involved in making a consistent V-notch are found in nearly every type of turning. What makes this cut so universally important is twofold.

First, it begins by entering the cut without being in contact with the workpiece. Unlike when using a gouge for shearing or a skew for planing cuts, the position of the tool as it enters the cut is solely up to you, with no physical contact with the workpiece to start you off. The key to entering the cut safely is in keeping the rotation of the tool aligned so that the outer bevel travels in the same plane as the motion.

And secondly, the V-notch depends on your ability to ride the bevel on a small surface that is not parallel to the axis, which is the same motion found in the beginning of cutting a cove and the end of cutting a bead.

The essential factors in making a successful V-notch are the angle that the tool is held in relation to the axis of the workpiece, the rotation of the tool and the motion of the tool as it enters and completes the cut. Problems with this cut originate with one of these three variables.

Position the skew at an angle to the axis of the workpiece so the outer bevel of the tool is at the same angle as the sidewall of the resulting V. The bevel should also be rotated away from the center of the V so that the edge points to the point at the bottom of the V. When presented this way, the tool will nicely track right into the correct position. But folks tend to hold the tool at an incorrect angle and try to make up for it by over-rotating the edge.

This leads to predictable results. If the tool is rotated

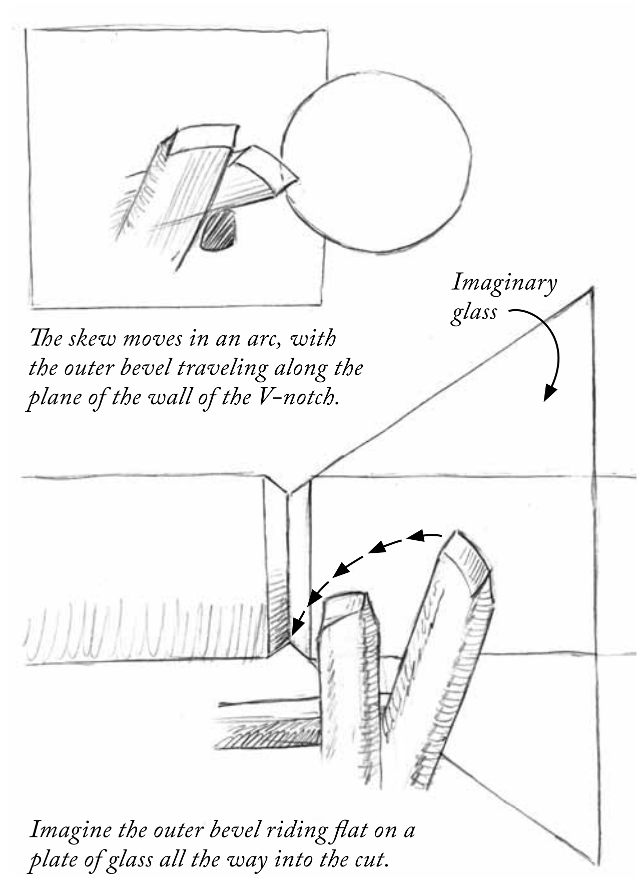



**FIG. 14.16** ***The correct path to cut a V-notch.***

too far toward the vertical, it will "jump" toward the center of the V when it makes contact. If it is rotated too far toward the horizontal, it will corkscrew down the side of the workpiece. As odd as it sounds, I recommend practicing both of these problems until you no longer fear them and can recognize the role that the rotation and angle of the tool plays.

The other issue stems from movement of the handle and from the path of the tool. As with planing, the skew must constantly travel forward; any hesitation and stalling gives the tool a chance to rotate as mentioned above. The motion should be like a karate chop. The cutting edge should move in and down in one fluid motion. The urge to dramatically adjust the angle or rotation of the tool during this motion must be resisted. If anything, a very slight movement of the handle and rotation of the tool toward the center of the V will help it ride on the bevel and safely to the apex of the V. Making several deep

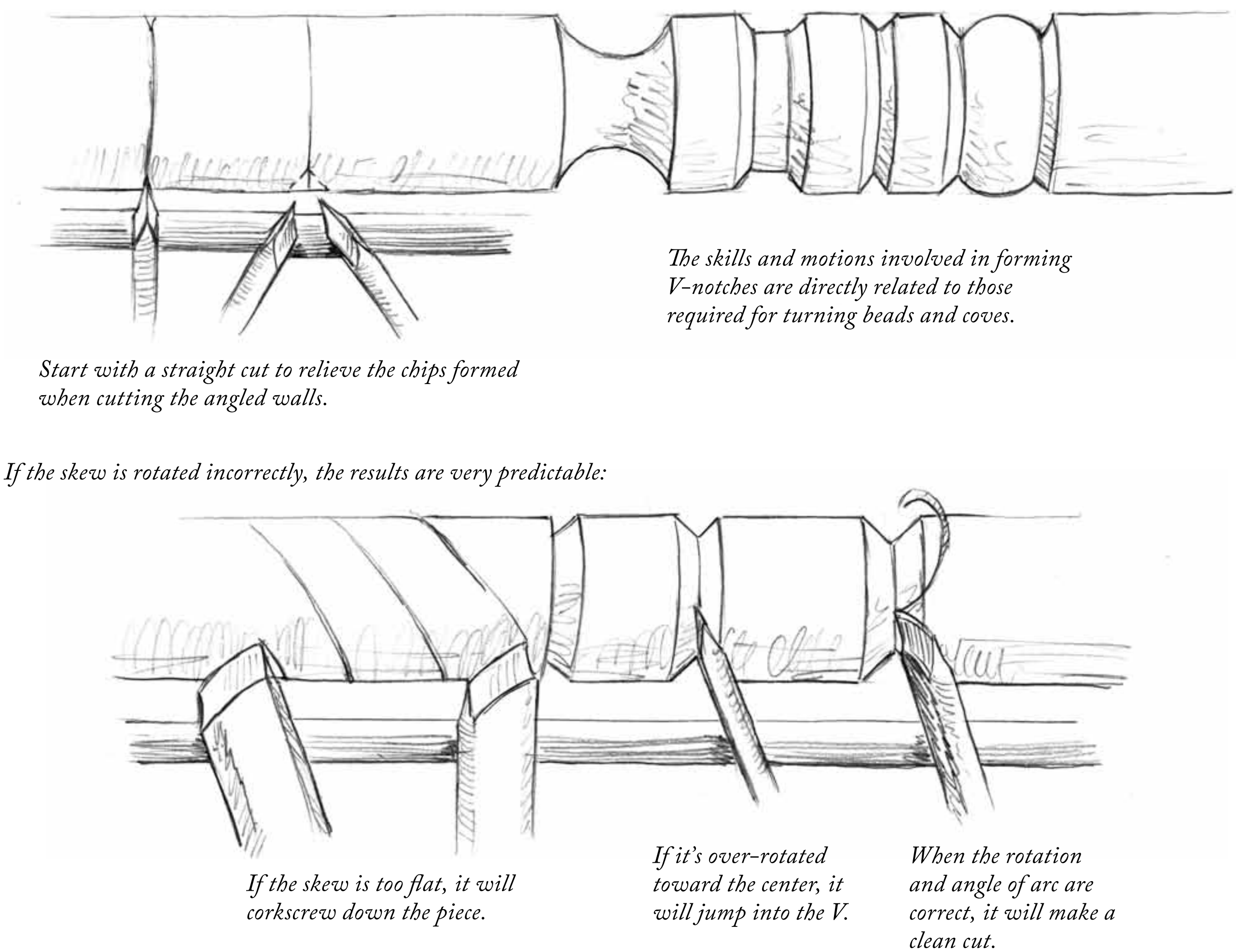



**FIG. 14.17** ***How to orient the skew when cutting a V-notch.***

V-notches in a row, one side at a time, will help cement the tool angles and body motion.

**CUTTING BEADS WITH A SKEW CHISEL**

Cutting a bead with a skew is easy if you think of it as starting the cut like you are planing and then rotating to end the cut like a V-notch. I use the heel of the skew, while I know others who have great success using the toe. The process is to make V-notches to define the sides and size of the bead, take a small cut on the corner with the heel of the skew, then back up to take another pass from closer to the center. Make several passes like this that remove a bit more of the curve each time.

I always leave a nearly imperceptible flat on the center of my beads so that I have a good starting point for both sides of the cut. I begin the cuts by lowering the skew on the flat into position to cut just to the side of the center. When the edge is almost contacting the workpiece, I roll the skew and lift the handle. With each pass, the rotation of the tool will become closer to vertical at the end. To stay in contact as you roll around the bead, you will have to shift the handle away from the center of the bead as you cut.

While this may seem nearly impossible, I've found that the way that I grasp the skew has a great deal to do with my success. If I have a comfortable grip at the beginning of the cut, then I will become increasingly uncomfortable as I cut. A better solution is to grip the tool so

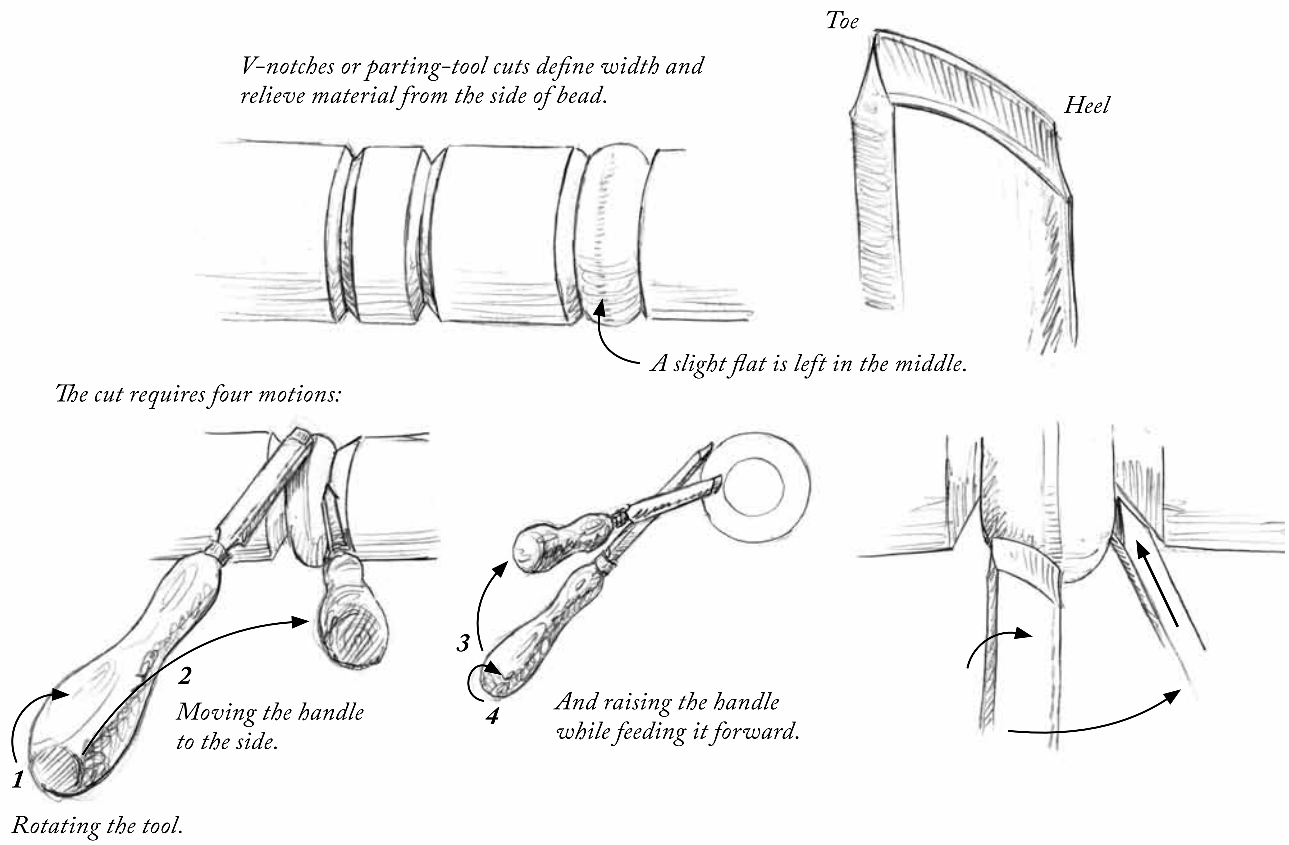



**FIG. 14.18** ***Cut a bead with a skew (tool rest omitted for clarity).***

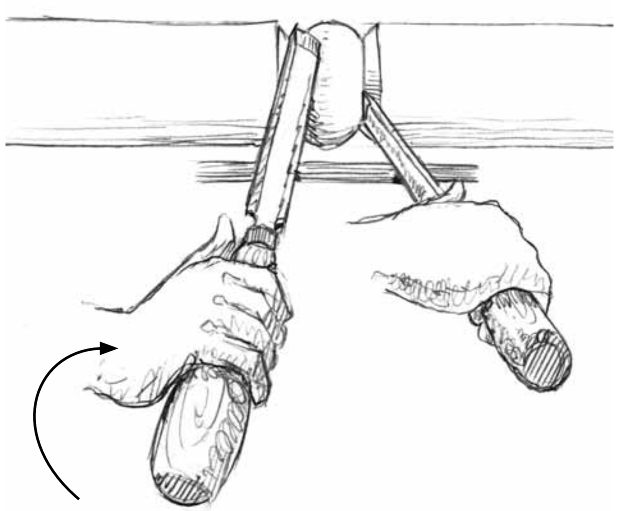



**FIG. 14.19** ***Plan your grip so you are most comfortable at the end of the cut.***

that you will be comfortable at the end of the cut; that way you will be moving from discomfort toward comfort, which is a natural tendency that guides you to the end position. Practice with making curved V-notches can be invaluable to perfecting this motion.

One problem I see that most folks have is they have trouble moving the handle sideways enough to keep the tool at the correct tangent to the bead as it rolls. Because the sideways movement isn't natural, usually due to poor body position, the turner will try to keep the tool cutting by rolling it more. This effectively puts the handle ahead of the cutting edge, causing the bevel to lose contact; this predictably causes a catch.

If you have this problem, try sliding the handle more sideways on the toolrest and rolling the tool less. The edge might lose contact with the bead, but you can safely follow through with the motion and return for another pass with a subtle adjustment in technique. If you are turning with your dominant hand only, be prepared that when turning the opposite side of the bead from your dominant

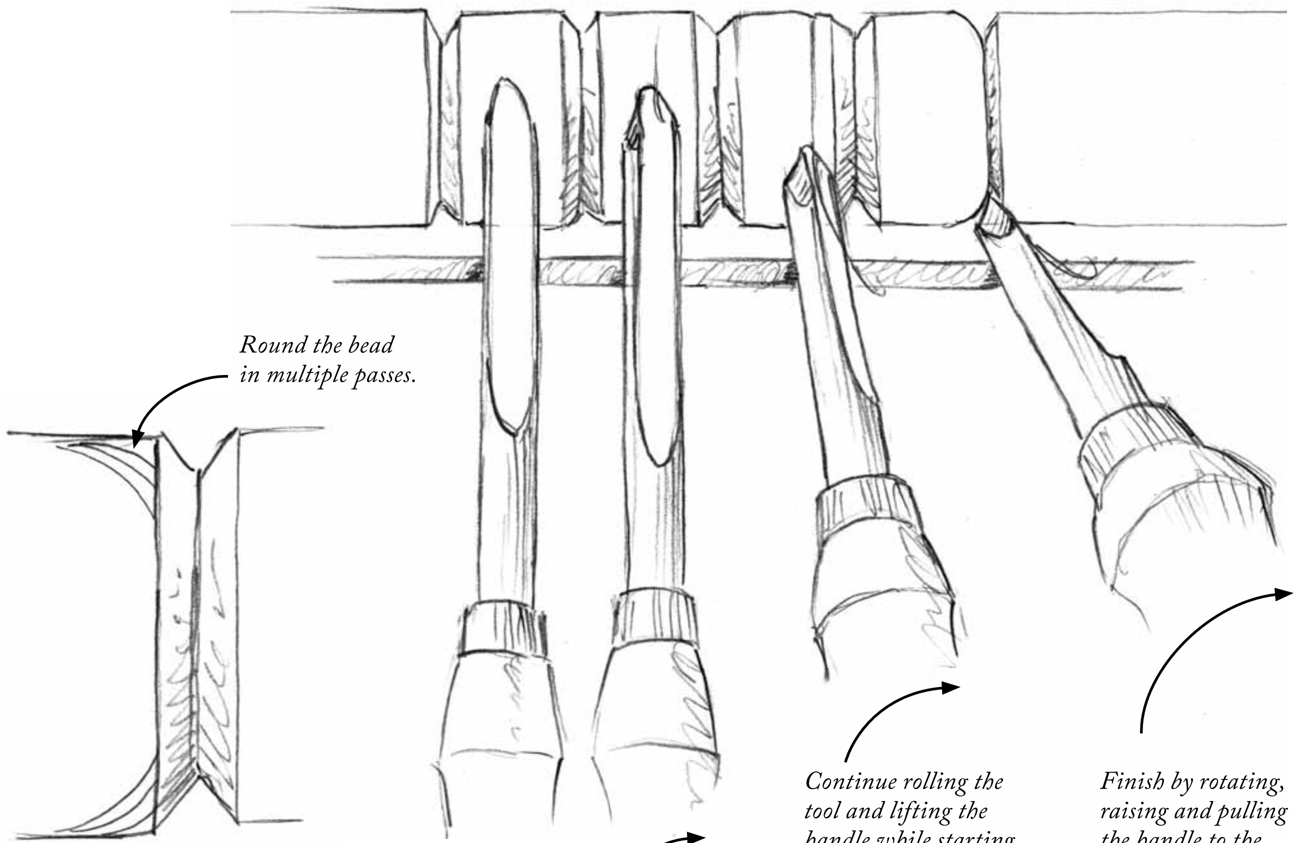



**FIG. 14.20** ***Cut beads with a spindle gouge.***

hand, it will be more difficult to get your body out of the way enough to move the handle enough to the side. Often it takes a lot of body motion to allow the cutting edge of the tool to move a small distance.

### CUTTING BEADS & BULBS/SWELLS WITH THE SPINDLE GOUGE

Most of the time I rough out my beads with the detail spindle gouge and finish them with a pass from the skew. As I showed above, the skew cuts beads fine, but I like to keep my skew for final finishing, and I find that the detail gouge is easy to control while hogging off material. The cutting action is similar to cutting a bead with a skew, but instead of the flat skew bevel, you use the area just to the right or left of the center of the curved blade. I always try to keep the same spot of the blade cutting throughout the process.

The process is the same as with the skew in that you begin with the blade in a neutral position and end up rolling it around the bead until the gouge is rotated sideways and the handle is pulled far enough to keep the bevel at a tangent to the bead.

Begin near the corner with the blade in a neutral position and roll the cutter across the corner while you raise the handle. Subsequent passes remove more material and increase the rotation and raising of the handle. As the bead becomes more complete, you will have to shift the handle farther away from the bead and feed the gouge deeper toward the axis to maintain contact with the side of the bead while raising the handle. Always return to begin each pass from the neutral position on the top of the bead. Again, position your grip so that the most comfortable point in the motion is at the end.

Cutting a "swell" or "vase" is similar to cutting a bead; actually, the lower half is just a portion of a large bead. But the top part starts out as a bead then reverses into a very shallow cove. I like to use the roughing gouge for this. To cut this, begin rolling like you are cutting a bead, but instead of continuing to rotate the gouge around toward being vertical, stop rotating at about 2 o'clock and keep cutting in that position; then roll back to a neutral planing cut to reverse the shape.

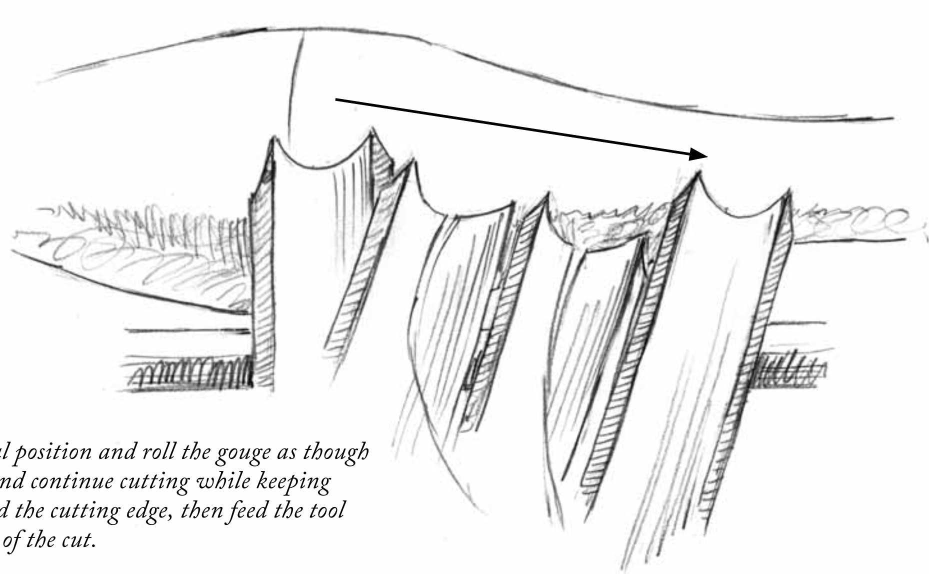
Coves are the only part of my turnings that I start and finish with the same tool: the detail gouge. There are really two things going on during the forming of a cove: excavating the material from the center and creating the shape of the cove. My strategy is to use the detail gouge to create a V-notch from the edges of the cove to the desired depth in the middle. This way, when you cut away the material from both sides, it detaches freely and doesn't resist the motion of the gouge as you take a series of cuts. The cutting takes place just to the side of the center of the tool as you slice toward the center of the V. If the tool is rotated too much toward the center it will dig too much. If it is not rotated enough, it will catch and corkscrew like the skew.

Once I have the V-cut, I hollow each side of the cove. The motion is a lot like cutting the V-notch, but instead of maintaining a single rotation throughout the cut, you roll the tool in the reverse order that you would for turning a bead. Start as though you were just making another pass for a V-notch, but start with the tool rolled more toward the center of the V to make it dive for a deeper cut. Roll it back to come out of the cut as you feed it toward the center of the cove. As the shape is refined, the edge of the flutes will be rotated completely vertical at the entry and horizontal at the end.

The cut ends by rolling the gouge until the sides of the flute are horizontal and then feeding the cutter forward until it rises back onto the bevel and comes safely out of the cut. It's important to exit the cut before you encounter the end grain that's exposed on the other side of the cove.

I repeat this for the other side. A series of light cuts will give you more control over the tool than a single deep hogging cut.

After a little practice, you will soon see that a few tools and the shapes they make are all that you need to execute a vast array of designs. Simple elements can add up to complex and pleasing shapes, especially once you learn to link them together, both in process and aesthetically.



*Start in a neutral position and roll the gouge as though turning a bead and continue cutting while keeping the handle behind the cutting edge, then feed the tool forward and out of the cut.*

**FIG. 14.21** ***Cutting a vase shape with a gouge.***

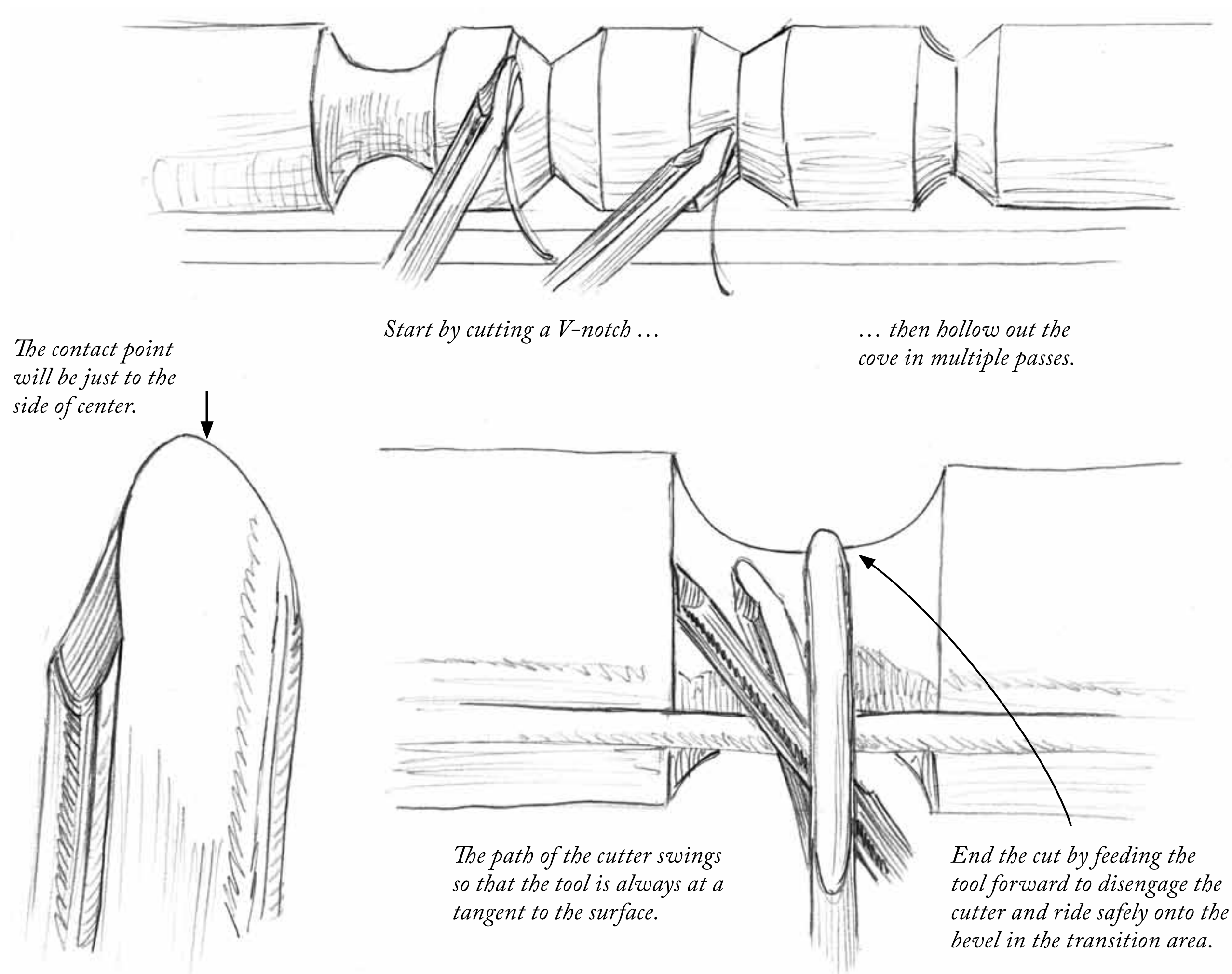



**FIG. 14.22** ***Cut coves with a detail gouge.***

While understanding the path that the tool must follow is half the battle, the other is learning to use your body as the vehicle.

## Conclusion

Of all the skills involved in chairmaking, turning sits apart. It is a separate skillset and will take time to master enough to keep pace with the other skills. It isn't unusual for someone to make fantastic spindles and carve a lovely seat but pair them with poor looking turnings. At first, your turning skills will likely improve quickly, but then plateau as you work to master the skew and more complex shapes.

I am a firm believer that chewing up a piece of wood for 20 minutes a day is more productive than spending eight hours cursing at a spinning piece. Progress is made in small increments and multiple moods, so it is important to be patient. I recall setting aside six or eight blanks in hopes of getting four decent legs and it taking the better part of a day. In time, I've improved my rate of success and time, which is a bit of a catch-22. I am usually just starting to really have fun when my fourth leg is done, and I have to turn off the lathe and go on to the next task.

# 15

# Turning: From Rough to Finish

The association between lathe turning and Windsors runs deep. When describing a Windsor chair to someone, the "ornately turned legs" often pinpoints the style in their mind. Turning is an ancient method for shaping wood that has seen little improvement (the motor is one) in centuries. It is the fastest way to transform rough wood into finished parts with perfectly sized joinery. Entire books have been written about the various techniques of creating the shapes so often associated with the Windsor style. For our purposes, though, there is some specialized knowledge that comes with turning chair legs from split wood that is worth highlighting. At the end of this chapter are options for making legs and parts with limited or no use of a lathe.

## Turning Design

The origin of a chair can often be traced county by county based on the style of its turnings. Whether bold and voluptuous or sleek and reserved, the turnings create a distinct attitude. The earliest American Windsors had baluster turnings in what would most likely be labeled as "high style" for the Windsor. When presented with a Windsor chair that doesn't have baluster turnings, many viewers will question whether it's a Windsor at all, which shows how deep the association between the balusters and Windsors runs. There is a basic order of the elements found in most balusters, but the size of the parts and variation between thick and thin areas give a lot of opportunity for personal expression.

After the early 19th century, the influence of Asian art can be seen in the simpler forms and "bamboo" style. While the baluster might be "high style," I think that sleek double-bobbin and bamboo-style turnings fit well with a wider range of decor, which may have added to the breadth of interest and longevity of the form.

This chapter will guide you from preparing stock to turning parts and joinery. For more information on turning tools and technique, look to the chapters Turning Tools as well as Turning Practice.

## Stock Preparation

Making successful turnings has as much to do with preparing material as with using sharp tools and good

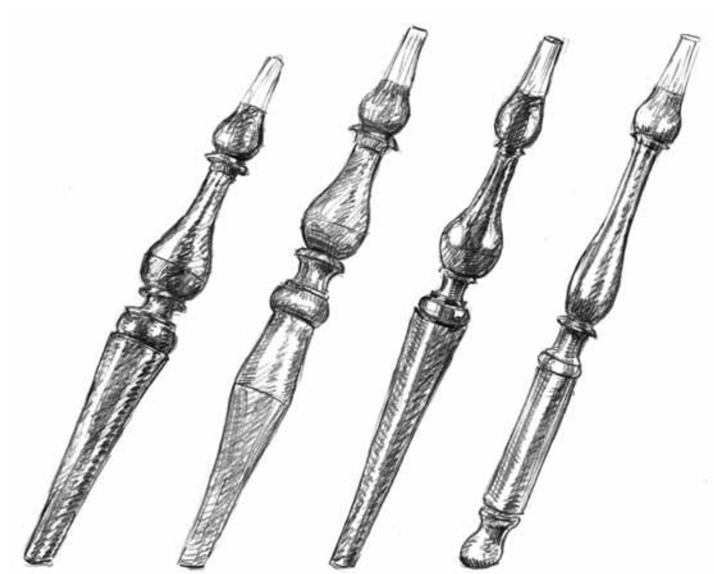


**FIG. 15.1** *Some sample Windsor baluster leg turnings.*

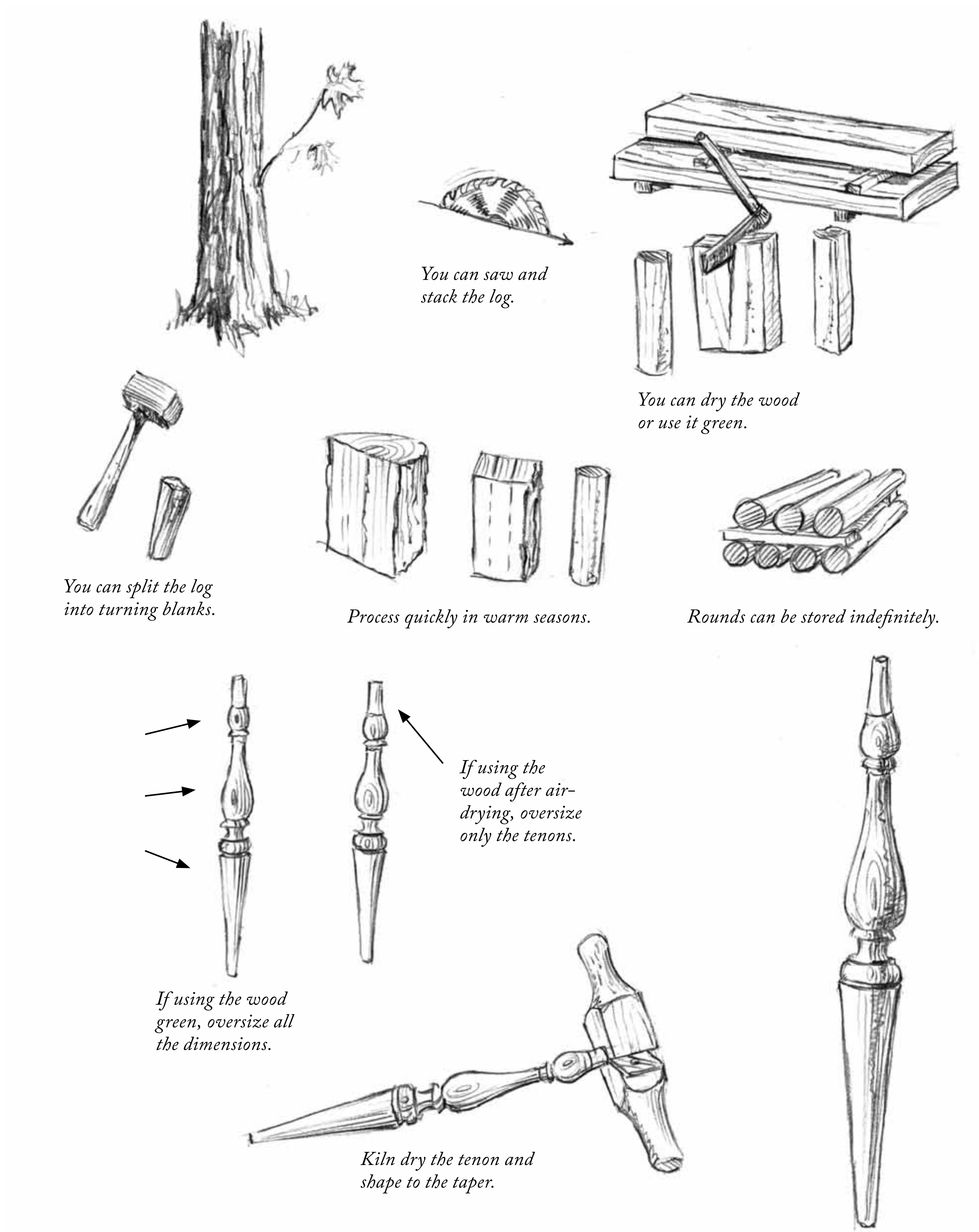



**FIG. 15.2** ***From the tree to a finished turning.***

*Ready to assemble*

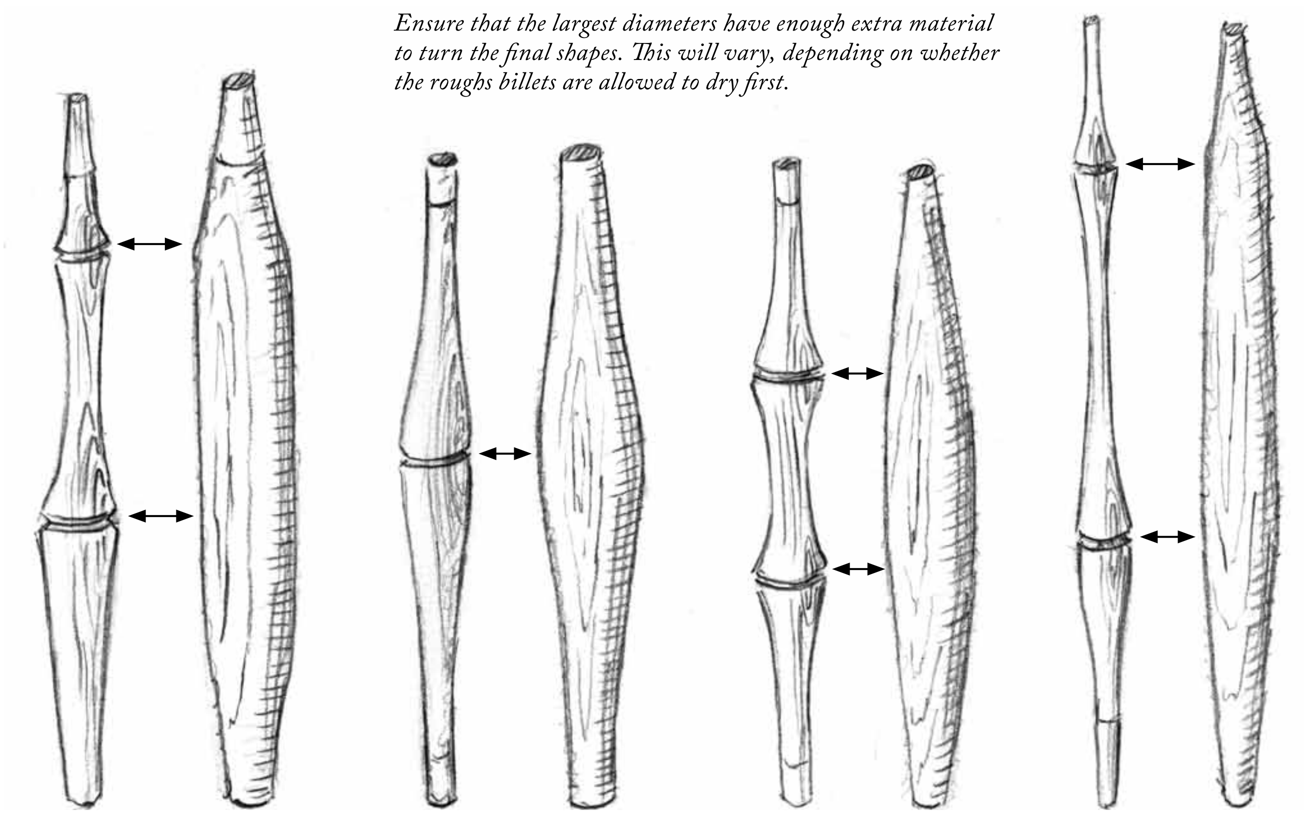



**FIG. 15.3** ***Keep the final shape in mind when rounding your green billets.***

technique. While starting with a straight tree is the first step for all of the parts, there are many different paths to processing the wood for turning. You can split or saw it, you can turn parts green, or dry them before turning. It depends mostly on issues surrounding storage, time restraints and personal preference.

Regardless of path you choose, the end product should achieve three important results:

• For strength, the parts should be made up of straight fibers that run from one end of the piece to the other.

• During assembly, the portion of a turning that will have a mortise should have a higher moisture content than the tenon that will join it.

• The tenon portion should be kiln-dried when it is sized, shaped and assembled.

There are many routes to meeting these requirements, and none is wrong as long as you find the process convenient and the joints are formed and assembled when the wood is at the correct moisture content. But don't get overwrought about moisture content; you don't need thick pamphlets or confusing charts to get the job done right.

When drying the small tenon ends of roughed parts, it takes only a few days to dry green wood enough to go into the kiln and then just a few more until it stops shrinking. I measure the shrinkage across the tangential plane periodically until it stabilizes, which is accurate enough to know when to stop the process. I rarely shape the final turnings from green wood due to storage and movement issues, but my process always begins with green wood, so I will start the explanation of the sequence of turning and drying from the log. There is more information on wood selection in the Woods for Chairmaking chapter and splitting technique in the Splitting Parts from the Log chapter.

Wood can be stored indefinitely once air-dried and suit all chairmaking needs, so if processing the parts is ever confusing, just remember that air-drying a part, or a lot of parts, is always a safe bet.

If you have never turned green wood, then I highly recommend you try it. There is no way to describe the fun of making shavings peel like a ribbon and pile at your feet as you glide along. Like bending wood, it's a rare moment where the interaction with the wood transcends all expectation and sets a new awareness for this amazing material and process.

When starting from a log, I either split out the parts or have the log sawn into planks of varying thickness. If I am having boards sawn, I sticker and stack them to dry and use them whenever I need them. If I am splitting billets from the log, I consider the season and, if necessary to avoid spoilage, process the entire log into rounds for later use. There is more information in the Splitting Parts from the Log chapter.

I split billets about 3⁄8" to 1⁄2" oversized, then I cut them to an appropriate length and turn them round. If I am going to let them air-dry before completing the final shaping, I will round them down to about 1⁄4" oversized, which should allow me plenty of room to turn them to round after they shrink to oval while drying. Because all of my turnings have ends with reduced diameters, I turn my blanks with tapered ends, which allows the end grain to be exposed down the length of the piece. This helps the parts dry fast and evenly, especially at the ends where they are sized for joints.

If I am going to turn a part to its final shape while the wood is still green, I oversize all the dimensions on the design pattern of the details at least 1⁄16" to allow for shrinkage. The parts with a larger diameter will shrink more, so you might consider stepping them up a bit more. For the cylindrical tenons on the ends of the stretchers that will end up 5⁄8" diameter (.625"), oversizing them to .680" (about 11⁄16") is a safe amount.

**PROCESSING LEGS**

Once the green leg is rounded, I set it aside to air-dry for a week or two, then I selectively dry the tenon end. I place the roughed round upside down and put the tenon end in holes in the top of the kiln. Once the tenon ends are dry, I turn the entire leg to finish size and shape. I either turn the tapered tenon at the lathe or finish it with a rounding cutter.

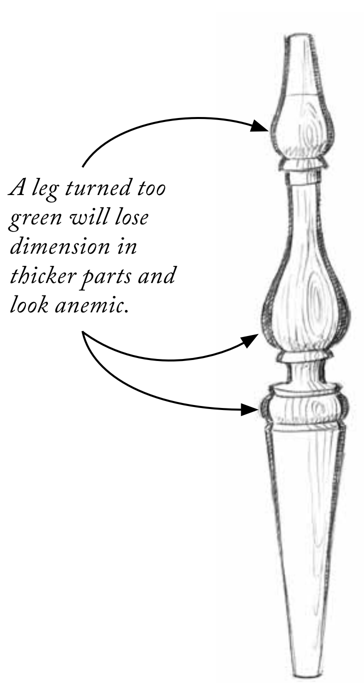



**FIG. 15.4** ***The larger diameters will shrink more as they dry.***

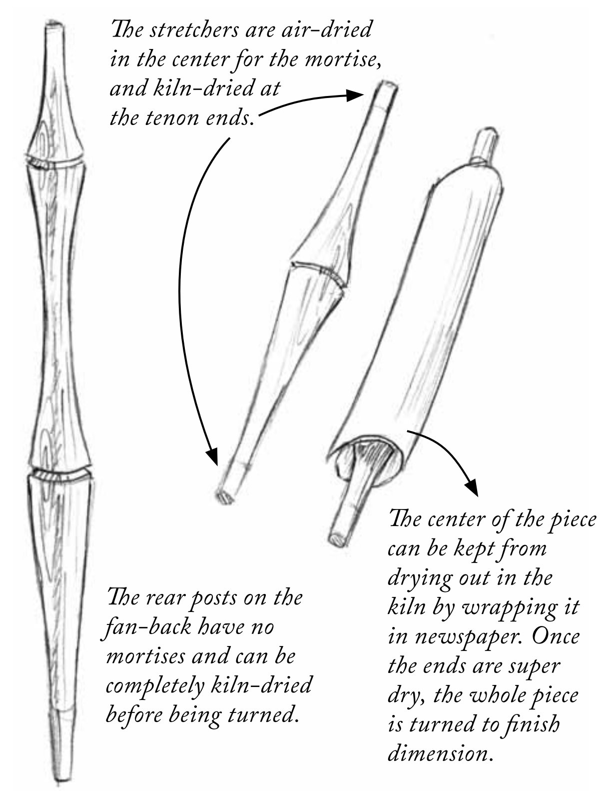



**FIG. 15.5** ***Some parts should be selectively kiln-dried for joinery.***

If you turn the leg while it is fully green, you can leave the tenon oversized and shape the tenon after kiln-drying it. Once it is dry, either re-chuck it in the lathe to turn the tapered tenon or cut it with a hand-held rounding cutter. The leg often warps a bit while drying, which might eliminate the lathe as a choice for forming the tenon.

**PROCESSING STRETCHERS AND POSTS**

For the stretchers for the project side chairs, I rough-turn 16"-long blanks and allow them to air-dry. For joinery purposes I want to maintain higher moisture content in the middle portion while drying the tenon ends. Therefore, I wrap the middle portion of the turning with foil or newspaper before placing it inside the kiln. The ends will dry noticeably oval-shaped. Once the stretchers stop shrinking, I cut them to length for the chair I am building and chuck them in the lathe for final shaping and tenon sizing.

There are some turned parts for the chair that have tenons on both ends and no mortises, such as the rear posts for the fan-back or the center stretchers. They tend to be thin parts, and I usually prefer to turn them from stock that I've kiln-dried. I rough down the stock and air-dry it before placing it in the kiln until it stops shrinking.

By turning the parts after drying them completely, I am assured of correctly sized tenons. Also, I've found that the fan-back stiles, with their thin diameters, tend to warp more if you turn them green or even air-dried, which makes turning the joints after drying nearly impossible.

## Roughing

Once the billet is ready to rough, I mount it in the lathe. The process that turners usually follow with preparing sawn blanks is to cut them square or octagonal, which makes locating the centers a snap. With a split billet, the part is usually somewhat uneven in shape and takes a slightly different process to mount on the lathe.

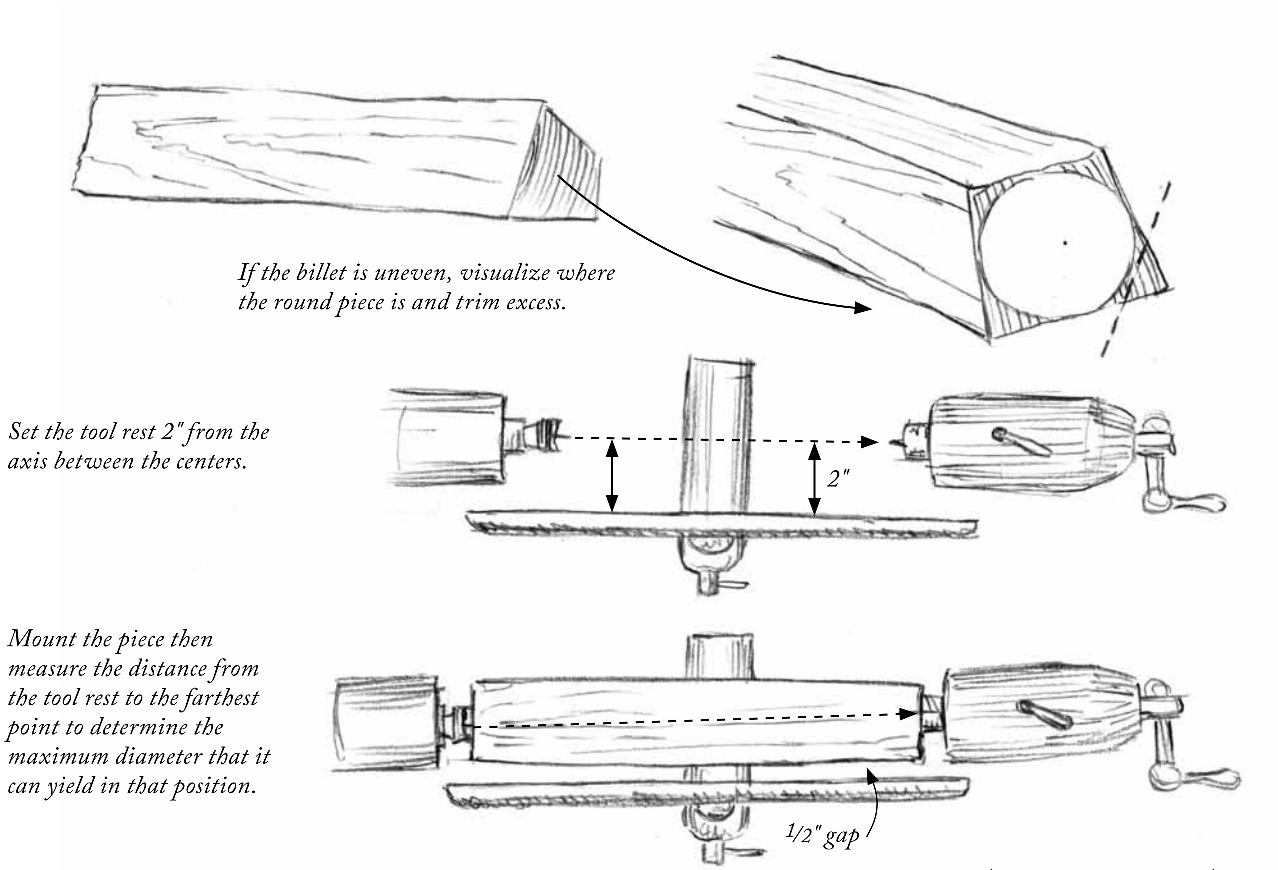



**FIG. 15.6** *How to position the billet on the lathe with the help of math.*

To ease the process, I hew away the larger corners of the billet with a hatchet, or I shave them with a drawknife. This can also help when centering the piece and prevents pieces from flying off in chunks. It's also a good idea to look for loose strips of wood that whip around and lash your arm. If you don't find them first, they will surely find you.

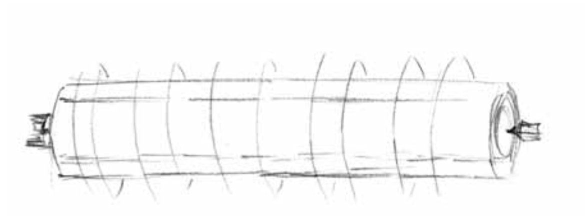
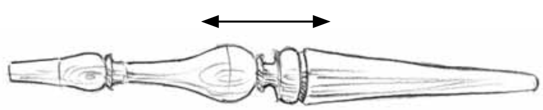
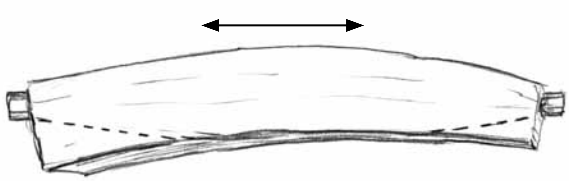


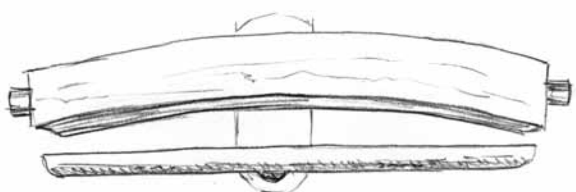
**FIG. 15.7** ***The "ghost" of the blank reveals the largest round diameter.***



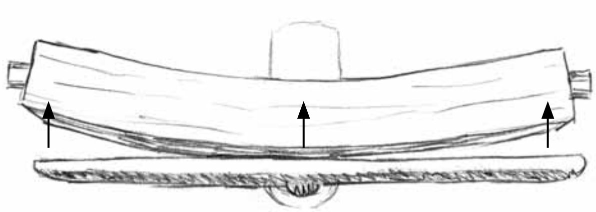
*The largest diameter is in the center of the leg.*



*Mount the piece to maximize material in the center.*



*Rotate the piece to check the difference between the sides.*



*In this case, shift the piece away from the tool rest.*

**FIG. 15.8** ***How to deal with mounting a curved part on the lathe.***

There are a couple of methods for accurately centering a billet. Setting the tool rest at a known distance parallel to the axis of the lathe can provide a mathematical option, or it can simply be a good reference for judging as you mount the billet.

The mathematical method is simple: Set the tool rest 2" from the lathe's centers, then put the blank in the lathe on what you assume to be close to center. Measure the distance from the tool rest to the blank at the farthest spot and subtract from 2". This gives you the largest radius of the blank that can be turned in that position. If the other points are much closer to the tool rest than the one you measured, shift the position of the blank to make them more consistent.

I don't usually bother with the math unless my blank is dangerously close to my final size. My preference is to start with a blank that is slightly oversized and chuck it in the lathe. I then compare the distance from the tool rest to the billet as I spin it by hand to make sure there is no great difference in the gaps from one side to another. As I spin it by hand, I check that it isn't too out of balance and make sure that the whole piece clears the tool rest. Then I turn on the lathe and watch the "ghost" image of the round.

If the round is too misshapen to spin without lots of vibration, I trim the offending corner with a hatchet or drawknife.

Remember, there are usually at most two areas that have the largest diameter, so the priority is making sure that the billet is centered best in those areas to achieve this. If the piece is curved, most chair parts will require that the middle be larger, so mounting it as shown will yield the largest diameter in the middle and reduce the "wobble." Most pieces can be balanced until they have minimal vibration.

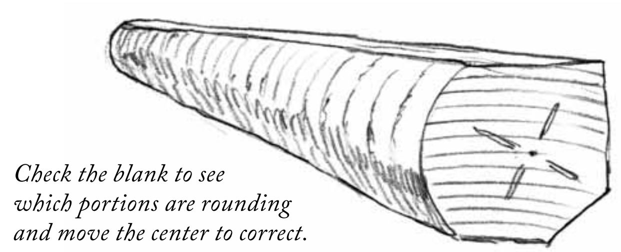



**FIG. 15.9** ***If you find you are cutting only one part of the billet, shift it in the lathe.***

Once I start turning the billet, I check to see that all of the surfaces are being rounded equally; if they are, I shift the part to bring the sides that aren't being cut closer to the tool rest.

I've seen lots of folks recommend roughing down at slow speeds, and it does seem less intense, especially with misshapen billets. But I prefer rounding down at a higher speed, which seems to make taking light cuts easier and more productive. Start spinning the piece at a low speed to make sure that no chunks fly off, but once you are ready to cut, speed it up.

Rounding down rough-split billets can be daunting because of the irregular shape and tendency for chunks of wood to "pop" off. A series of small "crosscuts" with a gouge can help reduce the tendency of any split to run. You can also reduce any problems by first turning the blank to a slight taper.

I start near the middle with the gouge on the tool rest, then draw the handle back and up until the bevel of the gouge makes contact. There will be an intermittent knocking on the bevel of the gouge at this point. Then I continue to retract the handle and lower the cutting edge of the gouge until it takes a light cut, at which point I move it toward the end of the piece while cutting a bit deeper as I go. Repeat this step, starting farther back in the uncut portion and following it to the end until you have knocked the corners off the whole workpiece.

From then on, it's safe to take deeper cuts from the large end and round down the whole piece. Always cut from the large diameter to the smaller diameter to ensure that you don't split out a large chunk.

While rounding down blanks, I always keep the pattern for the final part handy so that I can make sure the diameters don't get too small in the critical areas.

## Measuring

There are a number of ways to measure diameters when turning. The basic concept is to use a tool that compares the diameter to a fixed distance on a tool. It's usually a "go/no-go" gauge of some sort, either a notch of the desired size cut into a thin piece of metal, a wrench with a fixed opening or (my least-favorite choice) spring calipers. In each case, the tool is held lightly against the back of the spinning piece while the diameter is sized. When the gauge slips over the workpiece, you stop cutting. The

*Create a slight taper and always cut toward the small end.*

*Make a series of shallow gouge cuts to break up the long fibers into a series of short sections to prevent any splits from running too far.*

**FIG. 15.10** *How to safely rough blanks.*

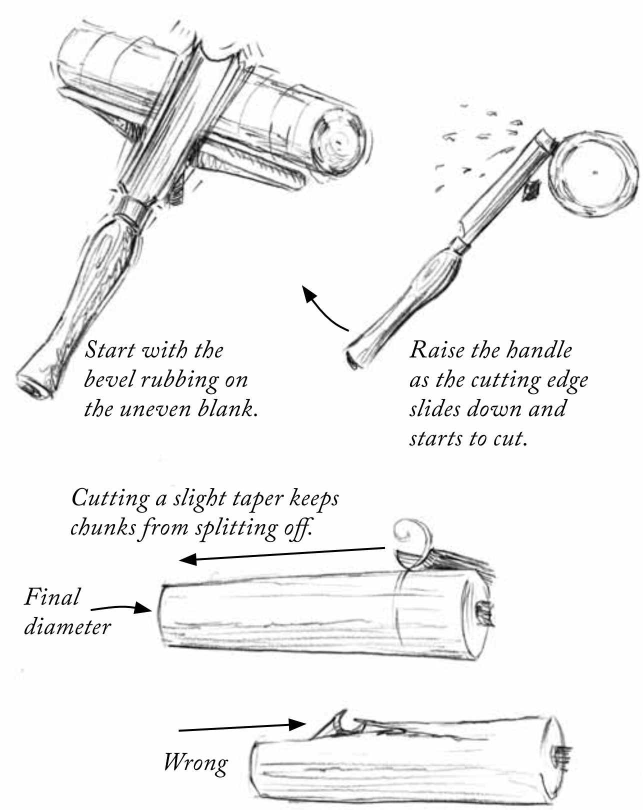



**FIG. 15.11** *How to start roughing a billet and avoid removing large chunks.*

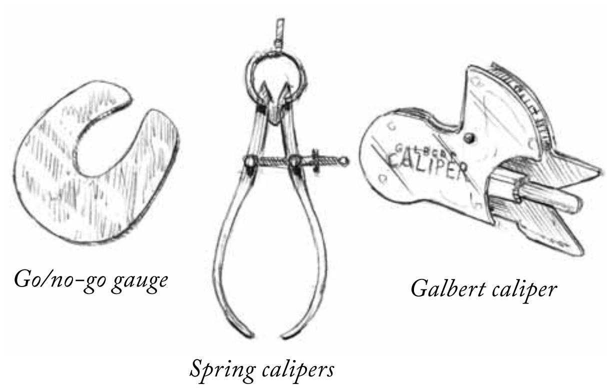



**FIG. 15.12** ***Three ways of measuring diameters.***

fixed gauges work well, but the spring calipers tend to flex or vibrate out of their setting. Perhaps the greatest drawback of all the go/no-go-type gauges is having to set them or organize and switch them out in the correct order. It only takes using the wrong gauge once, ruining an otherwise perfectly good turning, to get this point across.

I use a gauge of my own design that measures and gives a reading of the actual diameter of the piece as it is being turned. When the scale on the front of the tool shows the desired diameter, you stop cutting. The added benefit of knowing how much material needs to be removed during the process allows me to cut aggressively until I approach the desired diameter, and then slow down my cutting for accuracy. Coupled with benefit of never having to set or switch gauges, I became convinced of the merit of this gauge and now produce them commercially under the name The Galbert Caliper. For beginners, a simple series of clearly marked go/no-go gauges will work fine.

## Layout

The ability to make a series of shapes add up to a successful turning relies on controlling the position and size of the details. To the new turner, this is tough because the focus on "not screwing up the shape" usually takes precedence over the size and position. Layout is more than just locating the diameters of the details, it's about formulating a game plan for the order of sizing and cutting them. A good plan also limits the number of times you have to change the tool you are using, and keeps vibration to a minimum by reducing the depth of cut for a given detail.

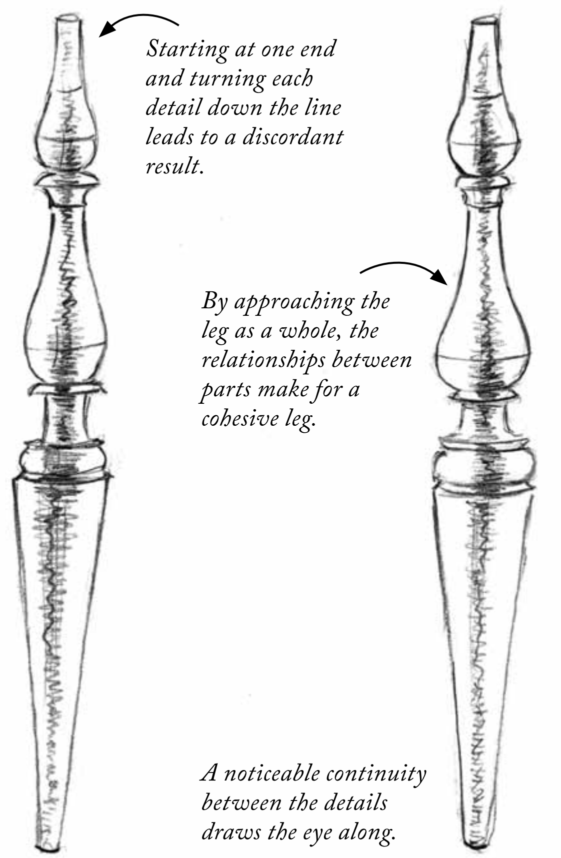



**FIG. 15.13** ***Different strategies for planning your sequence of cuts.***

The problem is that most new turners follow a simple plan: start at one end of the turning and turn each detail from left to right or right to left. This opens the potential for vibration because thin parts might be cut near the headstock; the force of the lathe rotation must then travel through the thin spot for the rest of the process. The other problem with starting at one end and working to the other is that any oversized or undersized detail will throw off the rest of the positions, making a mess of the design.

I plan a process that moves the whole turning along in stages. First I lay out and rough in the largest parts, then I lay out the finer, thinner details and refine all of the parts once I can be assured of their size and position. Experience will show which diameters are the most important to measure. Many details can be turned in relation to a nearby detail, saving lots of time. It's much like the

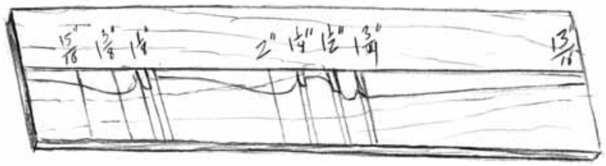


**FIG. 15.14** ***A typical turning pattern.***

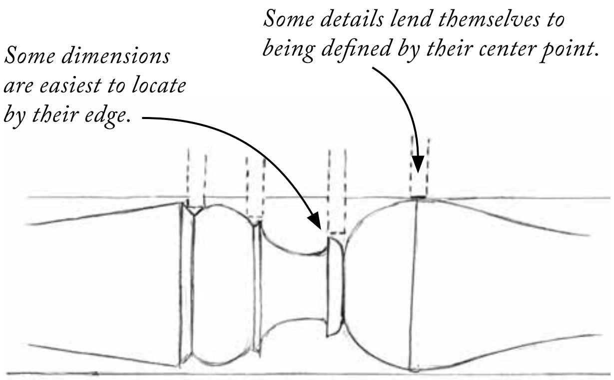



**FIG. 15.16** ***Create a layout using parting-tool cuts.***

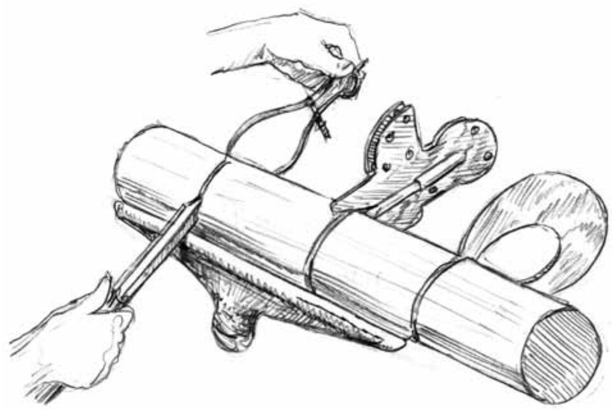


**FIG. 15.15** ***The diameter inside the parting-tool cut is measured from the back of the work.***

process for drawing a face. It's important to draw the head before you position the eyebrows.

I draw my turning patterns on wood templates that note the size and location of the major diameters of my designs. After roughing the piece slightly larger than the largest diameter (perhaps 1⁄16" or so), I mark the larger elements for the initial roughing.

My turning pattern has a number of diameters noted and a sketch of the basic shape. I use a parting tool to cut to the diameters.

It's important to come up with a consistent method of using and marking the diameters to know where the detail falls in relation to the parting tool's kerf. For example: Does the detail run to the middle of the kerf or stop at its side?

I've found that certain details lend themselves to a different approach to the kerf, so I use a simple notation on my pattern to relay this.

If you watched me turn 100 legs, you'd see that I follow the same order each time, having refined my plan to reduce vibration and ensure that I am not removing too much material with my parting tool. It can't be stressed enough that you should avoid excess force during the early stages of a turning. With a great deal of material to remove, it's easy to bear down on the workpiece. The tool can cut only so fast, and any excess pressure will stress the workpiece out of round, increasing the problems with vibration that can haunt you later in the process. Achieving smooth, chatter-free surfaces can be difficult (if not impossible) once excess vibration is introduced early on.

## Measuring for Joinery

Whenever you are sizing tenons, it is essential that you have a sample mortise drilled with the same bit, in the same material and in the same manner as you plan to use for the joint. A freshly drilled sample will also avoid

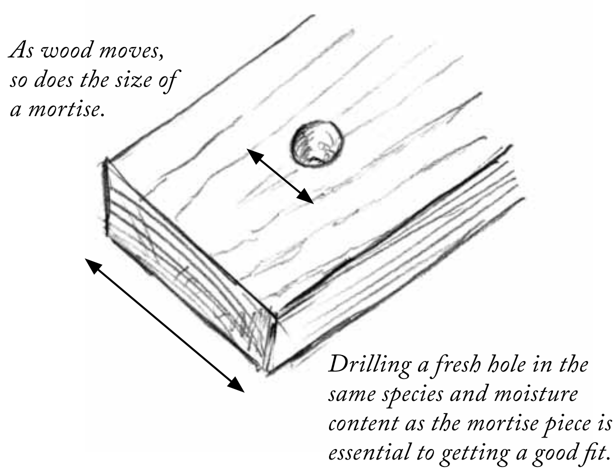



**FIG. 15.17** ***A freshly drilled mortise is better for sizing tenons.***

problems that can arise from shrinkage. A mortise allows moisture to escape freely from the interior of a part, which means that a mortise drilled last week will likely be a different size than when it was first drilled.

One simple method for turning accurate tenons is to use a wrench to test the size as you turn them. Be sure to use a wrench that has a gap that matches the drill bit you plan to use. If a test tenon is too small, carefully file the gap of the wrench until it matches the hole diameter. Then set this wrench aside so that it is dedicated to tenon sizing.

My preferred method when I turn tenons is a bedan sizing tool that I set to exactly match the mortises that I drill. There is a gap between the cutter and the sizing arm that I set to .625" (or whatever size hole my drill is making), and when the tenon fits between the two, I know that it is correctly sized.

It takes practice to keep from scraping with this tool or cutting too much material. First, I size the tenon within 1⁄16" of the final size. Then, using the bedan tool, I size a small area at the end of the tenon and check that the tool is well set with the dial caliper. I do this using the bedan

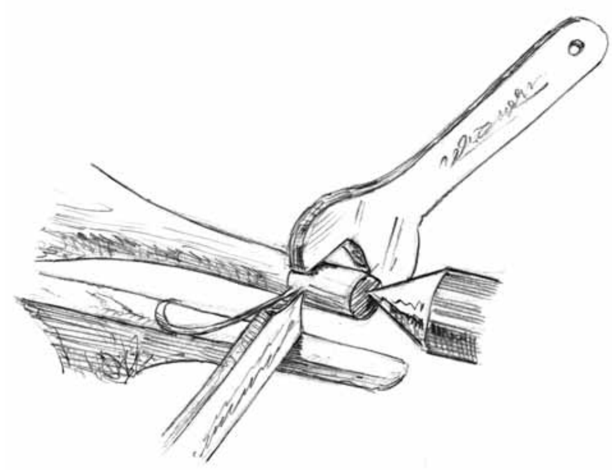


**FIG. 15.18** ***A box wrench helps size tenons.***

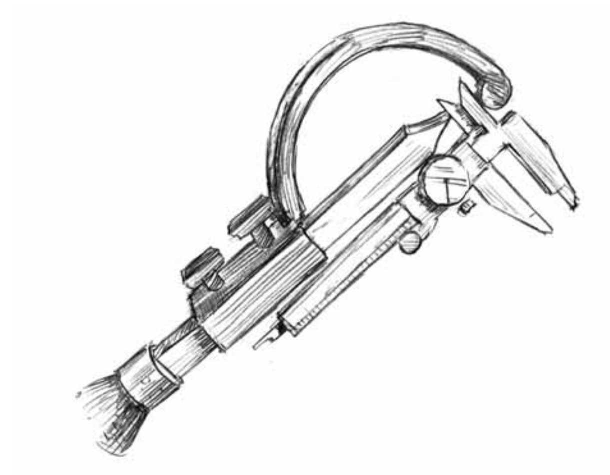
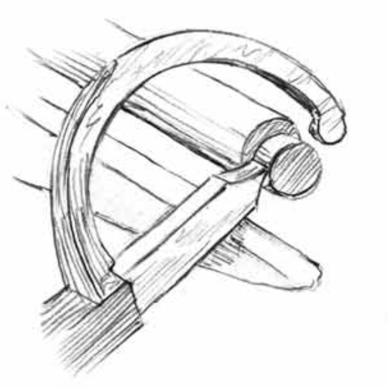
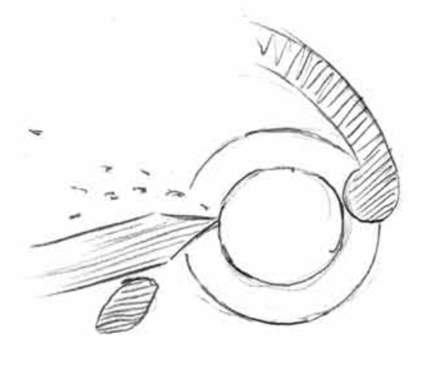


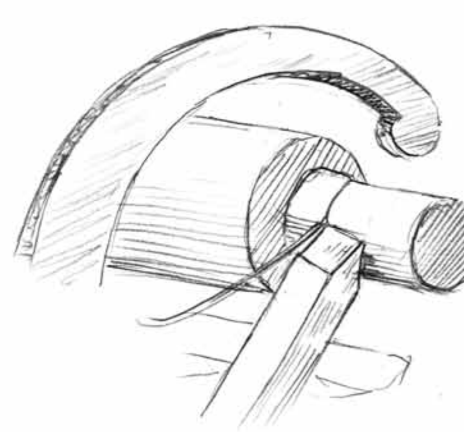
**FIG. 15.19** ***A bedan tool produces consistent tenon sizes.***



*Start by sizing the end with shearing cuts high on the round (tail center not shown). If you don't have a small center on the lathe, leave a wafer of wood at the end of the turning to keep from hitting the center.*



*Once the diameter approaches the final size, pull the ball of the sizing tool against the back of the round and drop the cutting edge downward. If there is excessive vibration and scraping, return to the shearing cuts to remove the excess.*



*Once the end is sized, use it as a visual guide while removing the excess material from the rest of the tenon, then, using a sideways shearing cut, cut the tenon to the final diameter.*

**FIG. 15.20** ***Shear cuts remove most of the material on a tenon.***

cutter like a parting tool and intermittently stop to see if the tenon can slip between the cutter and the sizing knob.

Then I remove material from the rest of the tenon with a shearing cut, using the area at the end as a guide.

It's vital that you keep the tenon surface parallel to the workpiece. I do this by cutting with the corner of the tool and moving sideways. If you form the whole tenon with a series of parting-type cuts, you will probably create a stepped surface. Use the sideways-shearing technique shown at left to prevent or minimize this.

Once close, I try to slip the gauge over the tenon and stop if it scrapes too much. I know that the piece is the correct size when I hear it barely touch as the cutter passes the tenon.

## Tenon Cutters for Cylindrical Tenons

Another method for cutting tenons is to use a tenon cutter. These are commercially available and do a fine job. I chuck the cutter in the lathe headstock using a Jacobs chuck.

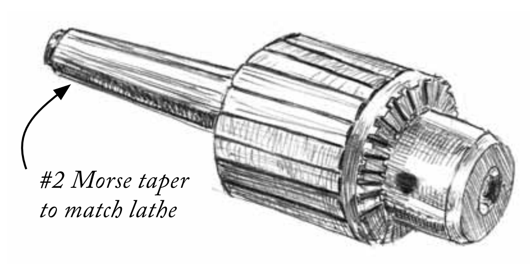



**FIG. 15.21** ***A Jacobs chuck for a typical lathe.***

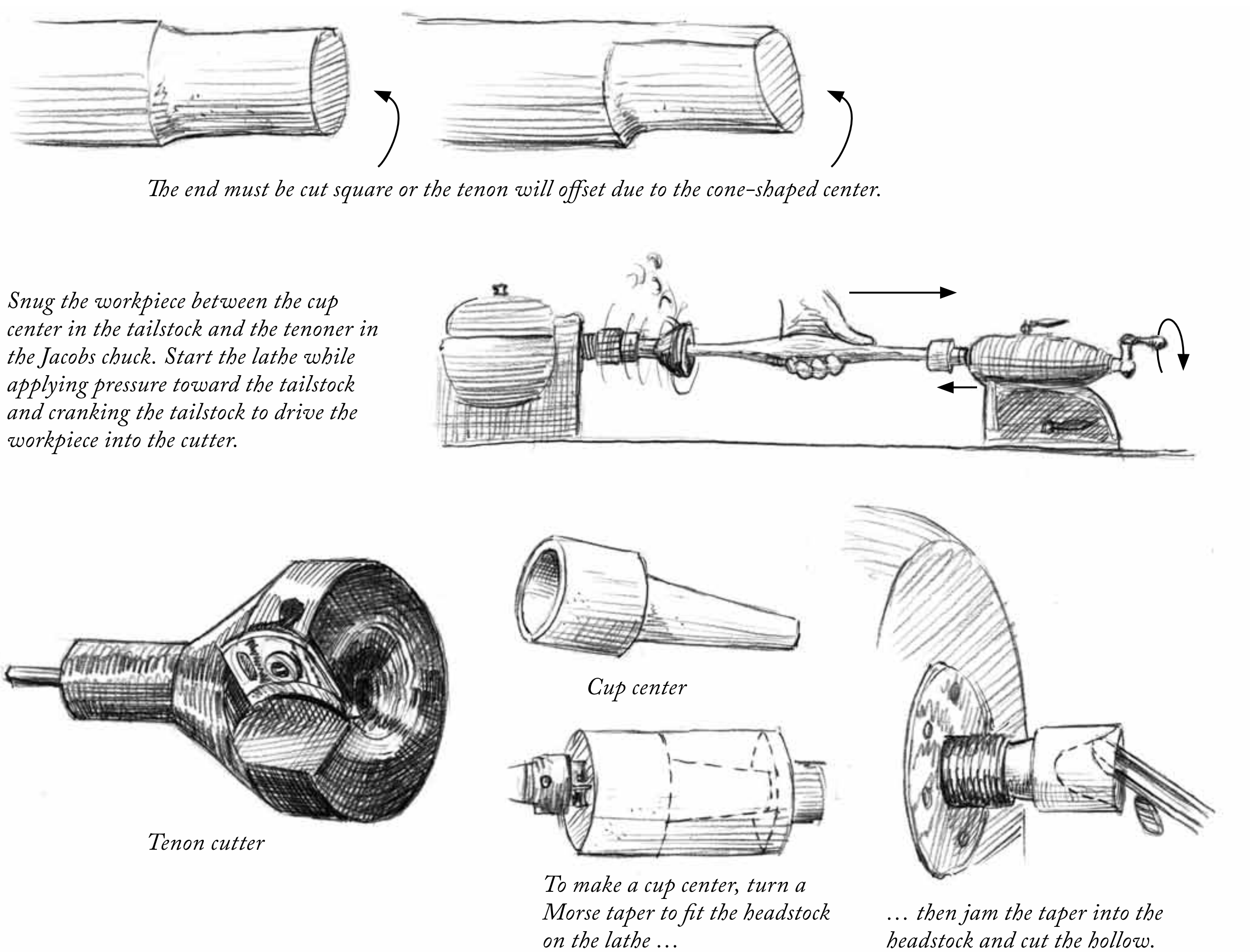
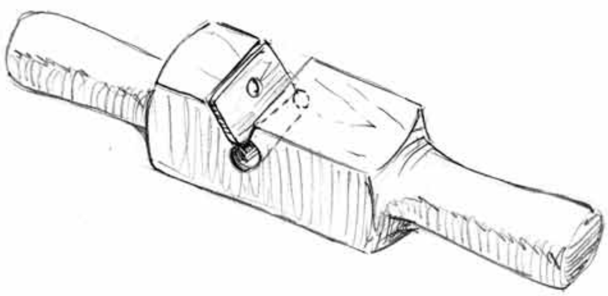



**FIG. 15.22** ***How to use a tenon cutter on a lathe.***

Then I set the tailstock to lightly clamp the workpiece against the tenon cutter. When the lathe is turned on, I hold the workpiece to keep it from spinning while applying pressure toward the tailstock. While I do this, a helper cranks the tailstock to feed the wood into the cutter. (While I've done this solo many times, a helper is a good idea with this operation.)

The tenon end must be cut square to the axis of the workpiece or the tenoner will cut off-center. Turn the lathe off before retracting the tailstock to prevent the cutter from grabbing the workpiece.

If the workpiece has warped during the drying process, the shoulders may be uneven, which will usually only be an issue if the diameter is already close to the final size of the tenon. A practice tenon should always be checked to size against the actual mortise that you plan to mate. The cutter leaves a convex shoulder that can be left or shaved away. I use this technique in large classes and it works beautifully.



## Cutting Tapered Tenons: Rounders

While I aspire to be the best turner that I can, I admit that expecting to turn perfectly straight tapers every time that I step up to the lathe is a pipe dream.

To ensure that my tenons are exactly as needed, I use a rounding plane to tune my tapered tenons. I like this method because each tenon gets a perfectly flat surface (or at least as flat as the blade) and is also the same size, which makes reaming a bit simpler.

There are also rounding planes for making straight tenons.

Rounding planes are simple cutting jigs with a blade positioned at the side of a mortise. The blade shaves material from a tenon as it advances into the mortise, not too differently than a pencil sharpener.

I like to use rounders to form tapered tenons because the straight edge of the blade will make every tenon that I form correctly shaped without variation.

The tapered rounders tend to have a single tapered shape, while the straight ones have a taper that leads to a straight section. To use them effectively, the workpiece should already be close in size to the final dimensions. When tapering a tenon, it helps to have the tenon formed to a lesser angle so that the cutting starts at the small end

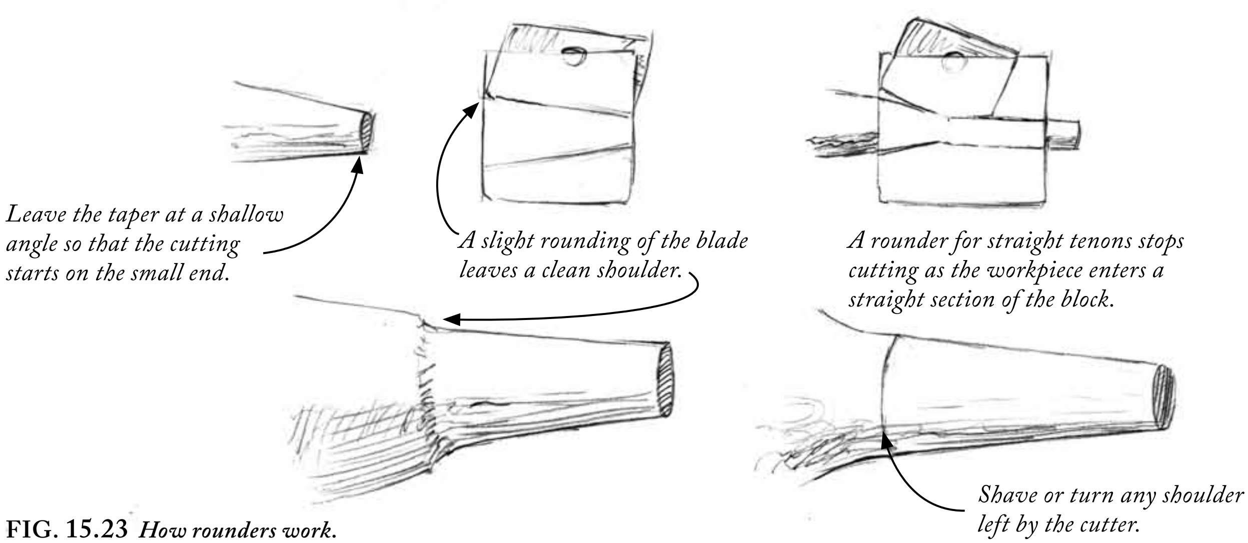



**FIG. 15.23** *How rounders work.*

of the taper and gets lighter as it approaches the end of the taper. It's also helpful to have the diameter beyond the taper be smaller than a continuance of the taper angle to prevent tearing out the fibers. Curving the blade at the mouth of the opening can also help keep tear-out to a minimum.

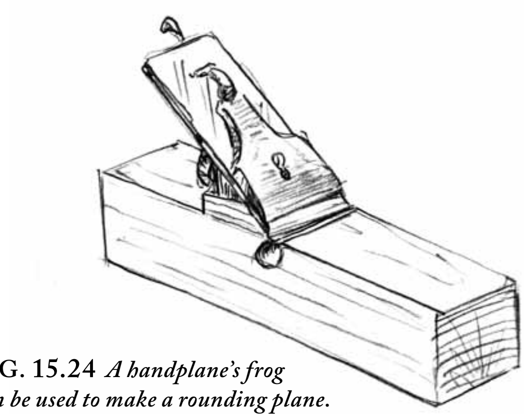


**FIG. 15.24** ***A handplane's frog can be used to make a rounding plane.***

Setting a rounder can be a bit tricky. I like to use a dummy tenon that I can gently press the blade against to set the position and depth of the cutter. Expect to make practice cuts with a rounder before introducing a prized chair part to it. I've made rounders by mounting old plane frogs onto a block with the desired mortise in it. This makes the adjustment a snap. Wider blades are helpful when forming tenons that pass through the seat.

If I am not using a rounding plane, I use a block that registers in the gap of my lathe, with a line on it at 3° to the axis of the lathe to judge the taper while turning.

I turn my tenon while looking at this mark. When the edge of the tenon is parallel to the mark, I know that it is 6° and will match my reamer. The only issue with this technique is the potential variance in the straight taper.

If my turned tenons require fine-tuning, I use a technique that David Sawyer showed me. Make a sample mortise in the waste at the back of the seat and scribble with a pencil inside of it. Then, force the tenon into the

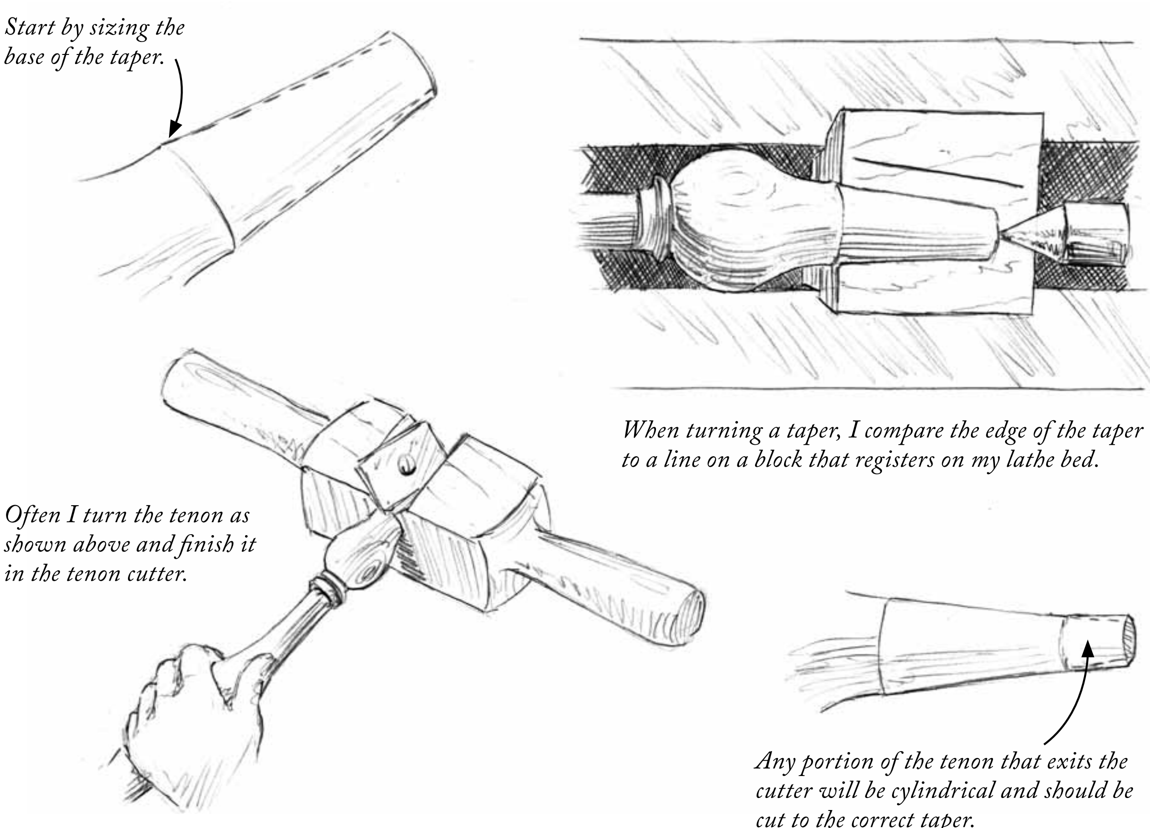



**FIG. 15.25** ***How to cut tapered tenons on the lathe.***

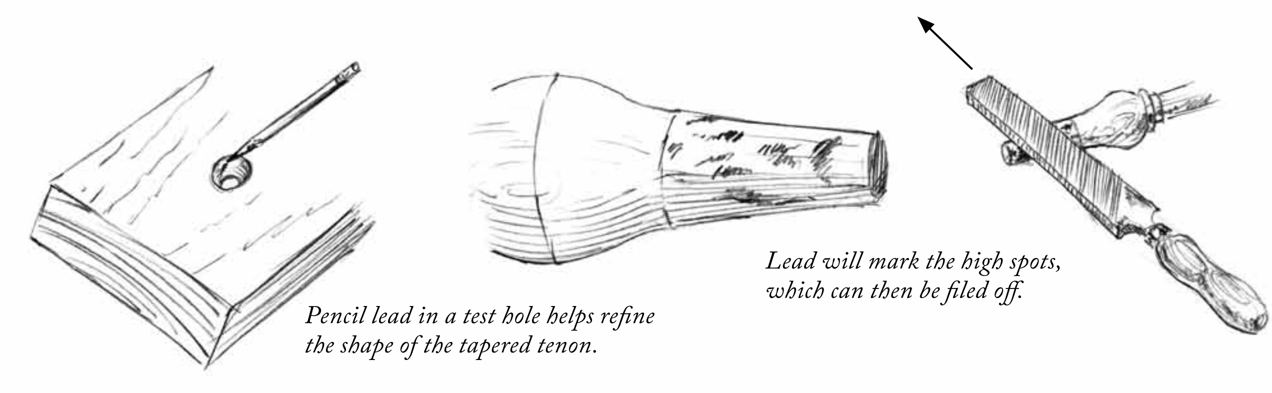



**FIG. 15.26** ***Fitting a tenon using pencil lead as a guide.***

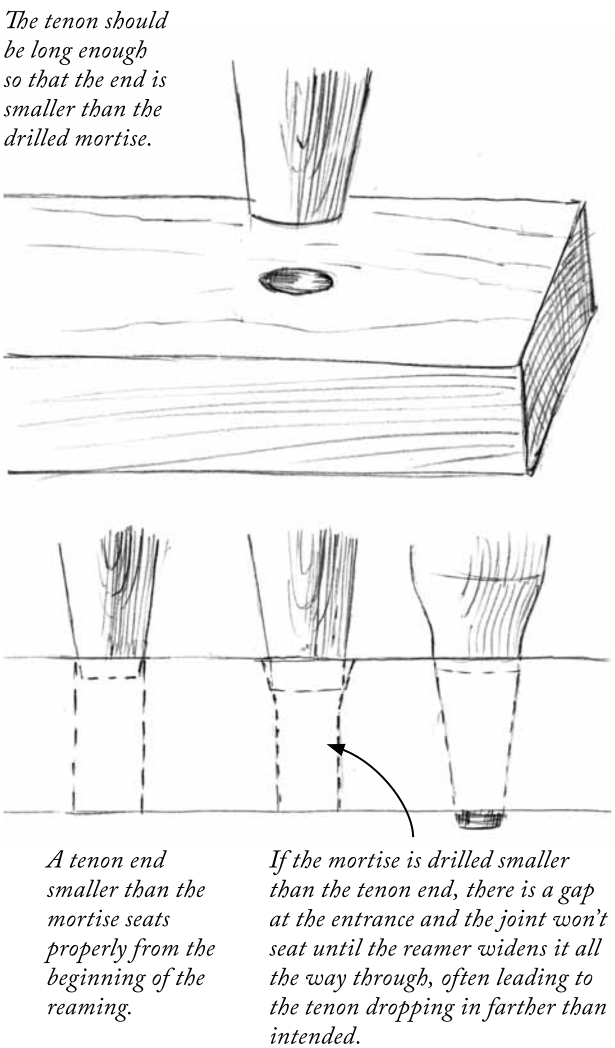



**FIG. 15.27** ***Why the end of the tenon should be smaller than the mortise's hole.***

mortise and spin it. When you pull it out, you will see the high spots marked with the lead. File or shave these spots then repeat the process until the majority of the tenon is making contact. I always give my tapered tenons a light scuff-sanding directly before gluing them up to eliminate any marking or burnishing that occurs during the fitting process.

It's a good idea to turn your tapers long enough that the small end is smaller than the hole that you plan to drill; that way it will seat well from the beginning of the process of reaming. Otherwise, there will be a small gap around the tenon at the entry until the hole has been widened at the exit to the size of the small end of the taper.

## Putting it all Together: The Bobbin

Since the beginning of my interest in making Windsor chairs, I've had a special affinity for the double-bobbin turning. It could be the clean, Asian-influenced lines, or perhaps that some refer to it as a "degenerate" style. It certainly was easier to produce in a factory setting and probably lowered the cost of chairs for the consumer, which helped propagate the style.

Well-proportioned bobbin-style legs are elegant and create a line-drawing-like silhouette that calls attention to the overall design and unity of a piece (yes, I went to art school). The double-bobbin pattern originated as an abstract bamboo, and with a subtle adjustment to the details can be made to look more like actual bamboo, which can be very pleasing.

I tend to recommend the double-bobbin to new turners because it is easier to attain at a high level of quality and provides solid training for more complex turnings.

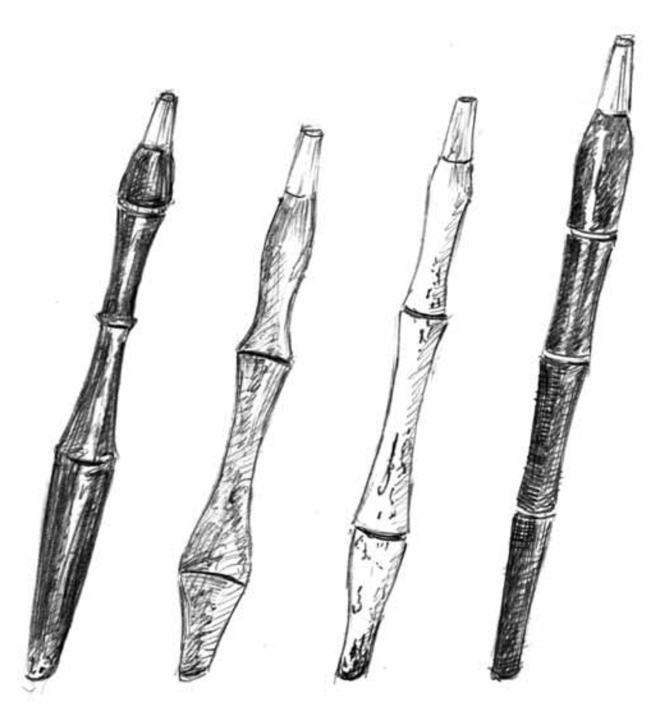


**FIG. 15.28** ***The "double-bobbin" and "bamboo" style of turnings.***

The variance from the thick to thin parts of a double bobbin are less than a baluster, which reduces the chance of vibration creeping in and making the job more difficult, plus there is lots of room to practice your skew-planing technique.

I begin my bobbins by roughing the air-dried blank down to 1¹¹⁄₁₆", which gives me ¹⁄₁₆" in excess to size my largest diameter (1⅝"). Because the thinnest parts are not so dramatic, I size all of the details at once, except for the bottom of the leg, which transmits the force of the lathe; that I size and cut last.

Once the details are sized as shown, I use a ¾" or 1" gouge to make a flat from one point to the other. Then I use the gouge to "hollow" the areas between the dimensioned points. When doing this, I leave a tiny ridge of material on either side of the parting-tool cuts, which helps later when using the skew.

The smallest diameter between the sized details is ¾". Instead of being halfway between the details, this point is biased toward the top in each section; that helps create a sense of weight toward the bottom. Most of the shaping is personal preference, but I've found these results to be the most pleasing and fluid. When shaping the "hollows," it's important to cut from the larger diameter toward the smaller, being careful to flatten out the shape as it enters the transition toward the opposite ascending fibers. This transition area is essential to clean cutting. If you keep the transition area too small, it can be difficult to stop cutting before hitting the exposed end grain on the opposing incline.

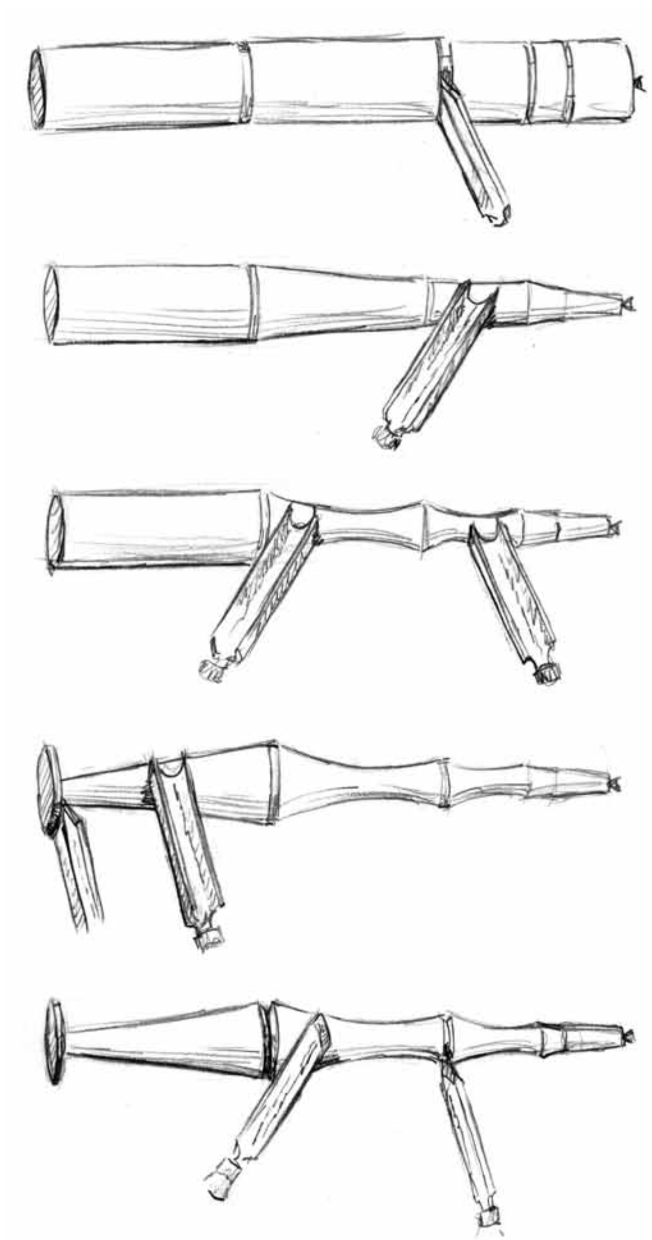


**FIG. 15.29** ***The proper sequence for bobbin turning.***

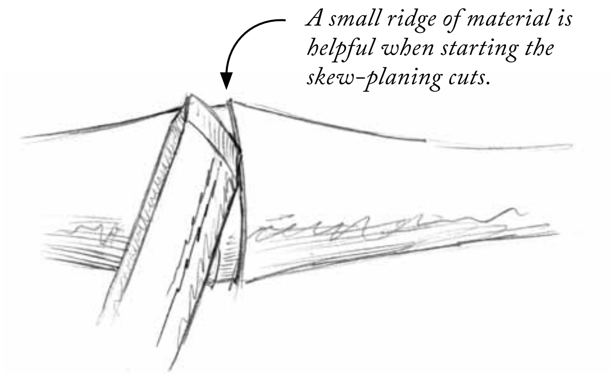



**FIG. 15.30** ***Start the skew in the remaining sides of the parting-tool cut.***

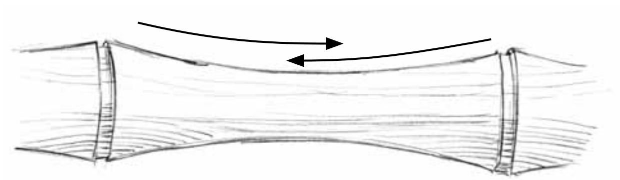


**FIG. 15.31** ***A flatter transition area allows for safe cutting in either direction.***

Once I've used the gouge to rough out the shape, I proceed to finish the shape and surface with a skew. Once this is done, I cut the V-notches and shape the tenon at the top. If your lathe has a large tailstock center, you will need to leave a "fillet" at the end that can be sawn or shaved away later. Be sure not to cut it off until you are sure that the piece doesn't need to be re-chucked in the lathe.

Finally, rough and skew the taper at the bottom of the leg. I always end the taper about 1" from the bottom and leave a straight section at the end. This straight section allows me to trim the legs later without worrying that the size of the foot will become too large.

## The Baluster

The baluster is quite a bit more complex a turning than the bobbin, and requires more skill and effort. The order of operations is also more critical to reducing chatter.

I have a sequence that I follow for each leg, and in some ways it goes against conventional wisdom for minimizing vibration. I first size the major diameters of the vases and the transition from the taper at the bottom of the leg to the bead.

My goal is to locate and size all of the major elements quickly to keep a cohesive vision of the entire shape. Plus, removing this material will make my other parting-tool cuts less deep, which reduces vibration.

Once the major sizes and rough shapes are in place, I work the bead and cove detail in the center. This is where I may run afoul of some recommended techniques, but I've found that it works well. I've heard it recommended that you should not cut thin areas in the center of a piece early in a turning, for fear the the rest of the process will suffer from vibration.

As a self-taught turner, my goal was to make it past the toughest part of the turning early in the process. I wanted to screw up in the first five minutes, not the last. I haven't found vibration to be an issue that can't be overcome by sharp tools, light cuts and changing lathe speeds.

I begin by sizing the details with a parting tool with the lathe speed relatively high. Then I slow the speed to remove the excess material and shape the details as shown in the sequence at right. I try to keep my tool swapping to a minimum, and with a little practice, you will find that all the shapes can be made with a detail gouge. Then I come in and finish up all the details, except for the cove, with a skew.

Then I turn the detail at the top of the large vase, which is similar to the detail I just completed. The sequence shows how I do this. Next, I finish out the upper part of the large vase and the top of the leg, including the tenon.

Finally, I speed the lathe back up and taper the bottom of the leg, finishing it off with a skew.

I cannot stress enough that you should follow the same sequence each time you turn a leg. It will build your speed and consistency by eliminating all the guesswork about what comes next. Plus, any trouble areas that you have with technique will become obvious.

## Stretchers

The simplest process to turn stretchers is to start with a blank that has been roughed out, air-dried and had the tenon ends dried in the kiln. Wrapping foil or newspaper around the center of the turning once it is air-dried (about a week to air-dry in most circumstances) and placing it in the kiln for a few days should do the job. Then I cut it to length and remount it on the lathe to turn it to final dimensions. The side stretchers for the balusters are simple affairs and follow the sequence shown in the

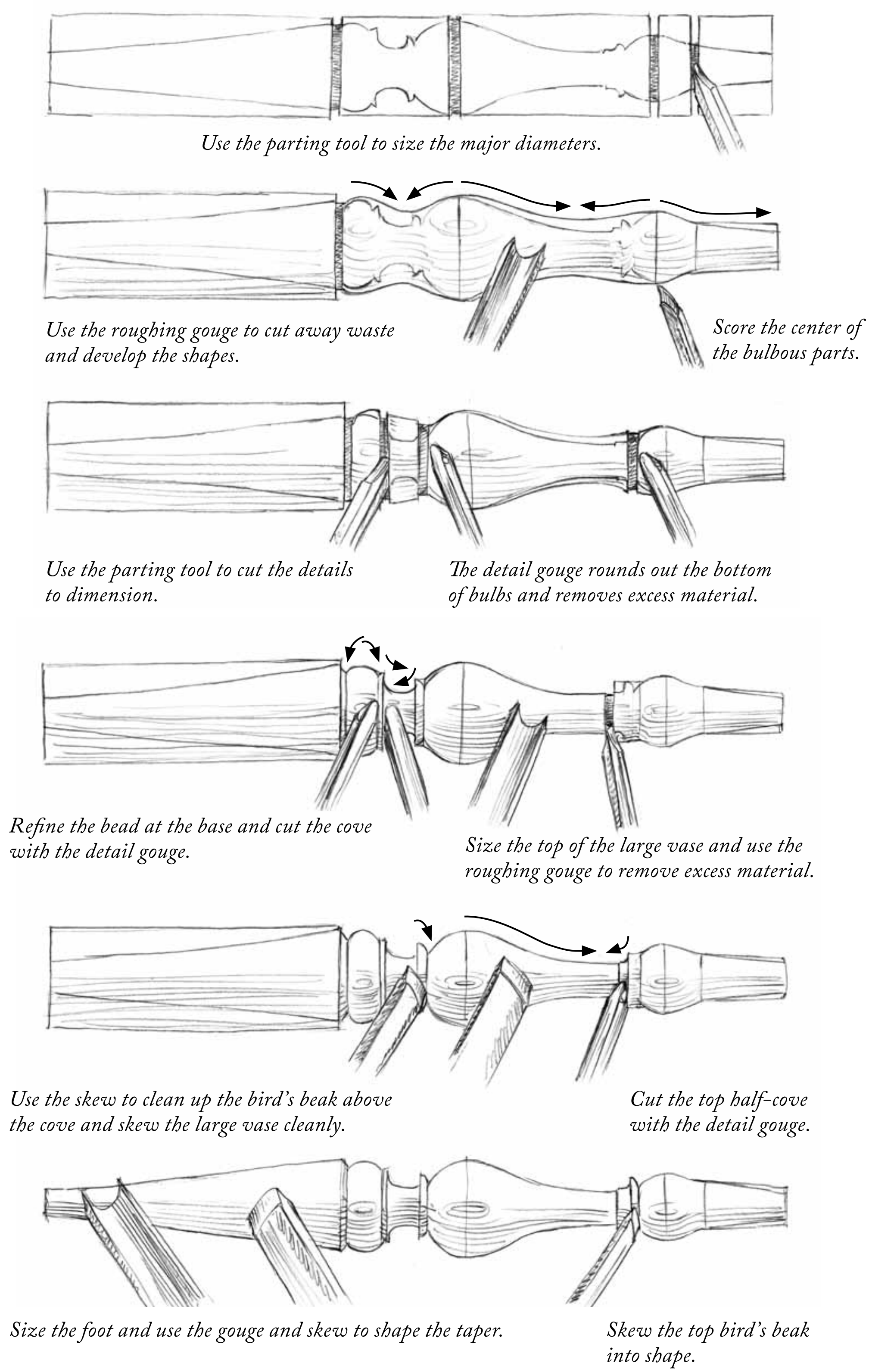



**FIG. 15.32** ***The turning sequence for a baluster.***

illustrations. The sequence for side stretchers in the bobbin style are similar; an example is shown at the end of the bobbin center stretcher sequence below.

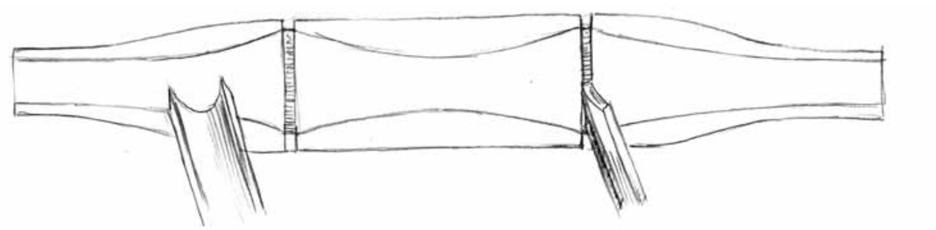
The center stretcher doesn't have the diameter limitations of the side stretchers because it has no mortises. I usually step down my largest diameter on the center stretcher by 1/8" from the side stretchers for visual variety.

On baluster legs, I include details such as the one at the top of the large vase on the the leg. It adds a little flair and helps relate the part to the legs. The sequence for turning the center stretchers for the baluster turnings is on the facing page.

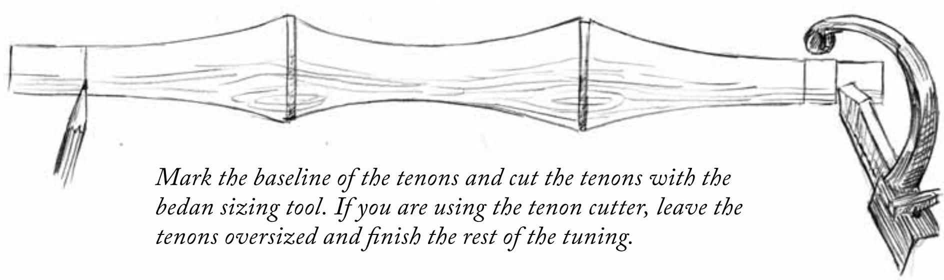
## Parts with Limited or no Lathe

Many of my contemporary chairs use simplified turnings often referred to as "cigar" shaped. I like to create the shapes on my lathe then refine the surface to finish using a spokeshave. I find that the facets add interest to the

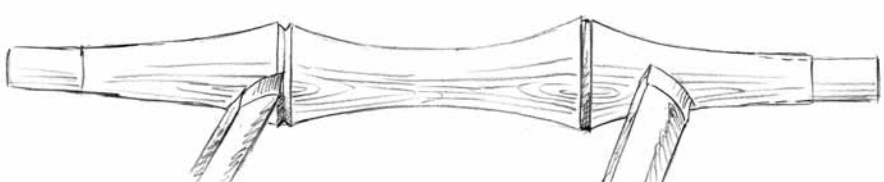
*Center stretchers*



*Size the large diameters with the parting tool and remove the bulk of the material with the gouge.*

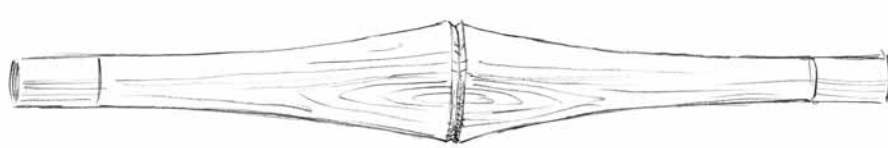


*Mark the baseline of the tenons and cut the tenons with the bedan sizing tool. If you are using the tenon cutter, leave the tenons oversized and finish the rest of the tuning.*



*Use the skew to cut the V-notches and plane the surface so that there is no shoulder at the tenon.*

*Side stretchers*



*The side stretchers are done the same way, the only difference being that there is only one large diameter in the middle and it is slightly larger than the center stretcher.*

**FIG. 15.33** ***How to turn a bobbin stretcher.***

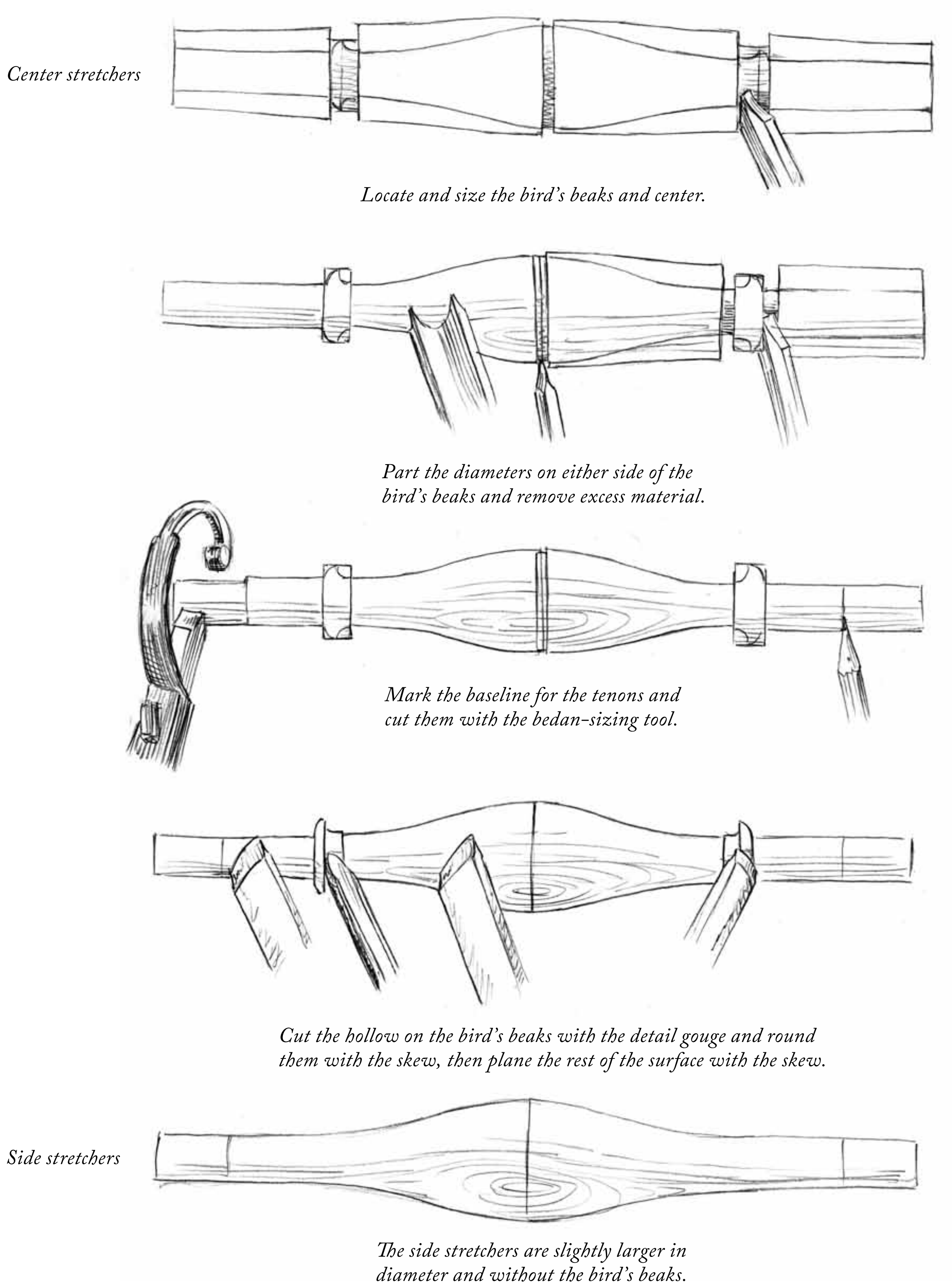



**FIG. 15.34** ***Turn baluster center and side stretchers.***

simple shapes and also eliminate the need for any other treatment or sanding.

If you wish to work through a chair without a lathe, you can still create pleasing parts by rough-shaping them with a drawknife to the dimensions shown. Of course, the quick trip to round offered by the lathe will be replaced with a sequence that follows the parts from a square cross section to octagon and finally round, much like a spindle. Cutting the tenons can be done with a tenon cutter, as shown, or carefully by hand, using a rasp or file and sample mortises to ensure a good fit.

*Size the major diameters with the parting tool and remove excess with a gouge.*

*Fair the curves.*

*Spokeshave to finished shape and surface.*

*Cut the taper on the end with a rounder or on the lathe.*

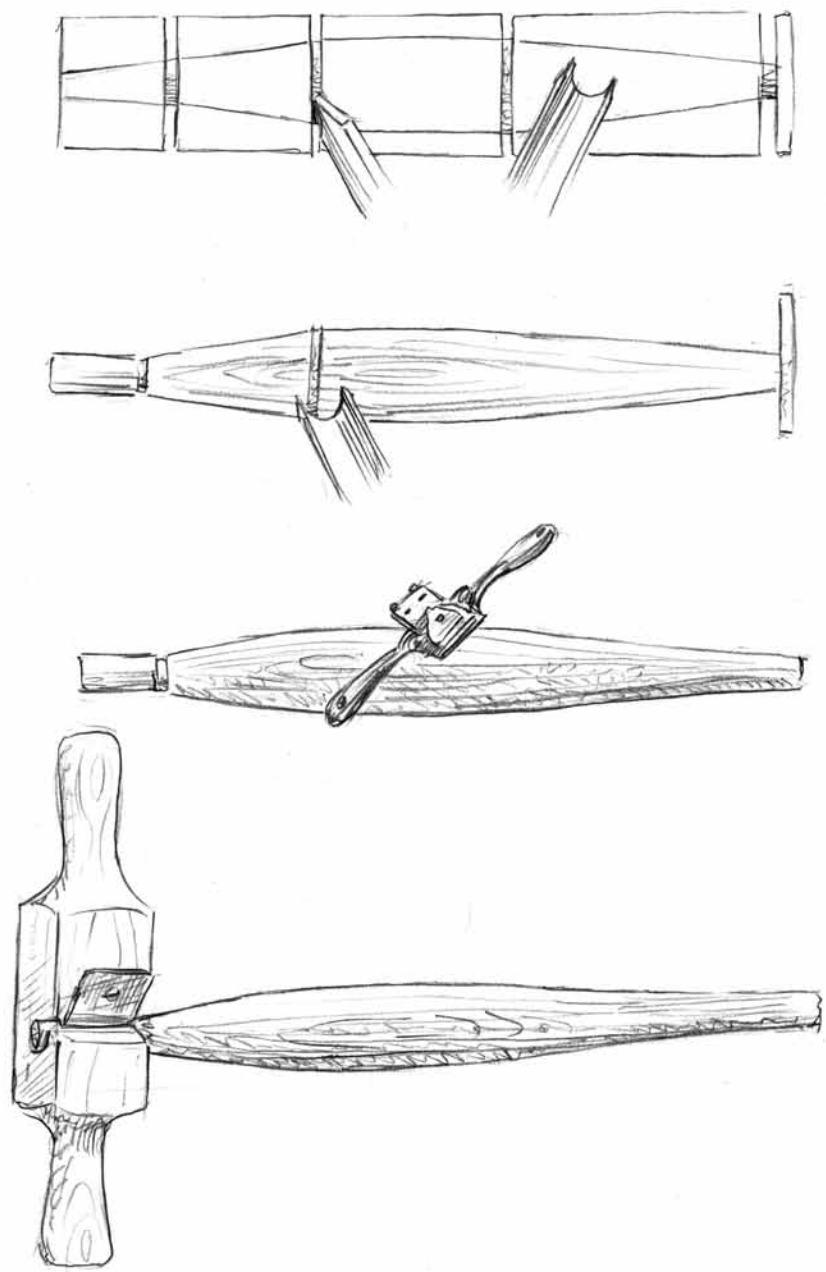


**FIG. 15.35** ***Make a cigar-shaped leg.***

## Conclusion

Turning is the fastest way to transform a dull blank of wood into an interesting visual component. The subtleties of the technique and design options keep my interest high and give my efforts at transforming a raw log into an elegant chair a huge boost. Like many cabinetmakers, I had never turned until I made chairs. Now it ranks amongst my favorite activities, and the return on my efforts to learn it have been rewarded, both in the speed of my production and more importantly, the joy that I have in practicing a hard-won skill.

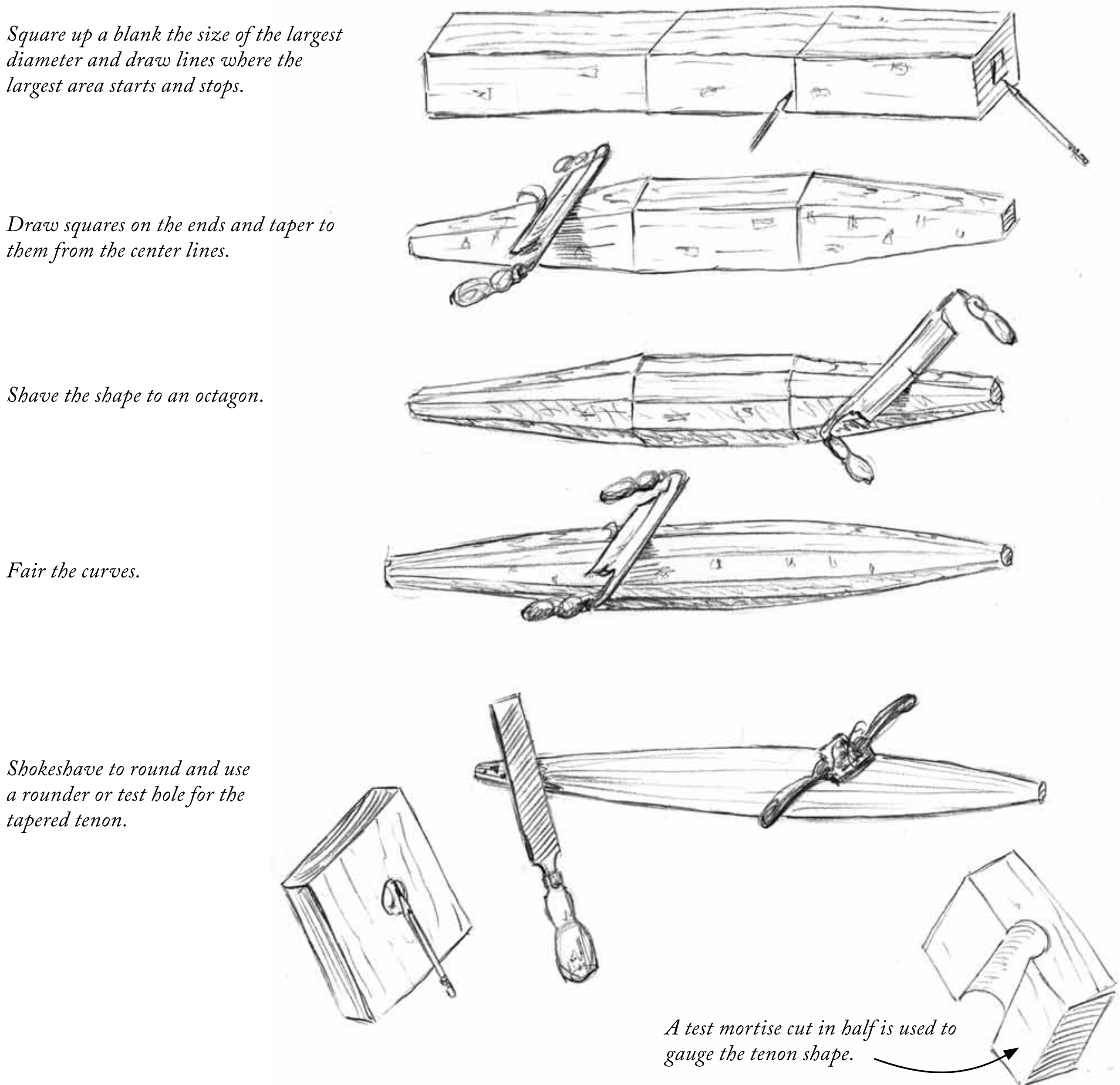



**FIG. 15.36** ***How to shave a leg without a lathe.***

# 16

# Drilling

Drilling a hole is probably the most widespread woodworking experience. Who hasn't drilled a hole to hang a picture or pilot a screw? But this shouldn't be mistaken for the experience of making a round mortise.

Producing a durable and comfortable chair relies heavily on successful drilling and reaming. The correctly sized hole in the right place and at the right angle sets the stage for an easy assembly and a comfortable chair. I spend lots of time practicing my drilling, not only to get comfortable with the tools, but also to assess the condition of the bit and the results in the wood that I intend to drill.

There are many places in chairmaking where varying results don't affect the success of the final product; drilling mortises isn't one of them.

Besides your control over the sharpness and geometry of the bit, I have found that the rate of rotation and the rate of feed play a great role in forming a proper mortise. Yes, it is still just drilling a hole, but a little deeper focus on the tools and techniques involved can make it far more interesting and attainable.

With drilling, I consider four important variables: the density of the material, the condition of the bit, the rate of rotation and the rate of feed. With auger bits, or other bits with lead screws, the rates of rotation and feed are linked, but with most power-drill driven bits, it is up to you. It's a good idea to drill a bunch of practice holes without concerning yourself with specific angles so that you can get used to the rate of feed that corresponds to the bit and the wood.

The speed of rotation that I use with power-tool bits is always the highest that the drill can manage. It's an easy mistake to think that the key to a clean entry is to have the tool rotating slowly as it enters, but it's just the opposite. A faster rotation allows the tool to proceed into the wood while taking lighter, cleaner cuts. One of the most important skills in drilling is to slowly lower the bit into the cut while it is spinning at its highest speed. This gives excellent entry cuts.

Once the bit is cutting wood, you must assess the rate of feed. This is how fast the bit will advance to the desired depth. When advancing at the correct rate, the bit will clear chips and descend at an even rate. If you are feeding too slowly, the bit will heat up and cause the inside of the hole to burnish and glaze. If you are feeding too fast,

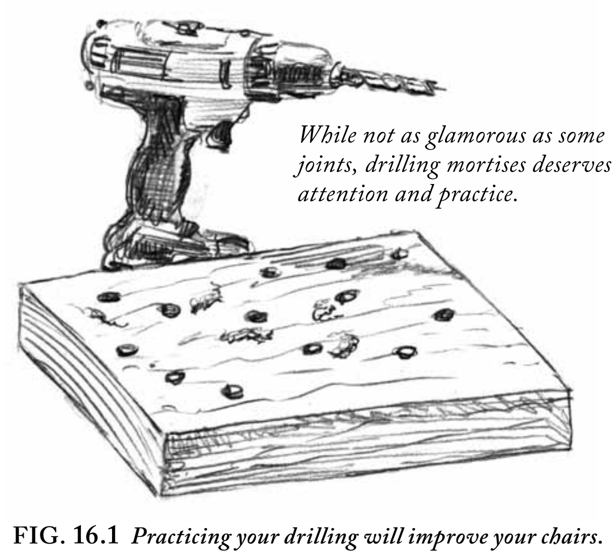



**FIG. 16.1** *Practicing your drilling will improve your chairs.*

the bit will chew its way to the bottom and likely clog. The bits I use are sharp and aggressive. I let the weight of the drill do the pushing, and if that is too much weight, I lighten the pressure by increasing my support of the drill. Extra sensitivity is required when drilling woods that are composed of layers with varying density, such as white pine. In these woods, drill bits tend to proceed slowly through the dense layers then plunge through the soft layers. Cutting the harder material while not chewing through the soft takes a sharp bit and practice.

Each wood will cut differently and may call for a different geometry in the bit. A single bit will drill different-sized holes in pine than in hard maple, and the rate of feed might be dramatically different. A bit that whispers through maple may chew a hole through the pine like a screw. Usually, a lower clearance angle on the cutter means a slower-cutting bit, which may work better for softer woods.

There are many styles of drill bits spanning history, each an advance at its time, and each in its own way can be made to work. Whether you pursue spoon bits, auger bits, brad points or Forstner bits is your choice. But learning to maintain them is essential. The usual arc of a drill bit's life is to start out factory sharp (which is not actually sharp) and go downhill until it is no longer usable

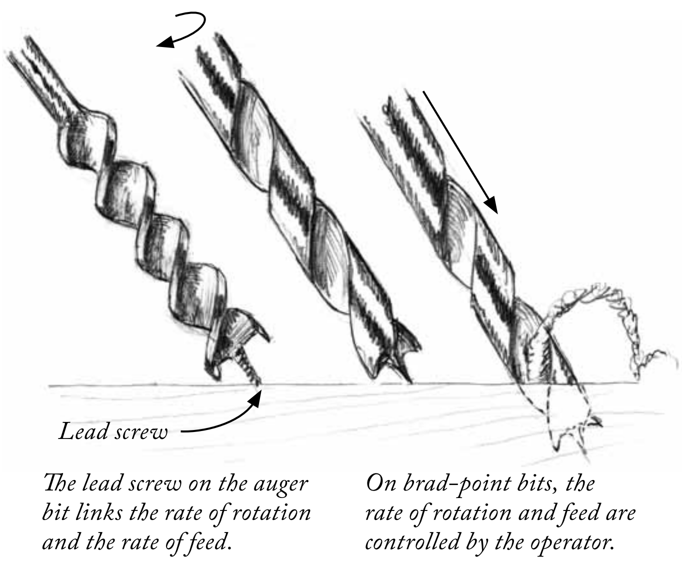



**FIG. 16.2** ***The difference between auger bits and bits for electric drills.***

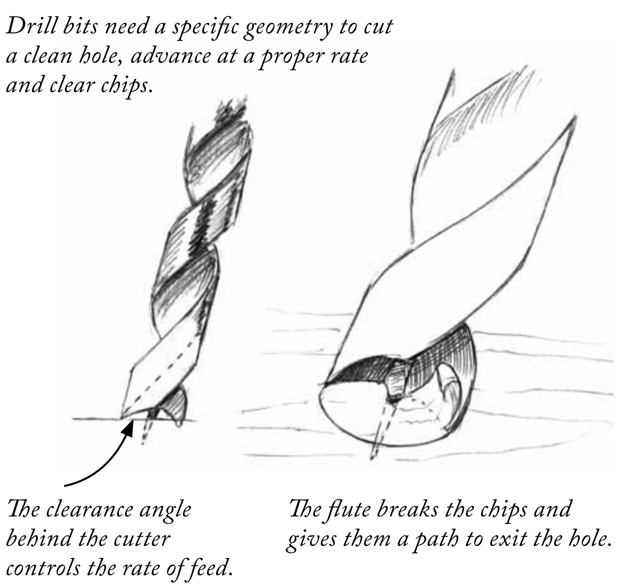



**FIG. 16.3** ***Cutting geometry of a bit for an electric drill.***

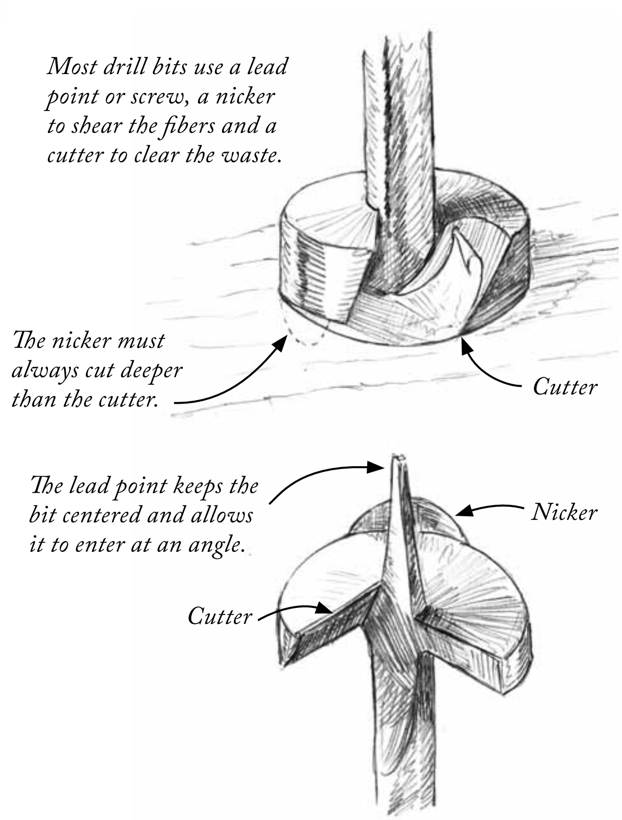



**FIG. 16.4** ***Cutting geometry of a Forstner-type bit.***

and it gets stuck in some dusty drawer. A drill bit has a tough job, alternating between cutting long grain and end grain without heating up too much or clogging with chips. Each bit has a different strategy for this and, in some cases, the type of bit can be matched to the job at hand for the best results.

There are a few different bits I use depending on the circumstances. Except for the spoon bit, they all follow the same basic rules.

To cleanly cut a hole, most bits use a long center point and two types of cutters, one to score the fibers around the perimeter of the hole and another to clear the waste. The auger, Forstner and brad point all do this. When sharpening these, it is vital that the outer nickers cut the full diameter of the bit, so they should always be filed or ground only on their inner face. The cutting portion of the bit that shears the waste must have a sharp edge and a clearance angle suited to the wood that you are cutting. Also, most nickers are too long and should be shortened so that they shear just one or two shavings' thickness ahead of the cutter.

I prefer to use brad points that I grind myself from regular high-speed steel machinist's bits. While they certainly take a bit more effort to grind, maintaining them and altering them to suit the task at hand is far faster and easier than with any other bit that I've used.

I also recommend this because no woodworker seems to be without a slew of dull old bits just waiting for new life as razor-sharp brad points. While grinding your own bits might sound impossible, it has a shallow learning curve and is a valuable skill worthy of the effort.

Regardless of what type of bit you use, it deserves the same attention as any other joint-making tool, such as a saw, chisel or plane.

## Types of Bits

There are several kinds of bits you can ue when constructing a chair. Here are some common choices.

### BRACE-DRIVEN BITS

Braces come in many sizes and have different ways of holding the bit. Most braces have chucks that can fit many types of bits, but I like the slimmer feel of the Spofford-style brace that holds the bit with a simple clamping screw. These usually hold only bits that have a tapered, square end. The "throw" of the brace will affect its usefulness in tight spots, and tools with bulbous chucks can be

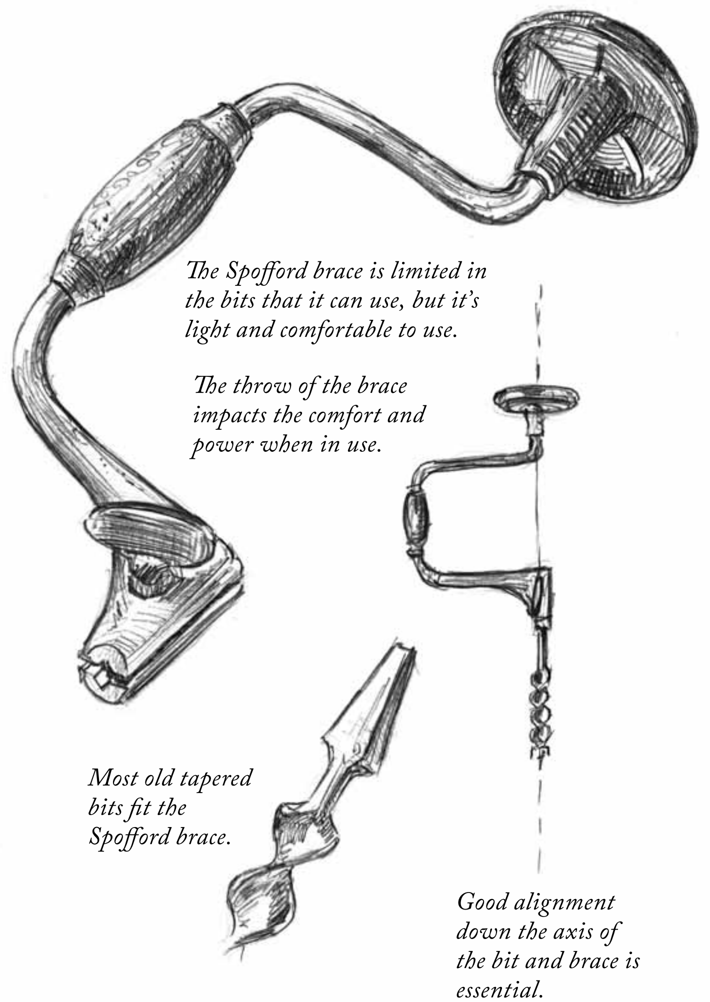



**FIG. 16.5** ***Details of the Spofford-style brace.***

visual obstacles when drilling. Whichever you choose, it's vital that the axis of the chuck and bit are in a straight line with the knob. Any variation, especially with a spoon bit that can cut on the entire length of the bit, will deform the hole and make a poor mortise.

***Spoon Bits.*** One of the earliest bits used in making Windsor chairs is the spoon bit. It's shaped like a long capsule that has been cut in half lengthwise and sharpened on one edge. The bevel is on the inside of the curve. Cutting with a sharp spoon bit defies belief. The shavings form to the inside and break into a shaped cone. It's a blast. Perhaps the toughest part of using a spoon bit, besides sharpening it properly, is getting it started. Because there is no point at the center, just a rounding,

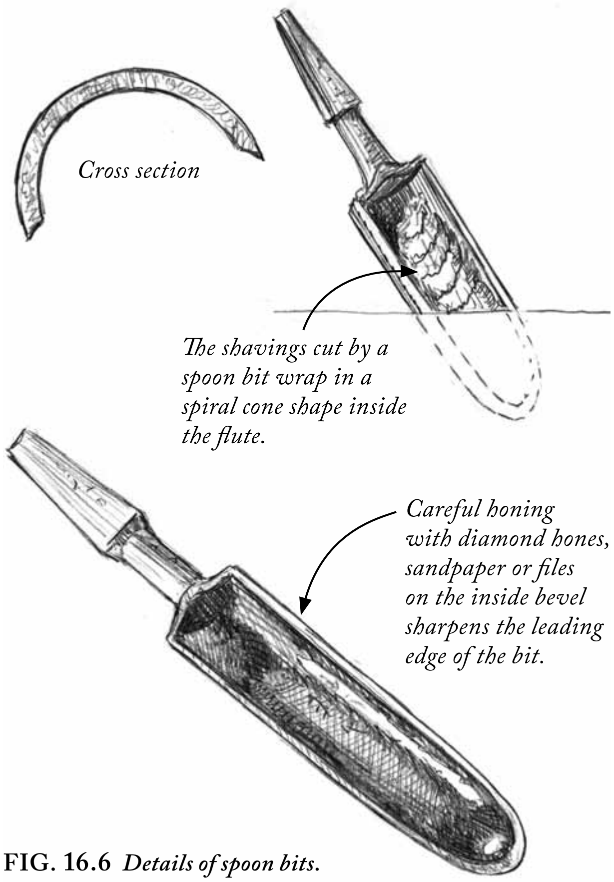



**FIG. 16.6** ***Details of spoon bits.***

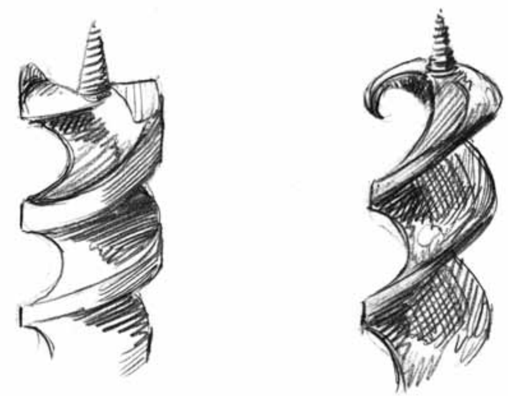



**FIG. 16.7** ***Different styles of auger bits.***

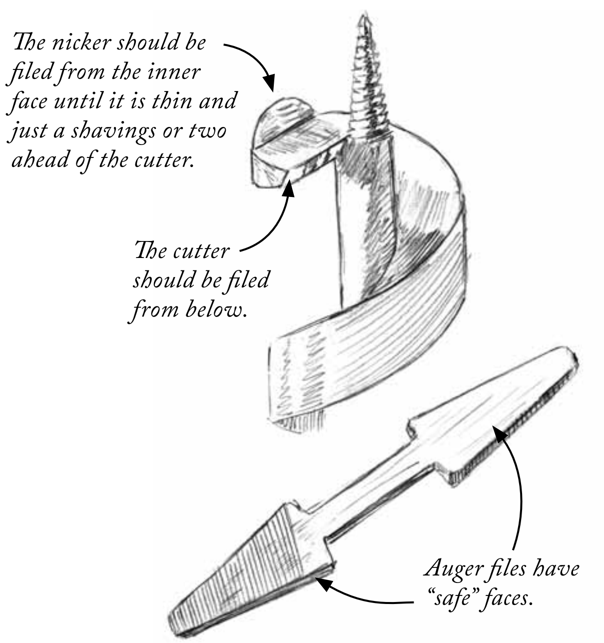



**FIG. 16.8** ***How to sharpen an auger bit with a file.***

the first cut tends to wander. But with practice, you can learn where the bit will wander to and start digging.

This can be even tougher on curved parts, where you must start with the tool perpendicular and move to the correct angle as you cut. I've heard it noted that the tool can adjust the hole by cutting sideways as you proceed, but I don't know why this would be desirable, because the hole would then be misshapen.

Maintaining the bit at its highest level of performance can take time. Care must be taken not to round over the cutting edge from the outer surface. Grinding the interior bevel with a grinding burr can help when shaping the edge to a reliable point. While I find these bits fascinating and historically relevant, I don't use them on a regular basis.

***Auger.*** Auger bits have a center screw that is threaded to pull the nickers and cutters into the wood. As the nickers are pulled into the surface, they score the wood and the cutter comes along and shears it to a slightly lesser depth, ensuring a clean entry. Augers have a few advantages. They are quiet, run cool and, due to the threads, always advance at the same rate. When drilling through-holes with an auger, the exit hole should be backed to prevent blow-out. Most often on the curved parts of the chair, it's more practical to drill until the point comes through the opposite face then finish from the other side. There are hard-to-find augers called Gedge, Scotch or

Cook's Patent bits that have nickers that fold over into the center of the tool. They are a bit tricky to sharpen, but they cut cleaner entry and exit holes.

The nickers on an auger must be razor sharp and cut just in advance of the cutters. If the nickers are too long, they will embed deeply and make it hard to advance the bit. This encourages the threads to strip out the wood inside the lead hole.

There are special files for sharpening auger bits that have smooth sides on one end of the file and smooth faces on the other (called "safe" edges) that allow you to sharpen one face without removing material from the adjacent ones.

One fun technique that Curtis Buchanan showed me is to count the rotations and relate them to the depth of cut. For instance, it might be 18 rotations from the time the nicker contacts the wood to a 1" depth, every time.

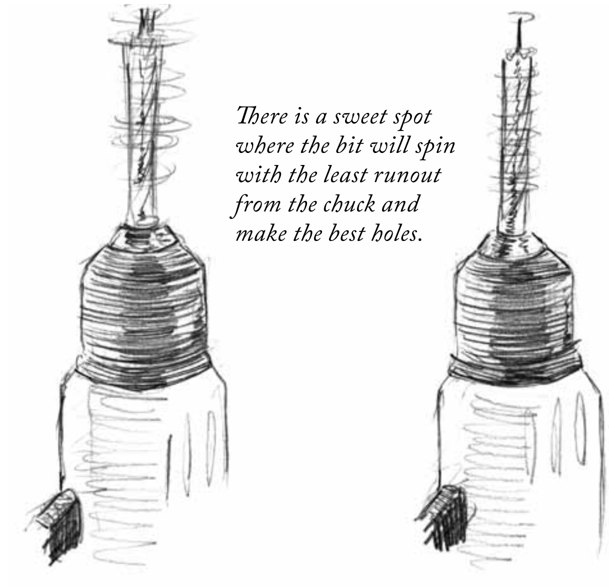



**FIG. 16.9** ***Finding the sweet spot for a particular bit and chuck.***

**BITS FOR THE POWER DRILL**

***The Drill.*** Corded or cordless power drills are ubiquitous. Even after just a short time, it's easy to become comfortable with them. As with the handheld brace, the condition of the drill will help determine your results. If the chuck spins eccentrically, the holes will be larger than desired. Test this by chucking up a bit and spinning it while looking at the center spur. If it wobbles, unchuck it, rotate it one-eighth of a turn, tighten it down and check it again. Often, there is a sweet spot for each bit and drill combination where the bit will spin true. I repeat this every time I chuck up a bit to ensure the best results.

One asset that most cordless drills have, and a couple of corded ones have as well, is a clutch. The clutch is adjusted by the ring around the chuck's base that has numbers and a picture of a drill bit on it. The numbers represent a level of torque that the drill can produce without stalling. While this feature was intended for driving screws to a limited depth, I've found it useful in making clean exit holes, which I will describe in the brad-point section below.

The drill bit icon on the clutch ring means that the clutch is at its firmest and the chuck will spin at its highest torque. I rarely drill at this setting. For blind holes, I prefer to set the clutch about halfway down so that if the drill grabs for any reason, the clutch will trip and the chuck and bit will stall.

When starting a hole, it is essential to have the drill running consistently at its fastest speed. Entering a cut while the drill is running slowly usually results in a torn surface.

***Forstner.*** Aside from the drill bits that I grind myself, I've found Forstner bits deliver the cleanest holes when using a power drill. The Forstner is similar to the auger except it usually has one nicker that runs nearly the entire perimeter of the bit and a short lead spur without threads. Also, there are no flutes to draw out the chips from the hole, so deep holes require occasionally stopping to clear them, otherwise they pack in behind the cutter and jam it. It's important to stop the drill before pulling it all the way out of the hole, otherwise it may grab the edge and chew it up.

The small shank on a Forstner bit gives the ability to steer the bit after drilling has begun, and the tool leaves a flat-bottomed mortise. Of course, unlike standard twist-type bits, the undersized shank cannot be used to guide the bit once the hole is established.

There was a simple type of Forstner with a single nicker made by Stanley, called the Powerbore, that is great for chairmaking in that it has a longer center spur, which is helpful when drilling at angles. Sadly, these are no longer in production, although some manufacturers make a crude version that can be tuned with some careful effort – namely, filing the lead point to a more slender girth. If you are ever wandering around a dusty hardware store, check out the drill-bit section; you might just hit the jackpot of "new old stock" Powerbores. I sharpen Forstner bits with an auger file and finish them with diamond hones.

***Twist and Brad-points.*** The bit that comes to mind when most folks think of drill bits is the twist bit. The problem is that this is a machinist's bit, suited to cutting metal, not wood. The only place where this bit excels in wood is when drilling directly into end grain (though even for this task I find that altering them helps because they tend to wander at the beginning of a cut). To keep the bit from wandering, I alter my shop-made brad points to create bits with a long center spur and the cutting geometry of a twist bit. I call this bit the "Bismark" because of its resemblance to the Prussian helmet.

For all of my drilling into the long fibers, I use a brad-point bit. Like the auger, it has nickers to score the fibers before the cutters clear the waste. There is no shortage of brad points on the market, but I've found them lacking in good geometry and sharpness. And if they are good, they are tough to maintain. This led me to start grinding my own bits, which seems difficult, but is actually quite simple. Besides the general condition of a shop-ground bit being easier to maintain, I can grind them with long center spurs, which helps when starting to drill at extreme angles. Bits with a short center spur must usually be started perpendicular to the surface being drilled then moved into position once the rotary motion begins. This can seem acrobatic and daunting when you are new to drilling.

Plus, if you are like me, you have a full drawer of worn bits that you can practice on. For a detailed process of grinding both the brad-point bits and the Bismark end-grain bits, refer to the appendix Grinding Drill Bits.

Whenever the bit is cutting, I run the drill at full speed, but as I remove the bit from the hole, I stop the spinning; otherwise the slightest misalignment can cause one of the nickers to catch the edge of the hole at the surface and chew it up. After a couple of times doing this, you will get the idea.

Holes that pass all the way through a workpiece call for further attention to prevent blowing out the wood on the exit side. When you have a flat surface, such as all the drilling through the seat, a backing board works to compress the exit area so that it can't splinter.

Backing each hole on the curved areas of chair parts is awkward, so I take advantage of the clutch on my cordless drill to help prevent splintering. This technique is covered in the chapter Uppercarriage Assembly: Balloon-back.

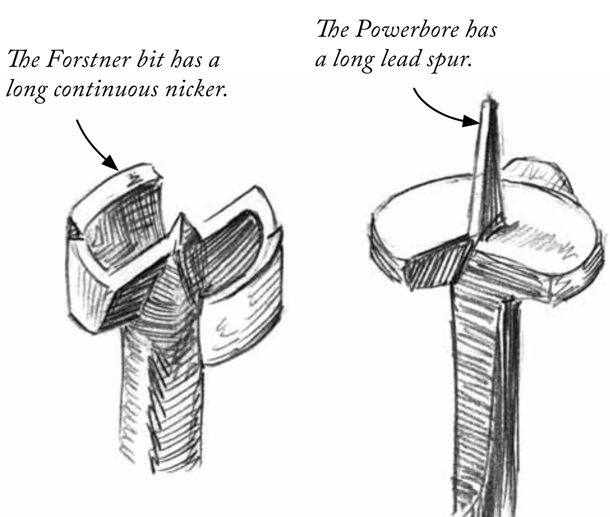



**FIG. 16.10** ***Forstner and Powerbore bits.***

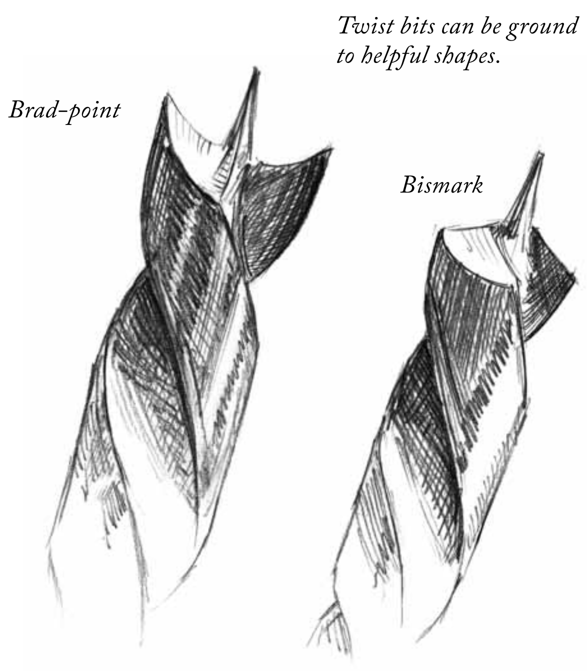



**FIG. 16.11** ***Shop-made brad-point and Bismark bit.***

## Drilling

Once you are comfortable with your tools, it's time to drill the mortises in the seat. I always start with the leg holes in the seat because any small errors in the angle will be corrected during reaming.

I do as much drilling and reaming as I can in the seat before the carving. Some folks prefer to carve the seat first, but I have never had any trouble carving a seat with holes in it, and I prefer having a flat reference surface for my sightlines. A sightline is a reference that I use to guide the drill. Instead of referencing the front and side of the chair, which requires me to position the drill at the rake and splay angles at the same time, I use a reference line that describes the axis in which the leg is vertical. We all have an innate sense of vertical, so reducing one of the angles to vertical is helpful. This allows me to focus mostly on the tilted angle when drilling. It may sound like an added step or complexity, but in practice, it is very simple to achieve. More information on sightlines is included in the chapter Chair Design & the Plans in this Book and the appendix on sightlines.

The other benefit is that any surface blemish from drilling or reaming the legs gets carved away when shaping the seat. You can expect the seat to warp a bit once it is carved because you are removing material from one face and not the other, but, if the seat is properly dried, warping is minimal and any effect that it has on the position of the legs is washed out by measuring for the stretchers after the carving is complete. I also prefer to do all of my

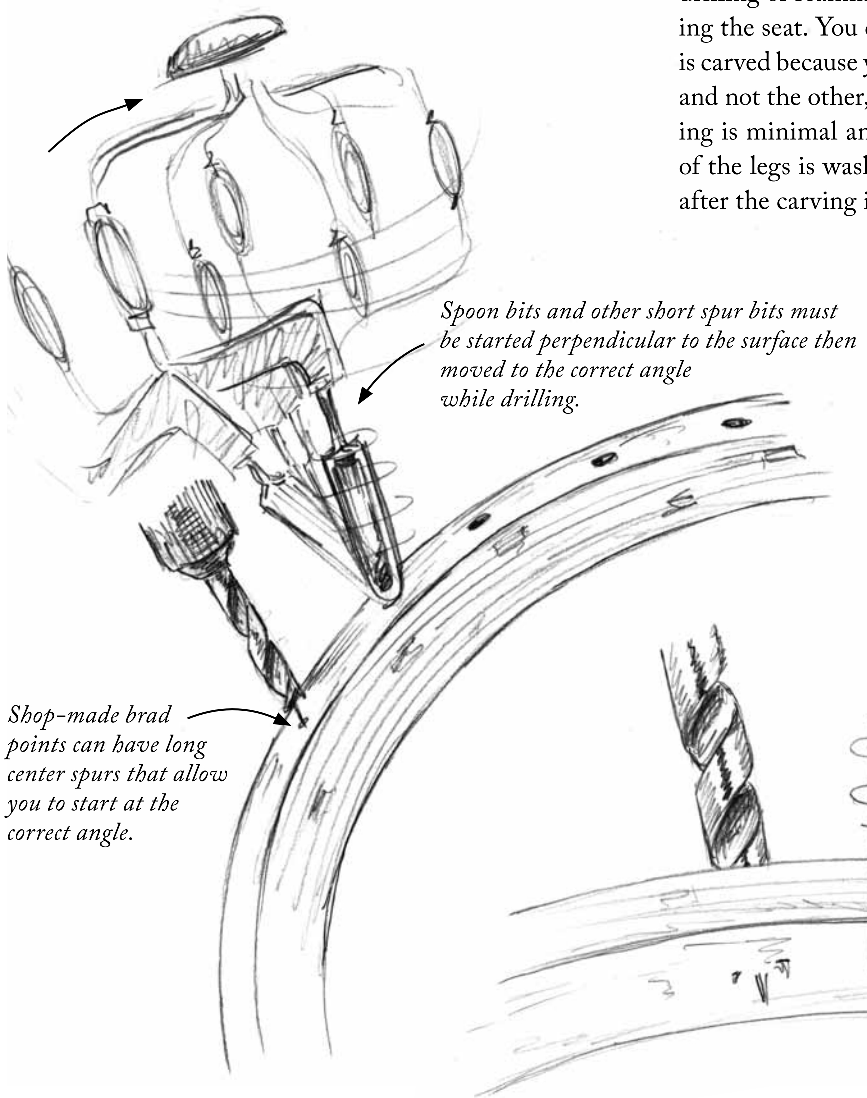



**FIG. 16.12** ***The advantage of a bit with a long center spur.***

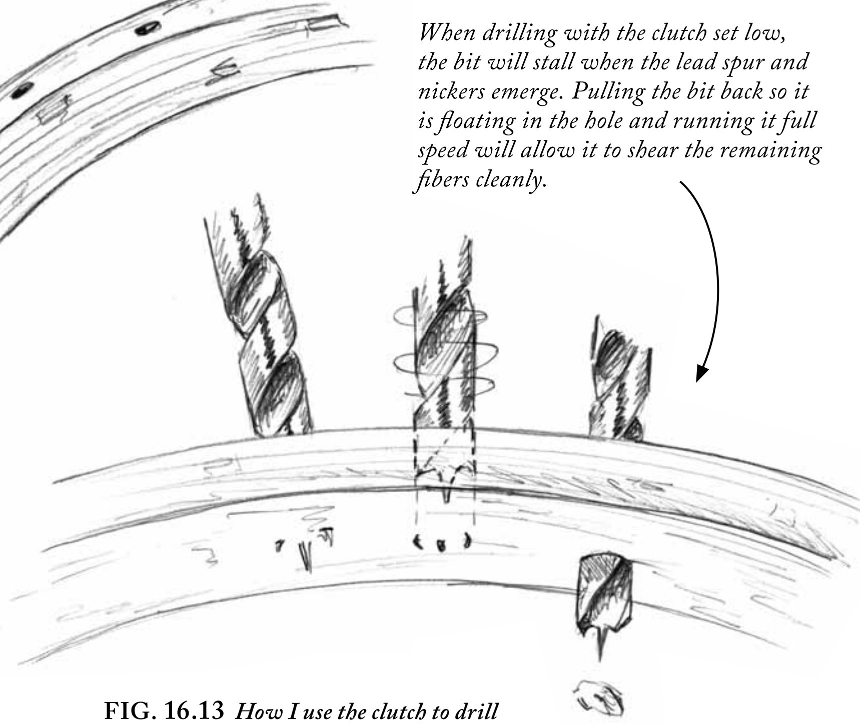



**FIG. 16.13** ***How I use the clutch to drill through-holes in curved parts.***

drilling from the top of the seat, which ensures that the locations of the holes appear consistent where they are most visible. If I were to drill the through-mortises from the bottom of the seat, any misalignment would show up on the seat of the final chair.

I begin by tracing the pattern onto my seat blank and transferring all of the hole locations, sizes and angles.

I don't draw all of the sightlines at once because it would become confusing. Instead, I draw only the sightlines for the hole that I am drilling. To help align my bit so that it is vertical in the sightline plane and at the correct resultant angle, I use two mirrors that are held at angles in wood jigs.

With one mirror positioned perpendicular to the sightline I can check my vertical alignment; with the other mirror parallel to the sightline with a bevel square set to the correct angle, I can check my drilling angle.

**NOTE:** The leg drilling is taking place from the top of the seat, therefore the resultant angle leans toward the center of the seat.

It's important that I can see the reflections in both mirrors by just darting my eyes. It's also critical to position the mirrors so that there is only a small visual gap between the bit and the square or bevel square; this makes it easier to judge that the bit is in line with the blade of the bevel square. A small magnet on the front of the jig can help stabilize the square.

Keeping the drill pressed against my body and my body stable is essential to consistent drilling. If I have to stop partway into the drilling to clear chips, I realign the bit using the mirrors before trying to put it back into the hole.

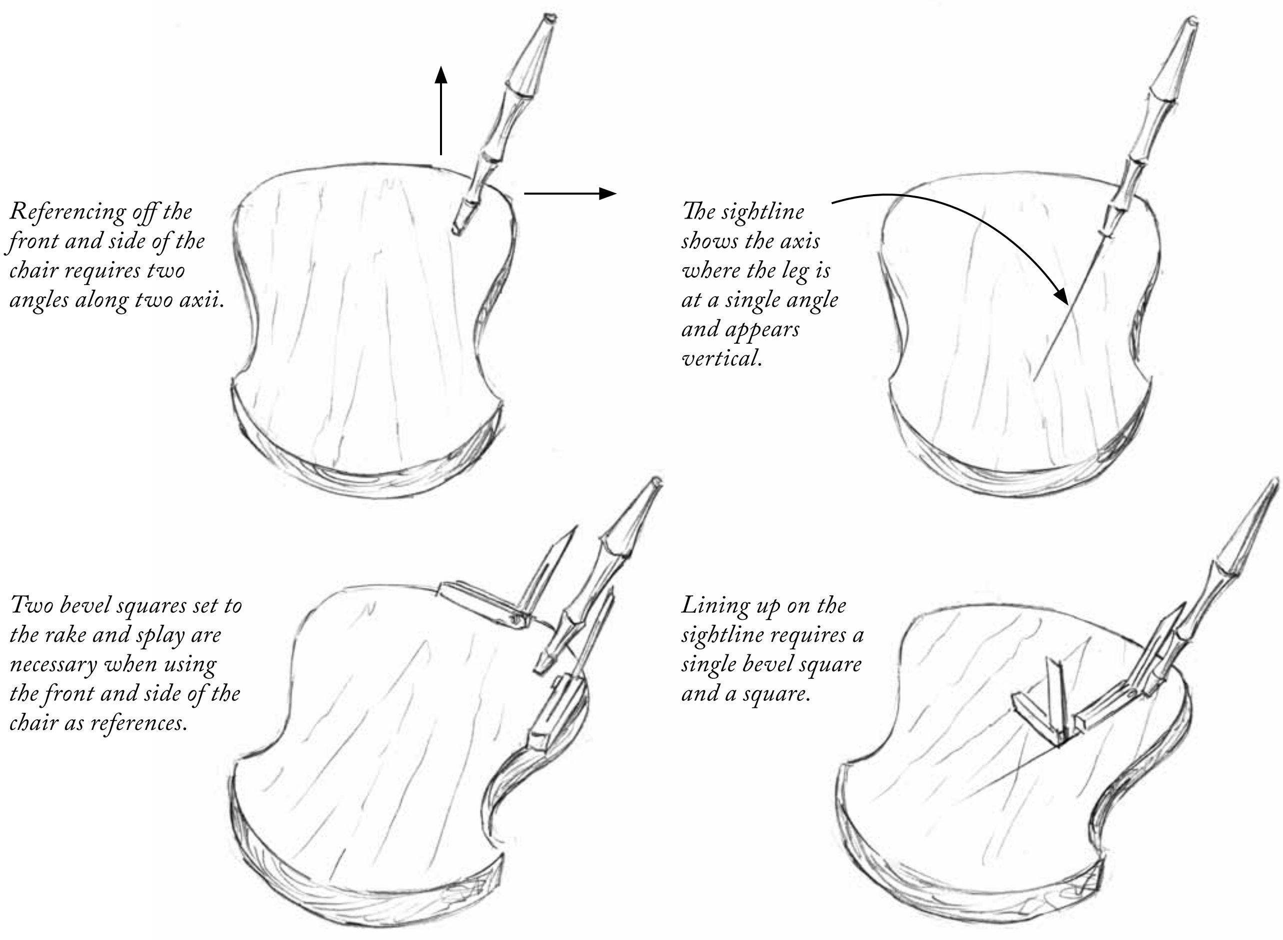



**FIG. 16.14** ***Sightlines simplify drilling by reducing one of the angles to 90˚.***

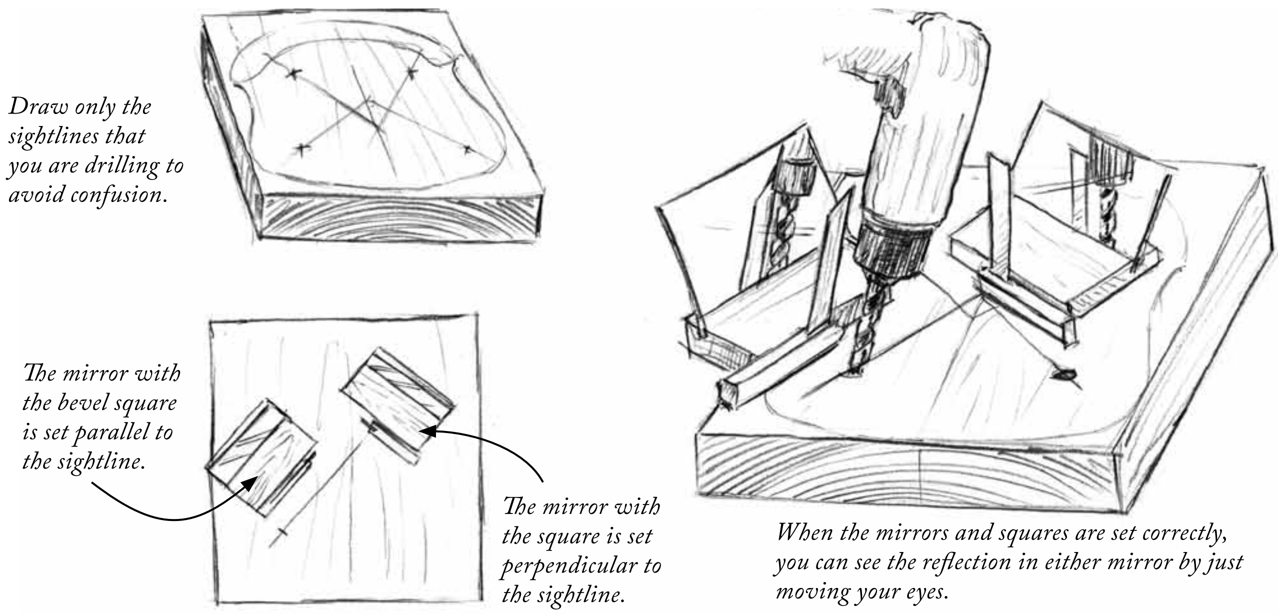



**FIG. 16.15** ***How to use sightlines and mirrors to drill accurate holes in the seat.***

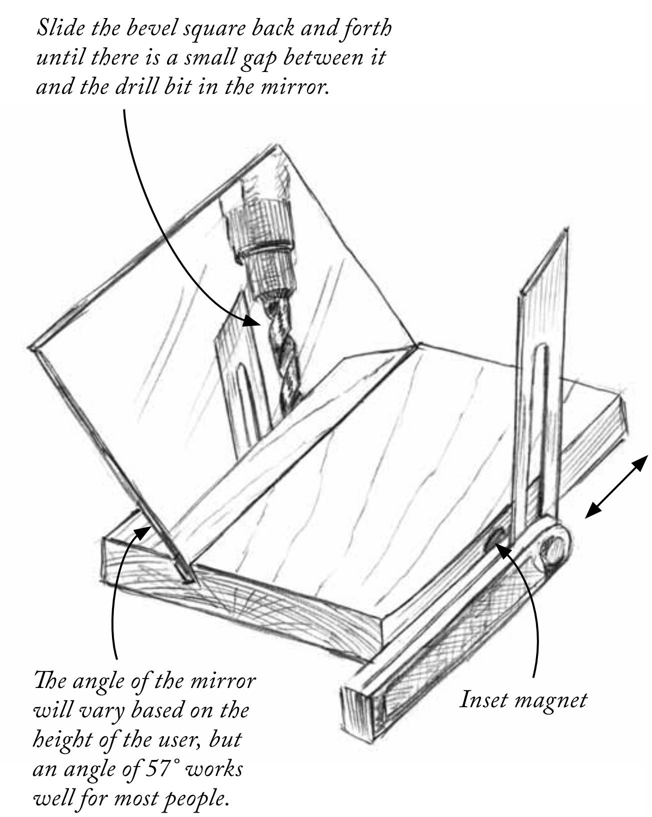



**FIG. 16.16** ***Mirror jigs for drilling.***

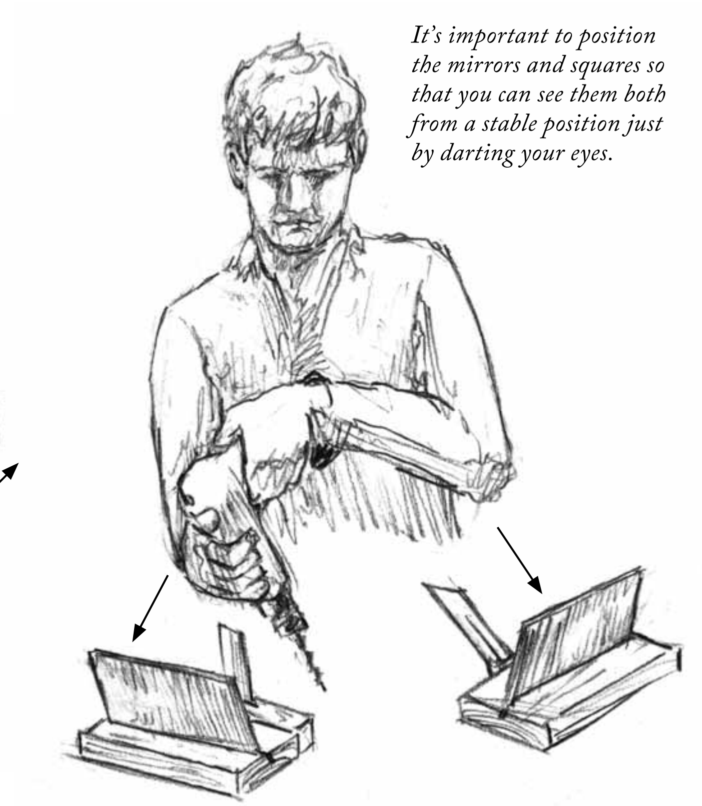



**FIG. 16.17** ***Proper body position when drilling with the mirror jigs.***

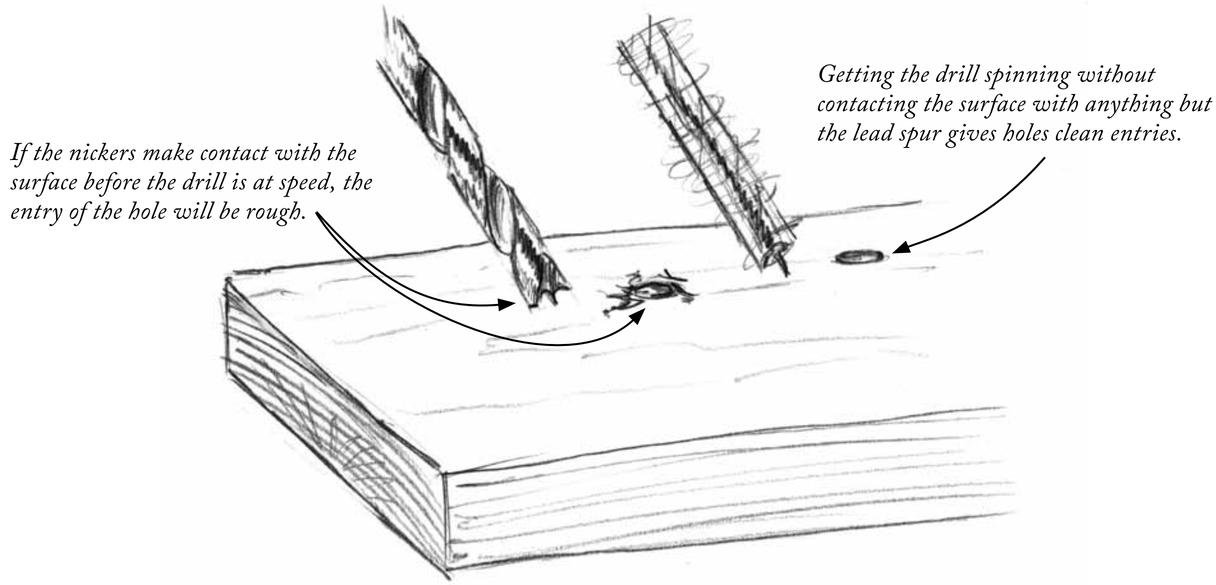



**FIG. 16.18** ***Don't start spinning the bit if a nicker is in contact with the wood.***

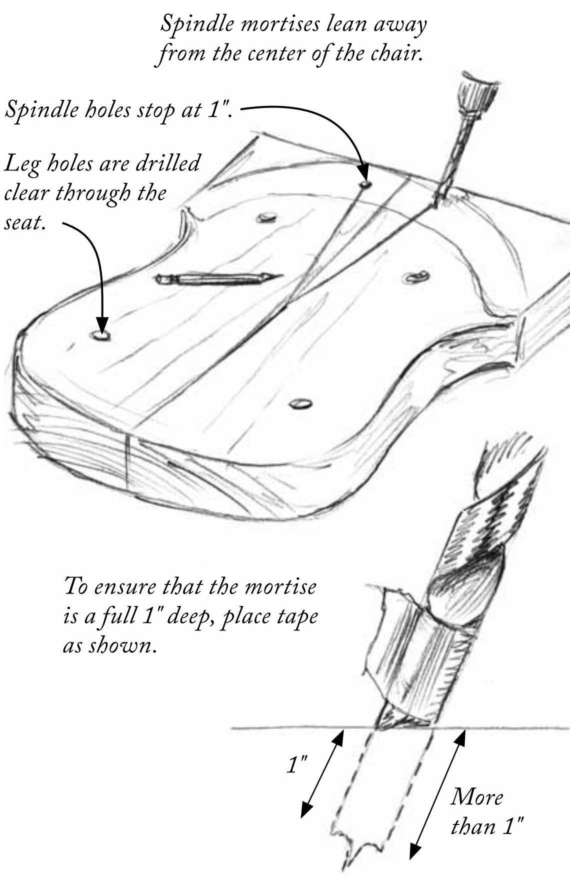



**FIG. 16.19** ***Be sure to tilt the drill bit the correct direction when drilling the spindle mortises.***

I use a backer board below the seat to prevent blowout and drilling into my benchtop. A piece of tape on the drill bit acts as a depth guide.

One mistake that is easy to make (and easy to avoid) is caused by the nickers making contact with the wood before the bit is up to speed. Often while focusing on holding the correct angle, the center spur slides deep into the soft wood until the nicker is in contact. When the trigger is pulled, the nicker grabs and tears out a chunk. To avoid this, make a conscious effort to get the drill spinning with only the center spur in contact, then slowly lower the bit into the cut. The long center spurs of a shop-made bradpoint helps with this job. If you are using a bit with a short center spur, you might need to begin the drill in a vertical position then move to the correct angle after getting the drill up to speed, but before feeding the bit down.

The leg holes are drilled with a 5⁄8" drill bit. As detailed above, every bit has its own rate of feed at which it will clear chips and cut without overheating or jamming. I bore a test hole in the same wood that I plan to drill to assess the rate of feed and condition of the bit. I almost always run the drill at its maximum speed where each rotation can take a small shaving. This gives clean entries and smooth-sided holes.

Once I've drilled my leg holes, I switch to a 1⁄2" bit and drill the holes in the back of the seat for the spindles.

Note that the drill will lean away from the center of the seat for the holes in the spindle deck. The spindle holes are 1" deep at their shallowest. I usually place tape around the bit about 1 1⁄8" back from the nickers and drill until the tape touches the surface. Then I measure the shallow side of the hole and move the tape back so that the drill will go the full 1" deep. These holes are not in an area that gets carved away, so take care to avoid tear-out on the spindle deck.

It's easy to get caught up in aligning to the sightlines and forget to change the angle when moving from one hole to another. Placing a piece of masking tape over the different-sized or -angled holes can help as a reminder.

I start with the center spindle then fan out, drilling pairs on either side until I reach the post holes. When building the balloon-back, I then drill the bow holes (the outermost holes on the spindle deck) with a 5⁄8" bit for the straight mortise. These are through-holes. When making the fan-back, I drill 1⁄2" through-holes for the rear posts, which will be reamed to a 6° taper.

## Fix a Misdrilled Hole

If all the planning and attentiveness somehow gives way to fate and a hole ends up at the wrong angle or the wrong size, the fix is relatively easy. If you have a plug cutter that can cut plugs from the face of a board, then you simply plug the hole and redrill.

I don't have those cutters, so I turn a plug on the lathe from the same material as the mortised piece and plug the hole. In doing so, the plug is positioned so that the redrilling must go into the end grain of the plug. For this, I use the Bismark bit. (I developed this bit for this purpose.)

Usually, the redrilling removes any visual evidence of the plug. I wish I could say that this lesson will prevent any need for plugs in the future, but experience tells me that Plan B is a handy thing to have.

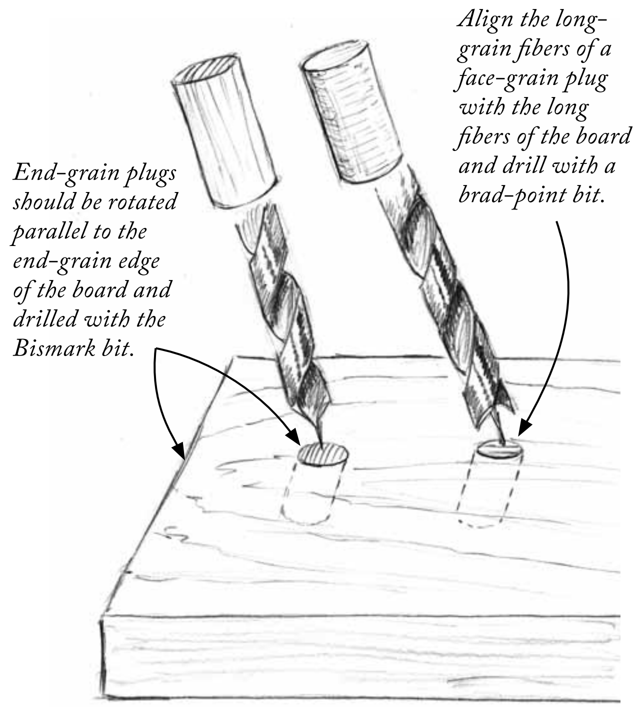
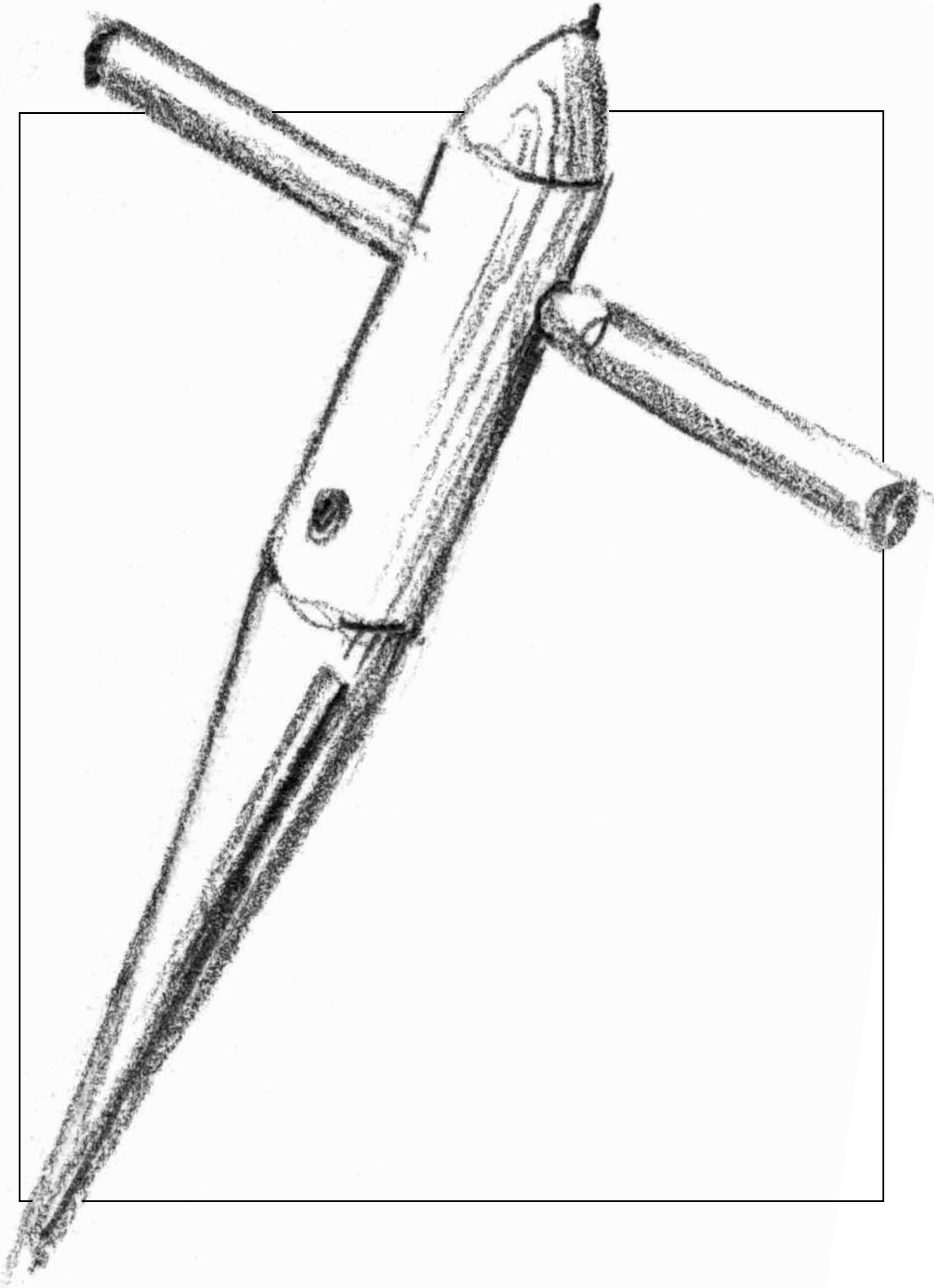



**FIG. 16.20** ***Use the Bismark bit to drill end-grain plugs and a standard brad point for face-grain plugs.***

## Conclusion

Good joinery could easily be described as an obsession in chairmaking. Understand that the simple act of drilling a hole is as critical as any visual aspect of the chair. Whatever method or device suits your needs, a deep understanding of the tool and its condition will help ensure the joint is made with control and will stand up to the rigors of daily use.



# 17

# Reaming

For me, the tapered mortise and tenon was revelation. One needs to look no further than the lathe to find this joint hard at work. The centers in most lathes are held in place with a tapered tenon. It's a mechanically locking joint that doesn't rely on glue or tightening a bolt. It frees with a simple tap or twist, but once tightened, it holds like grim death. I became a devotee for the simplicity of making it, its amazing strength and the many design possibilities that it opens.

A tapered tenon doesn't rely on perfect sizing, but instead on good geometry. The fact that the joint gets tighter as the tenon is driven home suits the shifting nature of wood. Seasonal movement in a tapered tenon could potentially break the glue bond, but the movement won't reduce the ability of the joint to hold tight. This is desirable on round mortises that offer little long-grain glue surface.

Tapered joints also aid when assembling structures with complex angles because the joints are not tight until driven home. Parallel-sided tenons must be aligned and tight from the moment the tenon enters the mortise.

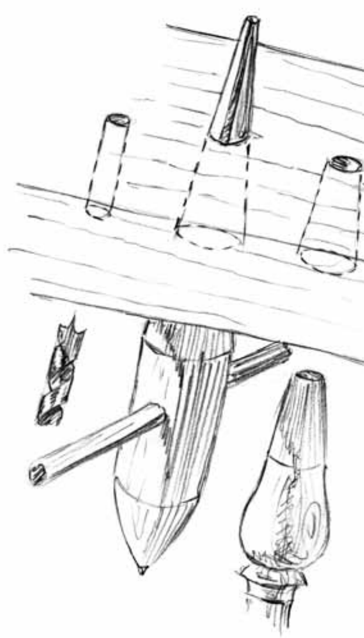



**FIG. 17.1** ***Tapered mortises are one of the foundations of Windsor joinery.***

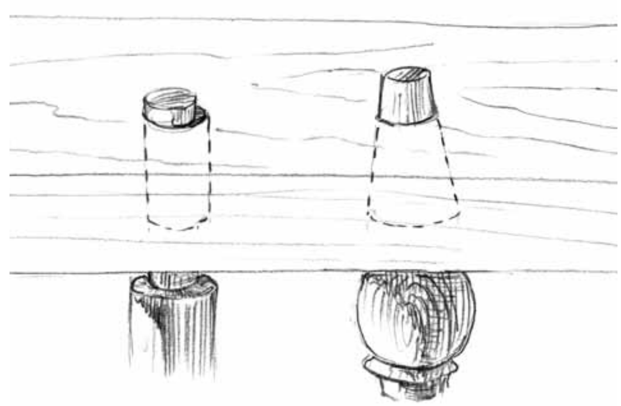



**FIG. 17.2** ***A tapered mortise and tenon is more about geometry than measurement.***

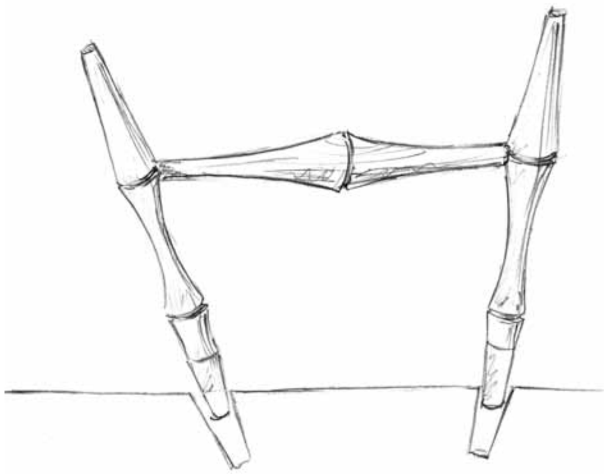


**FIG. 17.3** ***Structures with tapered joinery are easier to assemble.***

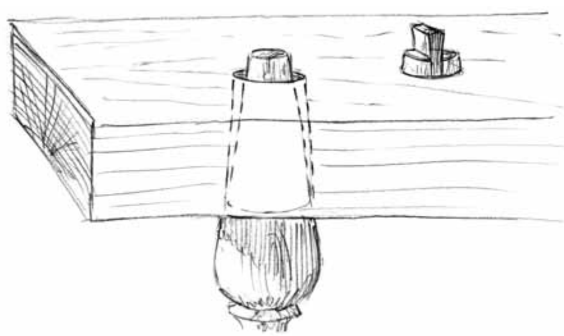


**FIG. 17.4** ***Wedges can increase the tightness of a tapered mortise-and-tenon joint at the exit.***

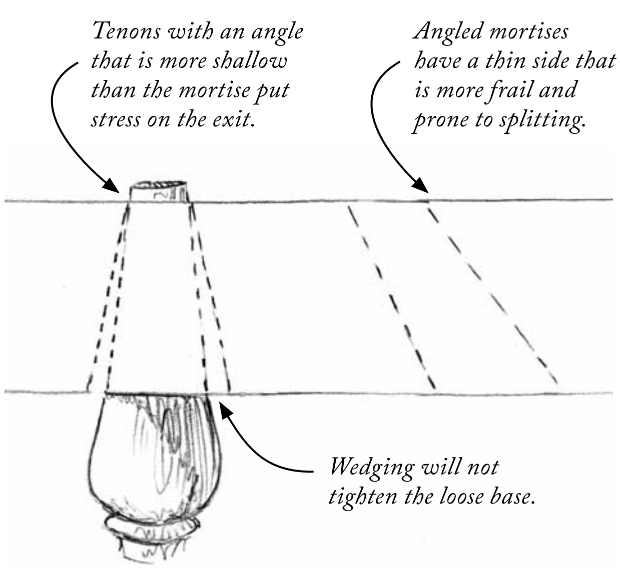



**FIG. 17.5** ***A too-small tenon at the base of the taper is troublesome.***

This feature of tapered joinery is especially helpful in chair assembly where multiple parts must be assembled simultaneously.

The mating surfaces in a cylindrical mortise and tenon are often glue-starved because glue is scraped away while the tenon is driven in. With a tapered tenon, the glue stays in place as the joint is assembled.

Plus, the ability to fine-tune the angle of a mortise while reaming gives great freedom of design in chairmaking, greatly simplifying your work with curved pieces. When working with curves, I often use points along the curve as references and make slight adjustments while reaming to ensure that the reference points are in the correct position.

Tapered tenons in chairs are usually matched to through-mortises. Driving a wedge into the small end of the tenon can tighten the joint, as well as add visual interest. While the exposed end grain of the tenon might increase the seasonal moisture exchange in the joint, wedging the joint adds to its tightness. In recent times, I've taken to double-wedging my tapered tenons where they pass through thin material to get the maximum locking effect.

A tapered joint that is loose at the top is preferred to one that is loose at the bottom. A wedge cannot tighten a tenon that is loose below the seat, and when driving such a tenon to depth, it is more likely to split the seat.

With the use of reversible hide glue, the joint is easily repairable. Slightly retracting a loose tenon will result in a gap large enough to add fresh glue to the joint.

## Types of Reamers

There are a number of reamers available commercially and they come in many shapes and sizes. You can also make your own.

I prefer a 6° taper on my tapered joints. Reamers often marketed as "chairmakers' reamers" are in the 11° to 12° range. While they form a locking joint, I've seen new chairmakers have difficulty with these reamers. The tools cut aggressively and can be difficult to control, especially in the beginning of the cut when there is little surface contact with the mortise. During the initial reaming with these larger tapers, you must remove more material before the taper "seats" fully. This gives too much time for the angle to get out of whack or for the hole to become misshapen.

Some reamers are meant to be chucked into a brace.

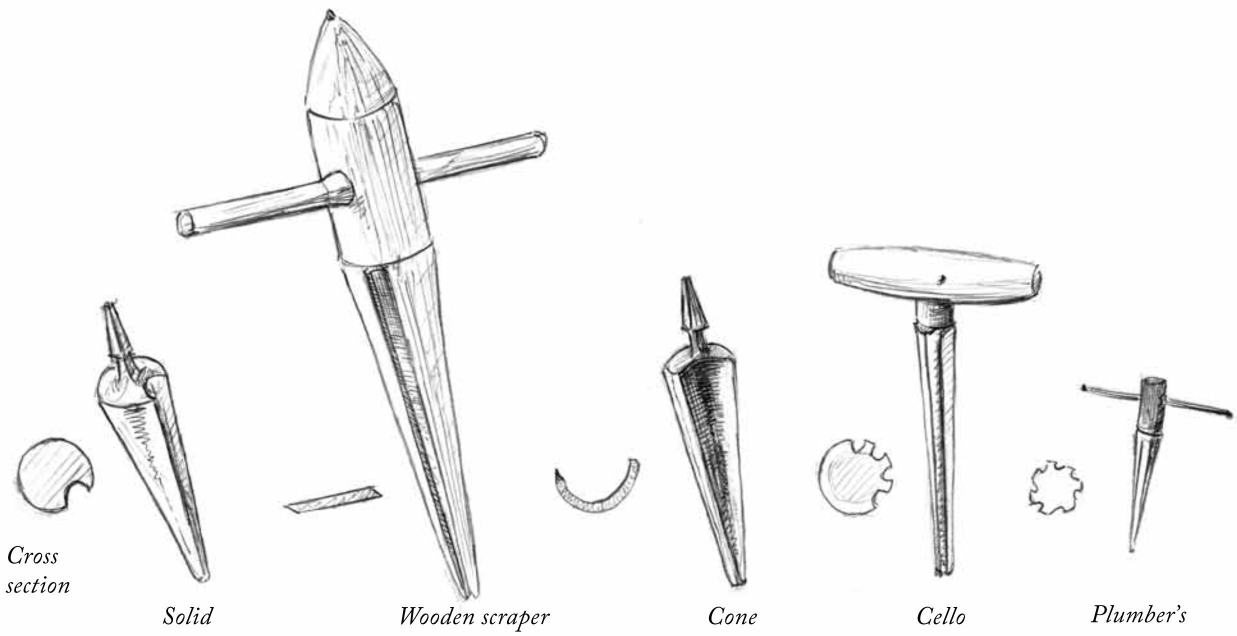



**FIG. 17.6** *Types of commercial and shop-made reamers.*

This adds an element of speed and leverage at the expense of control. It's a skill you could acquire, but it isn't the method I recommend for beginners.

I've found having a couple of different-sized reamers is helpful. A small plumber's reamer, sold at hardware stores, is a cheap and easy introduction to fitting small tapered tenons. While obviously not specifically designed to cut wood, the taper angle and the slower cutting action make the tool easy to control. I built many chairs that used this type of reamer for the arm-to-arm-post joints before investing in an instrument-maker's cello reamer. Luthiers use cello reamers for the tuning pegs on cellos and other stringed instruments. They come in a variety of sizes, and while expensive, they do a great job. As a matter of fact, they can be too aggressive, so care must be taken to not ream too fast, especially in thin arms. To keep these tools sharp, I use a diamond hone to carefully hone the edges, being careful not to touch the outer surfaces. I've also run a burnisher down the length of the edge to compress the edge and roll a small burr outward.

Early reamers were similar to spoon bits; they are basically half of a hollow cone that is sharp on one side. It's important that the edge be as far from the imaginary center of the cone as the rest of the radius or it won't cut. I focus on honing the interior bevel of the reamer and only touch the outer surface to turn the burr. Many of these tools will be soft like a scraper, so the burr will not fall off on its own and should be directed toward the outer surface to cut. These reamers obviously work, but they take expertise to sharpen and use.

## Scraper Reamers

When I was investigating the tools of the trade and trying to equip myself, I found that commercial reamers were expensive and older ones were hard to find and tune. Then I came across Jennie Alexander's web site with instructions to make a simple homemade reamer (see *greenwoodworking.com*). She developed this with Richard Starr, and I liked the simplicity of it and the fact that it could be made for next to nothing. The blade in this style of tapered reamer is usually an old saw blade or, in the case of the ones that I use now, 1075 spring steel.

After reading about this reamer, I marched directly to the flea market, bought a $2 keyhole saw and went to my little shop on 5th Street to make my first reamer. I followed the instructions on the web site, but instead of leaving the teeth on one side of the saw as Jennie recommended, I ground them off to create two clean cutting edges. I used that tool for 12 years.

The two main problems I faced with the shop-made reamer was that it was difficult to adjust the position of the blade, and shavings jammed inside the wooden body.

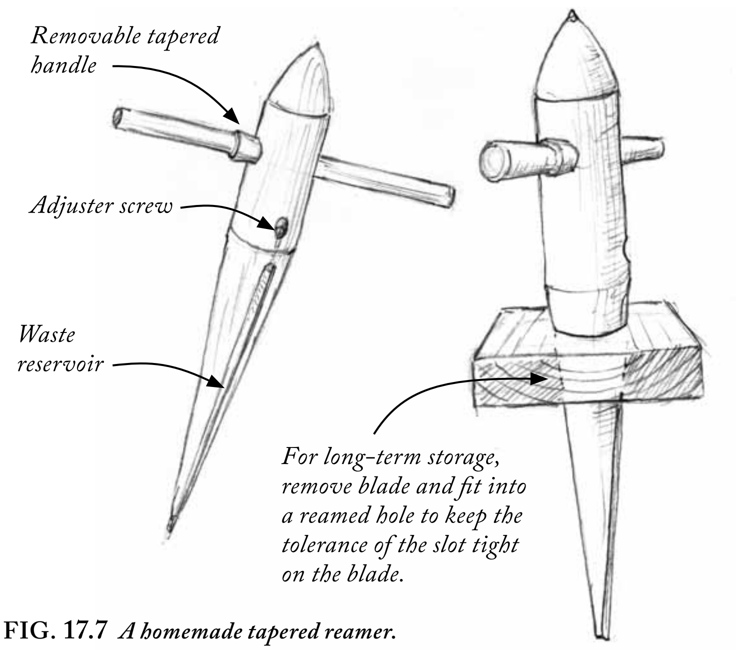



**FIG. 17.7** ***A homemade tapered reamer.***

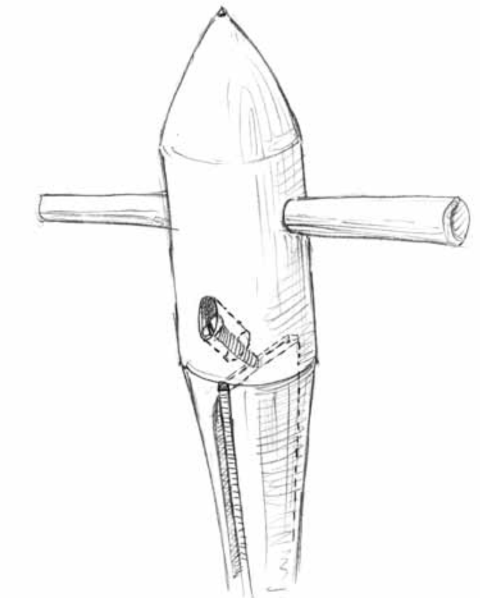


**FIG. 17.8** ***A screw adjuster for a tapered reamer.***

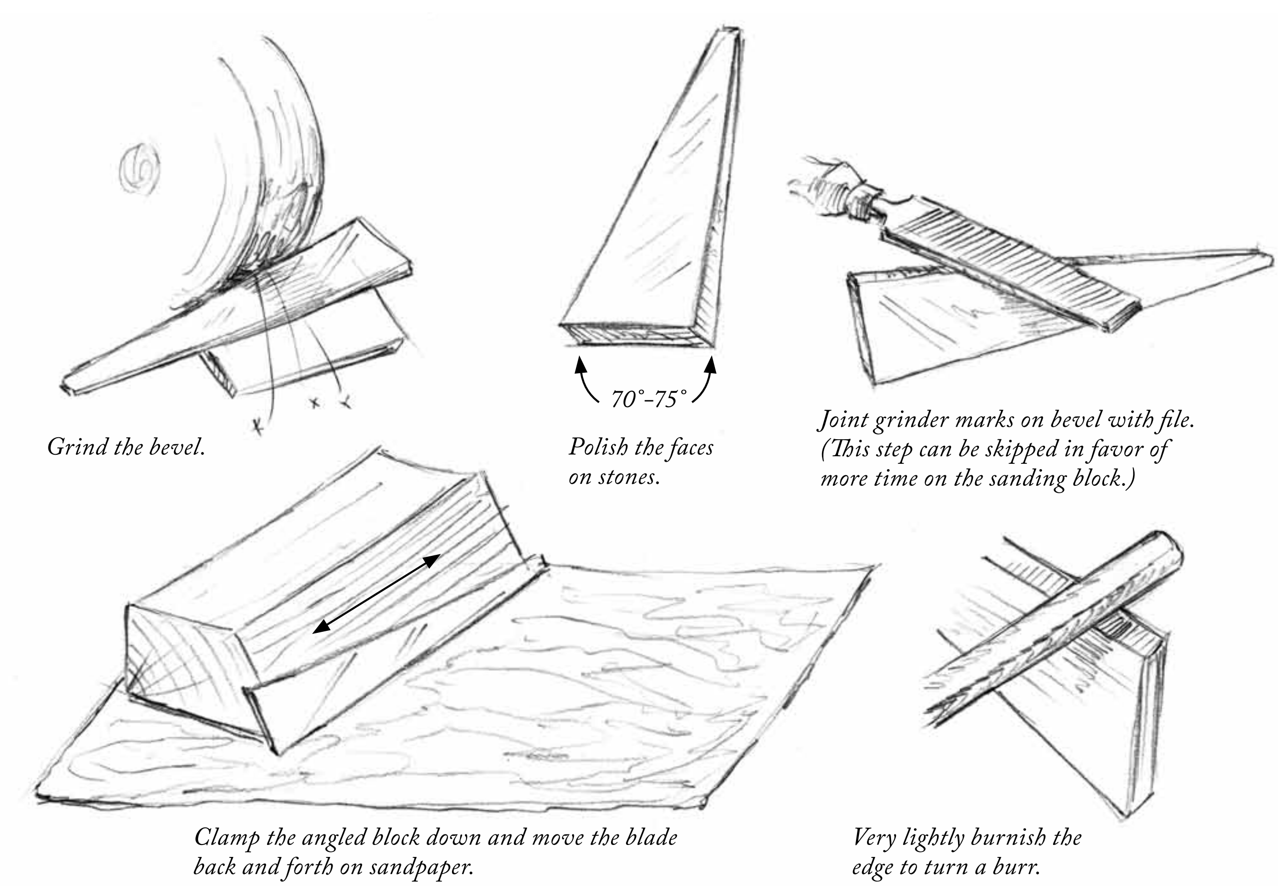
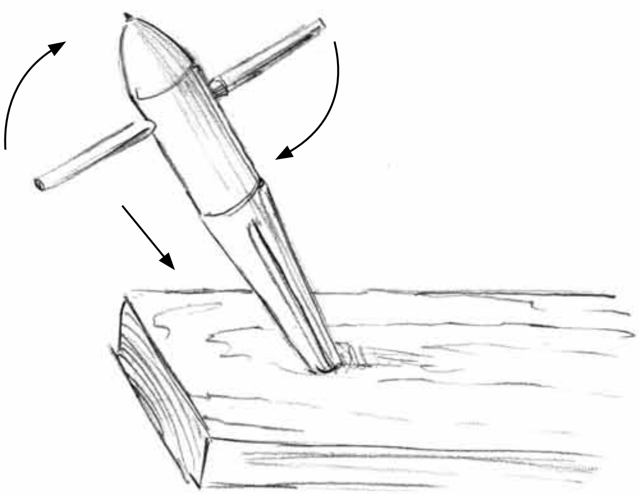



**FIG. 17.9** ***Sharpening the blade for the wooden reamer.***

Jennie swears by the helpful nature of the sawteeth for cutting the shavings up and preventing clogging. I've found that clearing the shavings every three or so rotations is good practice and helps keep any misalignment from sneaking up on you.

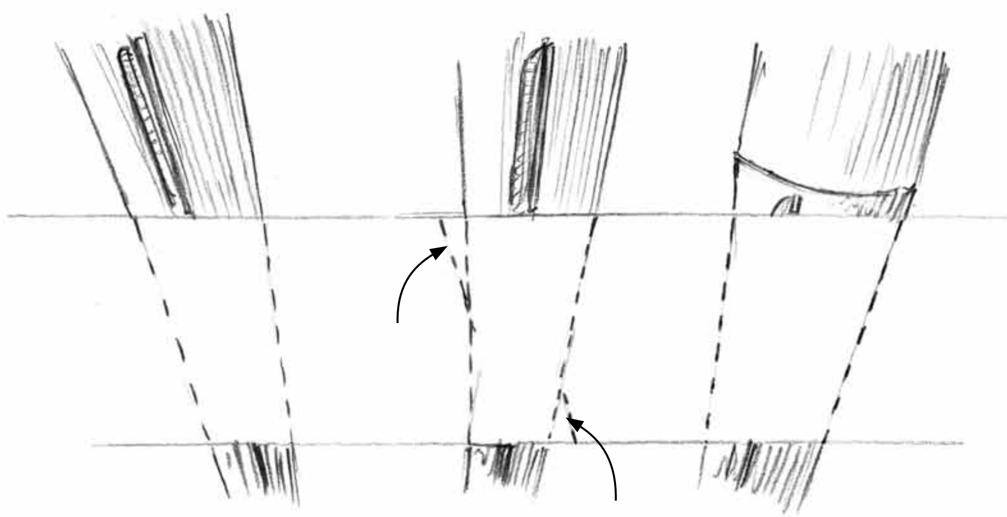
As for the adjustment issue, I got tired of jamming little shims behind the blade to advance it. Setting the tool to work well with different woods was a hassle, so I resolved to make a more sensitive adjustment. I designed the mechanical adjuster (shown at left) and, along with Tim Manney, the process for producing them. Tim builds these reamers and sells them.

By using a thicker blade, we could machine the slot in the body with a tighter tolerance that closes tight when placed in the mortise. This prevents shavings from



*Reamers operate with a rotating motion and downward pressure.*

*Good control comes from starting in a position that encourages full rotation.*

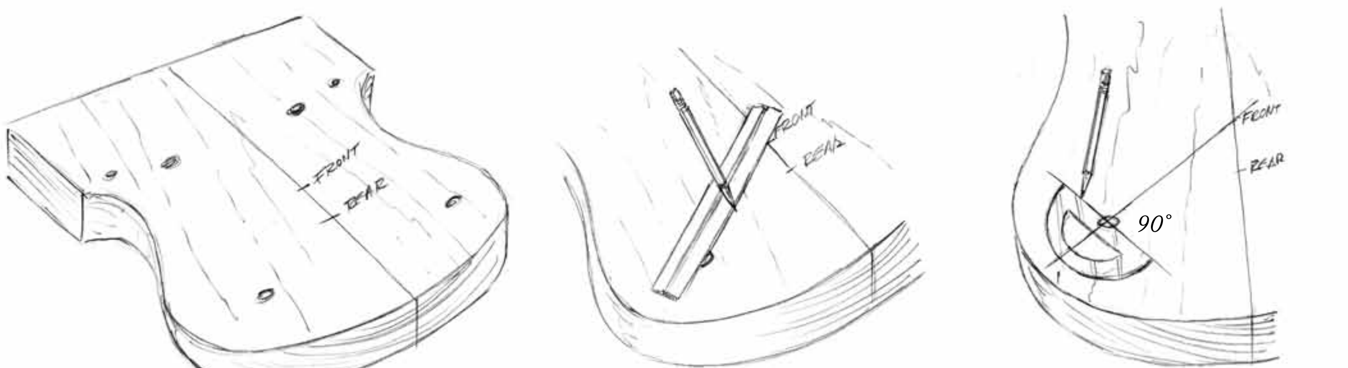


*The reamer must be fully engaged in the mortise, especially while adjusting the angle.*

*Otherwise, gaps may form.*

*Reaming to eliminate gaps may make the mortise too large.*

**FIG. 17.10** ***Techniques for proper reaming.***

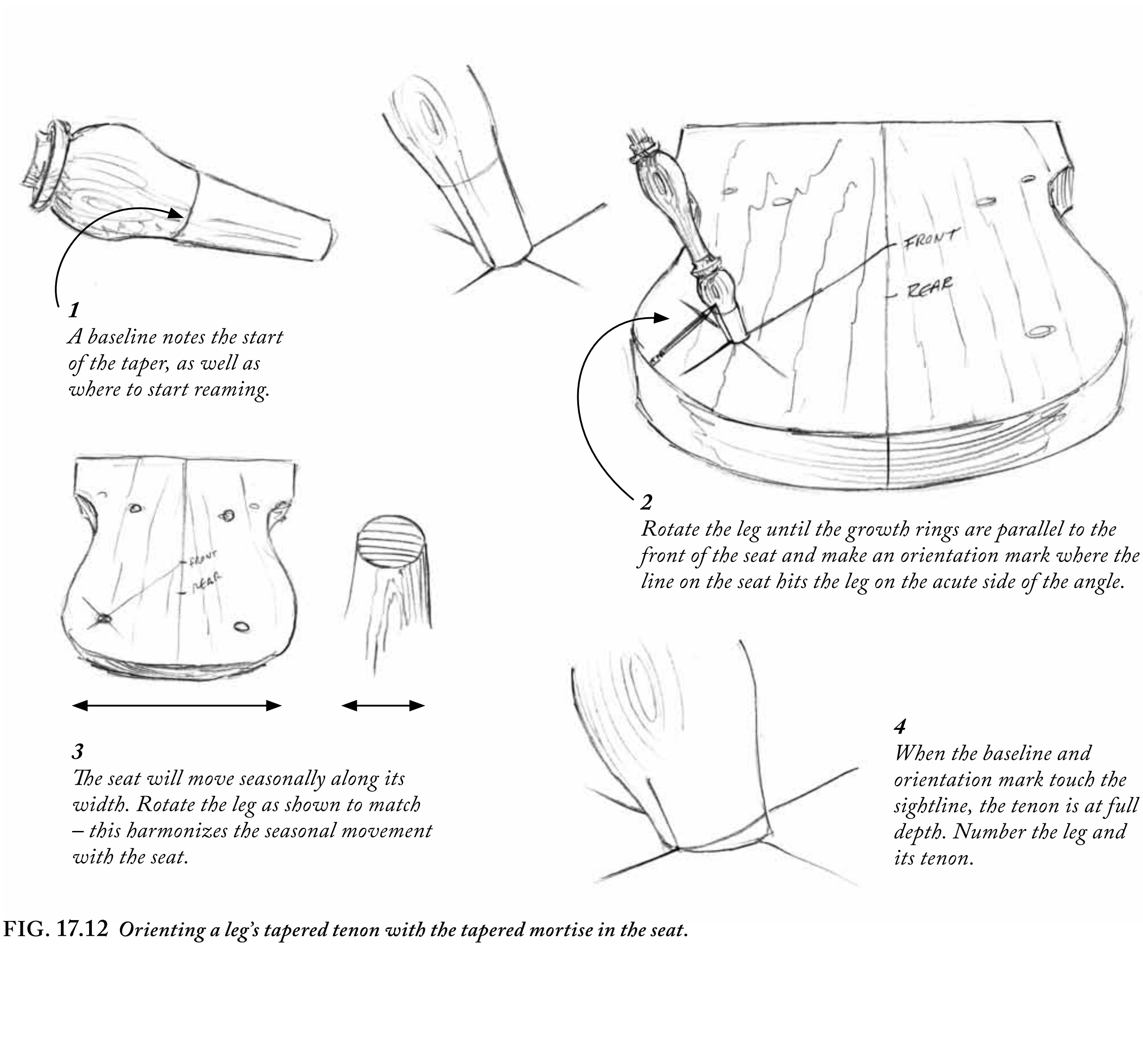



*Transfer the centerline and the locations where the sightlines for the front and rear legs intersect it.*

*Draw a line from the corresponding location on the centerline across the center of the mortise.*

*Draw a line 90° to the sightline, halfway across the mortise to form a "crosshair" for reaming.*

**FIG. 17.11** ***The sightline guides the vertical alignment of the leg, and the crosshair line is used to guide the resultant angle.***




***1***
*A baseline notes the start of the taper, as well as where to start reaming.*

***2***
*Rotate the leg until the growth rings are parallel to the front of the seat and make an orientation mark where the line on the seat hits the leg on the acute side of the angle.*

***3***
*The seat will move seasonally along its width. Rotate the leg as shown to match – this harmonizes the seasonal movement with the seat.*

***4***
*When the baseline and orientation mark touch the sightline, the tenon is at full depth. Number the leg and its tenon.*

**FIG. 17.12** ***Orienting a leg's tapered tenon with the tapered mortise in the seat.***

clogging the body. While the tool must still be removed every few turns to allow the shavings to drop out of the trough, it isn't necessary to remove the blade from the body to clear them.

Making or sharpening a blade for a wooden reamer is a lot like sharpening a scraper. First a suitable steel, such as an old keyhole sawblade or spring steel, must be ground to shape; take care not to soften it by getting it too hot. Polish the faces brightly, then joint the edges straight and at the correct angle. Finally, hone the edge on fine sandpaper by moving it against the face of an angled block and burnish it to turn the burr. Resharpening can consist of as little as reburnishing the burr, or it might require revisiting the more aggressive material removal of the previous steps.

## Reaming

When the tenon is dried and shaped, it's time to ream the mortise. If you are new to reaming, practice on a couple of holes in scrap wood first. Be sure that the scrap is the same species as the wood you will be reaming in the chair. If the reamer catches or doesn't cut enough, adjust the depth that the blade is exposed beyond the side of the reamer body until it spins easily in the hole while taking a light cut.

Don't worry about achieving a specific angle at first; just get used to the reamer's cutting action as you spin the tool in the hole. Remove the reamer from the hole every few turns to clear the chips and note how quickly it advances for the number of turns taken. Then try to gently alter the angle in the hole by applying a little extra pressure in one direction. The key is to use a rotary motion while simultaneously applying the correct downward pressure to influence the angle. If the amount of angle correction is greater than rate that the hole is enlarging, then the hole will become misshapen and not form a solid joint.

I suggest creating this problem in a practice hole before running into it on your chair. The solution, if there is enough material left to remove, is usually to ream deeper. Focus on reestablishing the correct geometry of the hole – at the expense of the angle if need be. I'll address other fixes for reaming errors later.

Before reaming a mortise, I always make sure to have the corresponding tenon ready. Each mortise is reamed to fit one specific tenon, then the parts are assigned to each other. Be sure to use a clear labeling method to avoid mixing up the legs. Tenons, either turned or made in rounders, will all be of a similar size, but they may still vary slightly. Assigning a specific tenon to a specific mortise allows you to compensate for any variations in the size of the tenon or warped parts.

To create references for alignment while reaming, I transfer the sightlines from the pattern to the underside of the seat. First I cut out the front of the seat but leave the excess portion beyond the spindle deck for clamping. Then I place the pattern on the underside of the seat and transfer the centerline and the points on the centerline where the sightlines for the front and rear legs intersect it.

When forming the tenon, I mark the diameter for the larger end of the taper with a score mark 2½" in from the top of the leg. This baseline mark is where the tenon begins to taper. Correct sizing at this point also helps to ensure consistent sizing of the tenons.

Before reaming, I determine the depth of the reaming via the mark where the taper begins on the tenon of the leg. This will usually be a 15⁄16" diameter on legs. Reaming stops when the mark at the base of the tenon first makes contact with the seat, which be will where it touches the sightline at the acute side of the resultant angle.

The rotation of the leg in the mortise is determined by aligning its growth rings perpendicular to the long fibers of the seat. The ensures that the direction the leg moves the most is aligned with the seasonal movement of the seat. Once I have the rotation of the leg correct, I draw a line up the tenon to the baseline of the taper. This helps to reorient the leg during assembly.

I use a shop-made bevel square and a try square to guide my reamer and measure the results. I strive for all the accuracy I can muster, both in the way I ream and in

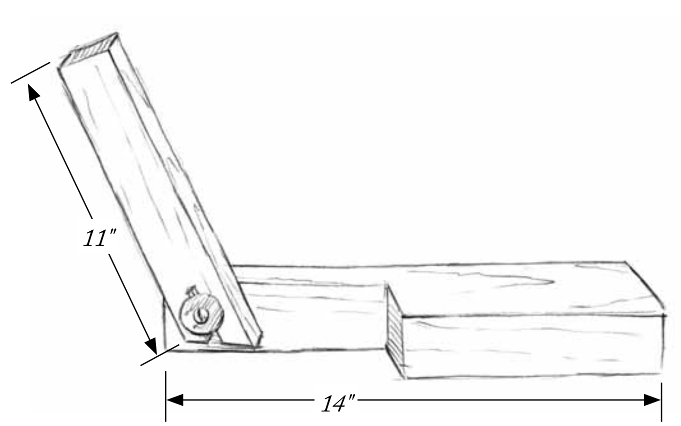



**FIG. 17.13** *Details of a shop-made bevel.*

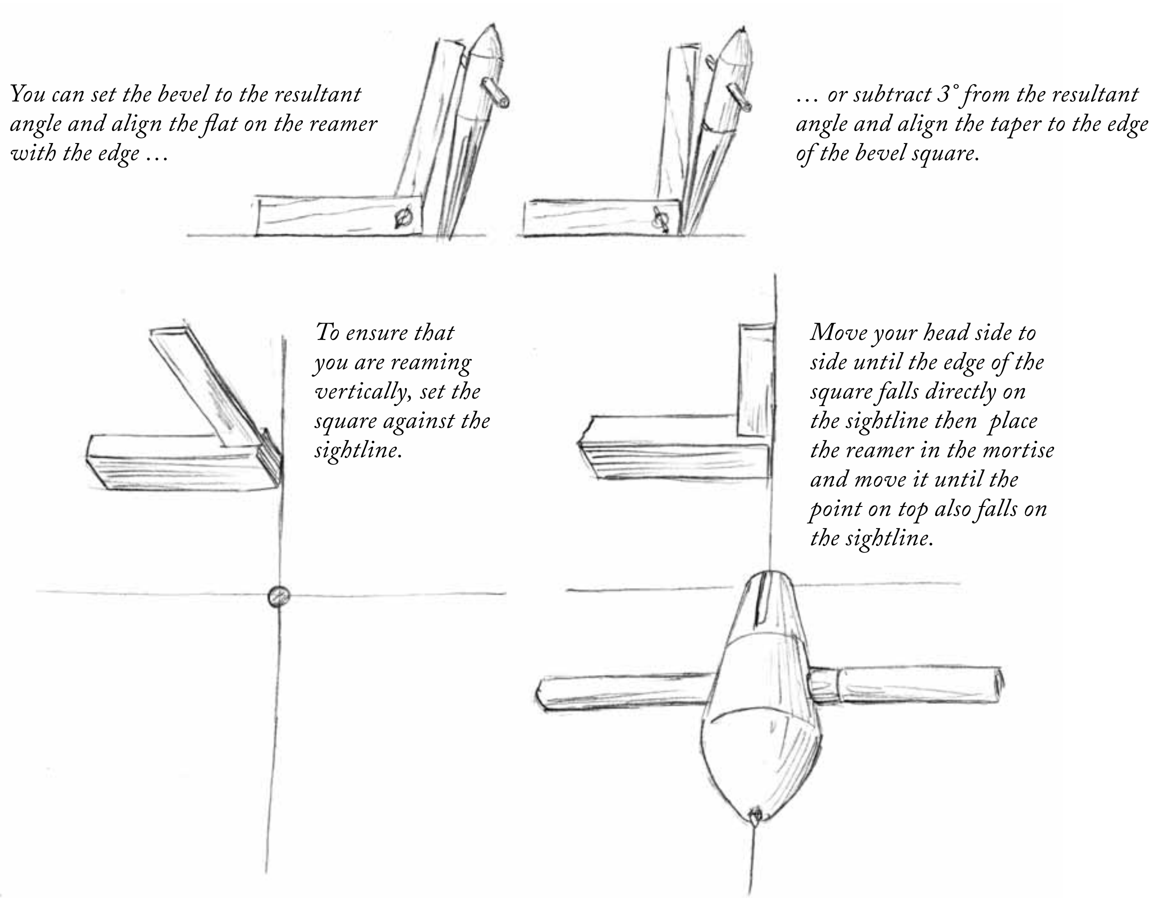



**FIG. 17.14** ***How to use the bevel when reaming the leg holes.***

the way I measure results. This is one of those instances where a less-precise method might achieve acceptable results for the forgiving leg angles, but that method might not be reliable for more critical parts, such as the posts on a fan-back.

The shop-made bevel is quick to make, and the broad surface of the blade helps make sighting the angle easier, especially for those new to the job.

When you begin reaming, the tool will not make contact with the hole except at the edge. This makes it difficult to keep a consistent angle as you start, but the process allows for correction. It is important to reference against the bevel square and square, and to check the angles again as soon as the reamer seats in the hole.

Align the reamer to the correct angle by placing the bevel against the flat portion of the reamer near the handle. Or, if your reamer doesn't have this flat, simply subtract 3° from the angle you are drilling and place it against the tapered part of the reamer. (The 3° is half of the 6° reamer.)

If you do this, remember to reset the bevel to the correct angle when you start judging the angle using the leg instead of the reamer.

Take only two or three turns, remove the reamer to clear out the shavings and check the angles. If you are using the shop-made reamer, you'll might need to pull the blade from the slot to clean out shavings jammed in the kerf. The reamer I use doesn't require removing the blade, but running a brush or pencil down the kerf may be needed to free chips that become impacted if you ream more than a few turns.

By placing the reamer in the hole and fixing your viewpoint with the square, you can check the accuracy of the vertical alignment.

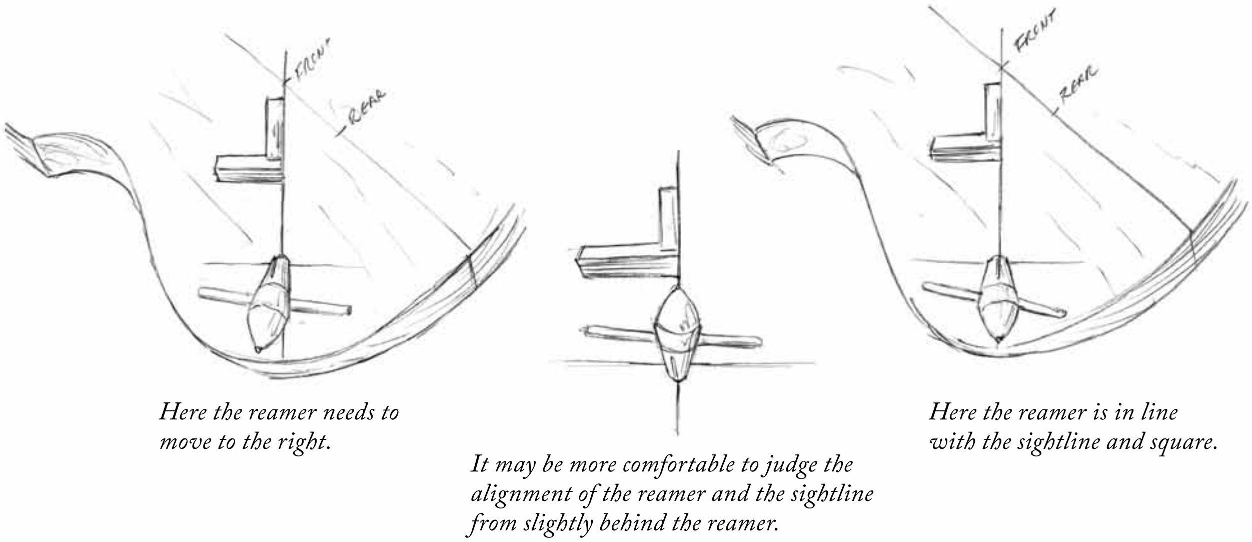



**FIG. 17.15** ***Note that the viewpoint of the square aligned with the sightline is the same in all the above images.***

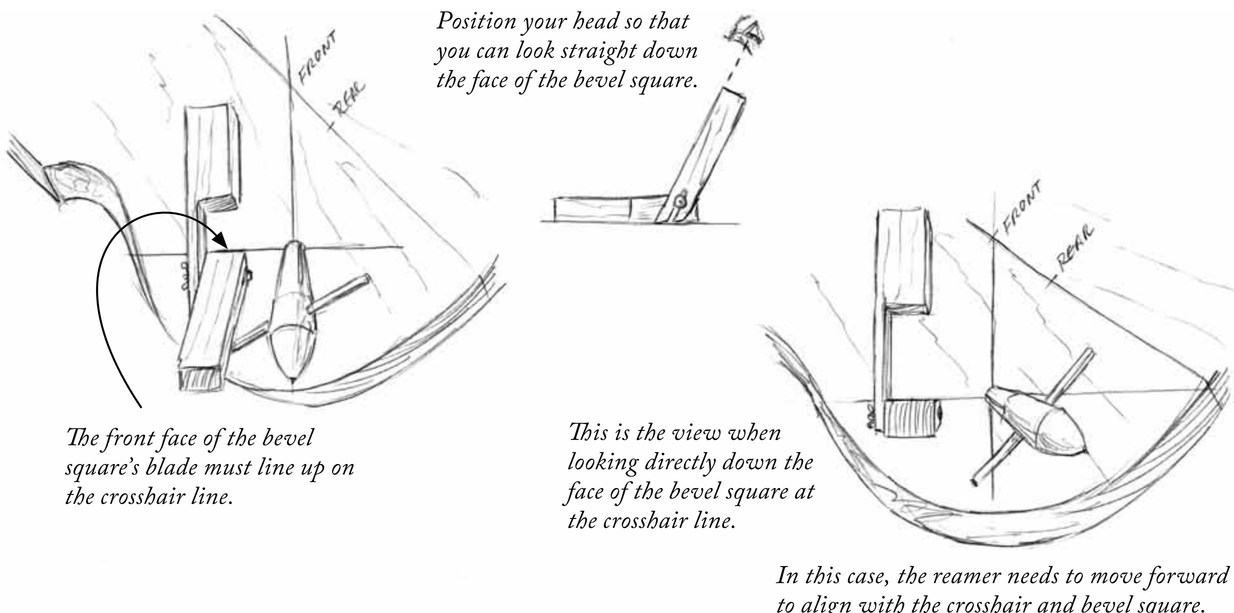



**FIG. 17.16** ***Checking the resultant angle alignment with the bevel.***

Now that the reamer is firmly registered in the mortise, I use a more accurate method for assessing the resultant angle. Place the bevel so that it is touching the crosshair line as shown and sight directly down the face of the bevel square. Then note the location of the center mark on the top of the reamer.

If the reamer is out of alignment, which it probably will be, note which direction will correct it and ream again. This time put extra pressure laterally on the reamer in the direction you want it to move. Be sure that the reamer is fully seated in the mortise when adjusting the alignment. Worse than a slightly off-angle leg is a

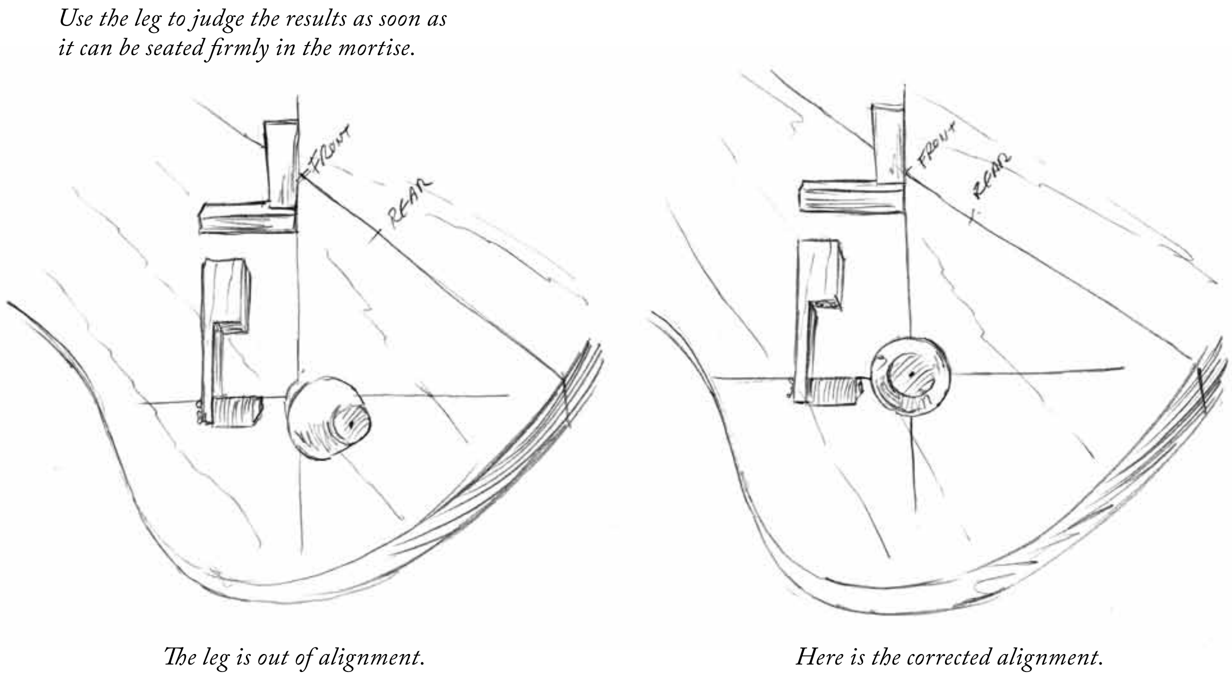



**FIG. 17.17** ***Even though the assessment of the vertical alignment and resultant angle can be made separately, this image shows both squares being sighted at once.***

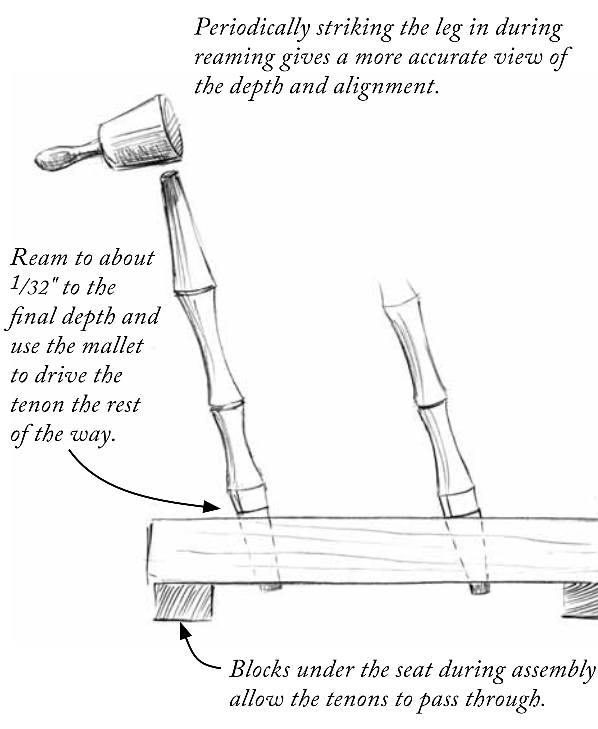



**FIG. 17.18** ***Check the fit and angle of the leg periodically as you ream the mortise.***

misshaped mortise that will not create a good joint. Usually you will need to correct a bit for both the vertical adjustment and the resultant angle at the same time.

As soon as the leg fits into the mortise, use it to check the fit, and use the center mark left by the lathe to check the alignment.

Because the leg is longer than the reamer, it offers a more accurate assessment of the angle. Plus, if the leg is warped, it's more important that the footprint of the chair be even, which will make the warping a non-issue.

To finish the job, repeat these steps until the leg almost advances to the line around the end of the tapered tenon. As I approach the line, I tap the leg into the hole, which can cause the angle to shift a bit. This is good to note early so you can adjust for it as you go. Stop about 1/32" shy to allow for pounding the leg into the mortise. The sound of tapping the leg will change as the tenon seats fully from a light "ting" sound to a dull "thud."

A tapered tenon acts as a wedge, and while the seat material is thick, the angle of the mortise leaves a thin side of exposed end grain. It is possible to split the seat while driving in the leg. This is usually due to a tenon that is not tapered enough or a seat that isn't properly dried.

Reaming a leg is a lot like watching an airplane come in for a landing. It is a series of subtle corrections and over-corrections that add up to a safe landing. The joint will change throughout the process, even when you are not trying to adjust the alignment. It is easier to adjust the alignment early on when the reamer is making contact with less of the mortise than near the end. Attempts to make large changes in alignment often overshoot the goal or misshape the mortise.

On matching parts, such as the front legs, I start with the smaller of the two tenons. I do this in case my reaming needs improvement after the smaller tenon is reamed to full depth. If that's the case, I substitute the troublesome piece with the leg that has the larger tenon to gain a couple more turns. Of course, this second chance can be taken only once, and you try to be more accurate on the second one. It's also not a bad idea to ream in symmetrical parts at the same time to ensure that they match. I don't do this; instead, if my first leg is a degree or two off, I simply adjust my bevel and ream the second to match. While my goal is always perfect reaming, small deviations from the goal are usually not obvious, especially if the corresponding symmetrical part matches.

If you do choose to ream both front or rear legs in tandem, you can use winding sticks to check that they are raking at the same angle. A line across the axis of the seat helps to visually check this, or you can set a straightedge at the base of each leg and one at the end. This technique is shown below when reaming the fan-back posts.

Once each mortise is fully reamed, I label each leg with the location of the mortise that it fits. As improbable as it sounds, most assembly screw-ups come from poor labeling. I prefer to use "left" and "right" and "front" and "rear" marked on my legs, because it always enables me to locate the correct mortise with only the information on the leg. Whatever you choose, be consistent and don't try to be discreet with the labels; make them clear and obvious. It's sad to see a chair that has all the right geometry get screwed up just because the legs are put in the wrong mortises.

## Reaming Problems

Following are some of the problems you might encounter when reaming and how to deal with them.

### GAPS

Gaps or misshapen mortises usually result from attempting to correct for grossly misaligned mortises or from not putting enough downward pressure on the reamer while making lateral adjustments. Reaming the mortise wider and turning a slightly larger tenon is a good fix for this; it avoids plugging and is usually undetectable.

### MORTISE REAMED TOO DEEP

A couple of spins of the reamer is all it takes to make a mortise too deep. The baseline on the tenon will fall partially beneath the surface of the seat. This means that there is slightly less of the tenon in contact with the mortise, which is not a structural problem. If the tenon seats substantially lower, it may be smart to lower the symmetrical mating part the same amount to limit the effect on the stretcher alignment.

### WRONG ANGLE

If the mortise is reamed at the wrong angle or simply poorly reamed, there is the option of shifting the position of the other symmetrical mating part to match. If this is not an option because it is already positioned or the angle is too extreme, you can plug the hole with a tapered plug or turn another part with a larger tapered tenon to gain another few turns of the reamer for correction. Keep in mind that the perception of the angle being out during reaming is usually greater than when the chair is complete. With all the parts joined, moderate differences in the angles are not perceptible.

### UNABLE TO ADJUST DURING REAMING

If you are unable to make the adjustments necessary during reaming, look to the condition of the tool and possibly your technique. You might be favoring a lateral direction while spinning the reamer without being aware of it. Also, a dull reamer may have trouble cutting the end-grain portions of the mortise and will nudge you in undesirable directions. Also, you should check the reamer as it exits the bottom of the plank to make sure there is nothing impeding its movement.

## Ream the Fan-back Posts

Reaming the rear post for the fan-back is similar to reaming the legs, but the relationship of the posts to each other and to the seat has a greater impact on the comfort and appearance of the chair. The problems that you will run into are: Your posts are reamed too far back or forward, they are misaligned with one farther back than the other, are windswept (see below) or are not the correct distance apart at the top.

The process begins with reaming, just like with the legs, at the angles prescribed by the pattern and following the sightline and crosshair line. But once you can fit the posts in, use the center mark on the top to judge the angle. Be sure to orient the posts for seasonal movement and to put them back in the mortises in the same orientation each time, otherwise slight warping of the posts can keep you chasing inconsistent results.

In a perfect world, if the mark on the top of the post is aligned with the sightline and the resultant angle, then you are set. But I find it more practical to observe the results as I ream to compensate for any imperfection.

There are a few methods for ensuring that the posts are aligned correctly to each other and the chair. Most of these techniques require that you ream the posts to the same depth to get accurate readings. I perform each of these tests every time I ream a few turns. While this might seem like a lot of work, keep in mind that the position of these posts is critical to the geometry and appearance of the chair.

First, I check for twist in the rake of the posts by setting a straightedge at the top of the posts and sight down to the spindle locations on the seat top.

Then I take diagonal measurements from the base of the post to the top of the other post to see if the posts are windswept. This measurement is unreliable if the posts are reamed to unequal depths. If the numbers are not equal, I check the sightline plane to see which is the issue.

Then I check the center-to-center distance between the posts at the tenon lines at the top. This line is found on the pattern and marked with a pencil during the turning process. The distance should be approximately 18¾" apart, but keep in mind that this distance is final when the posts are fully seated, so it will be slightly larger during the process. The same sighting process for checking the vertical plane for windswept posts will show which post to adjust if the distance is incorrect.

Once the posts are reamed about halfway to the baseline, use spring clamps to hold the crest to the back of the posts at the height of the tenon line. Use a protractor with string tied to it to check the angle to a point about 3⁄16" in front of the center of the crest. The 3⁄16" measurement accounts for the final location of the center spindle once

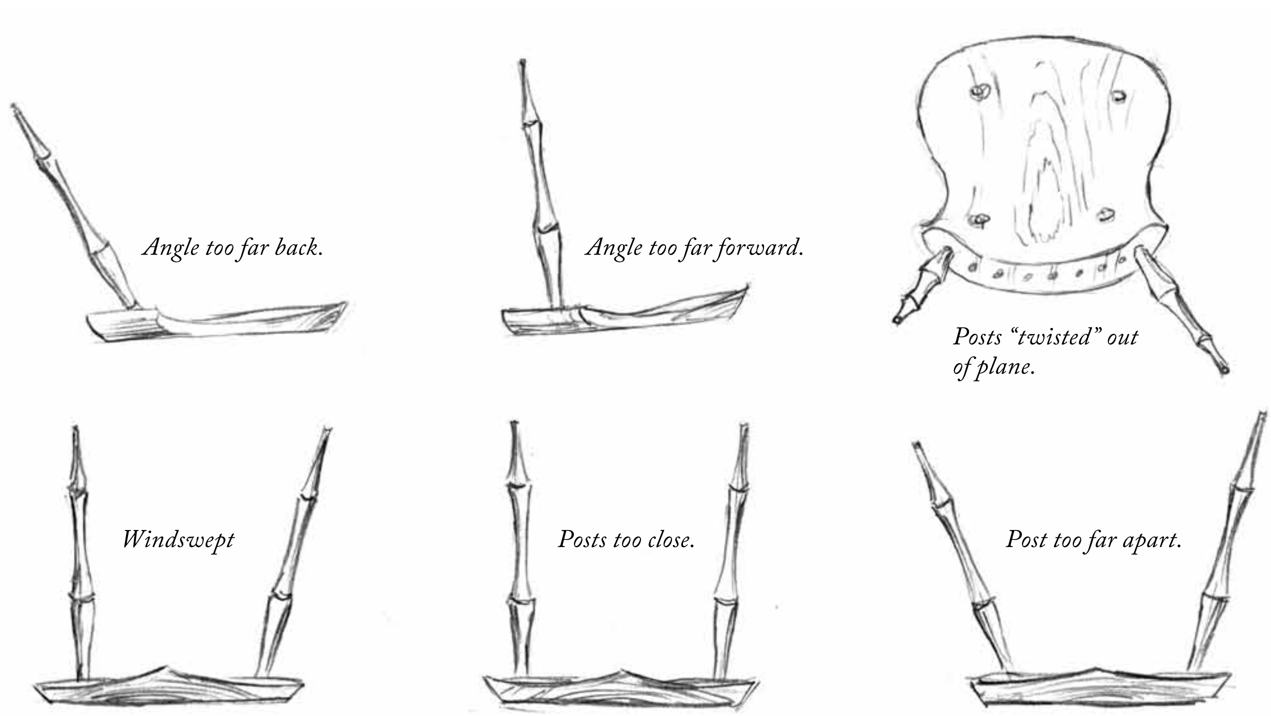



**FIG. 17.19** ***Errors when reaming the back posts of the fan back.***

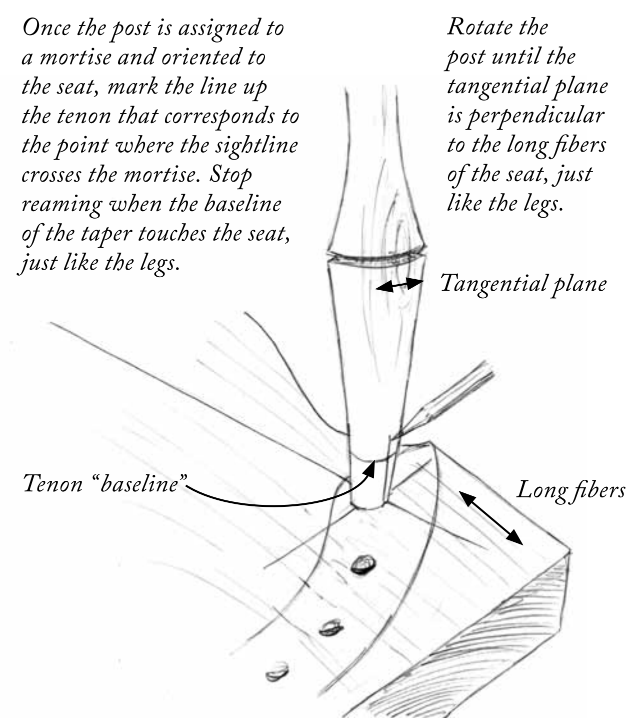



**FIG. 17.20** ***Reaming the posts for the fan-back chair.***

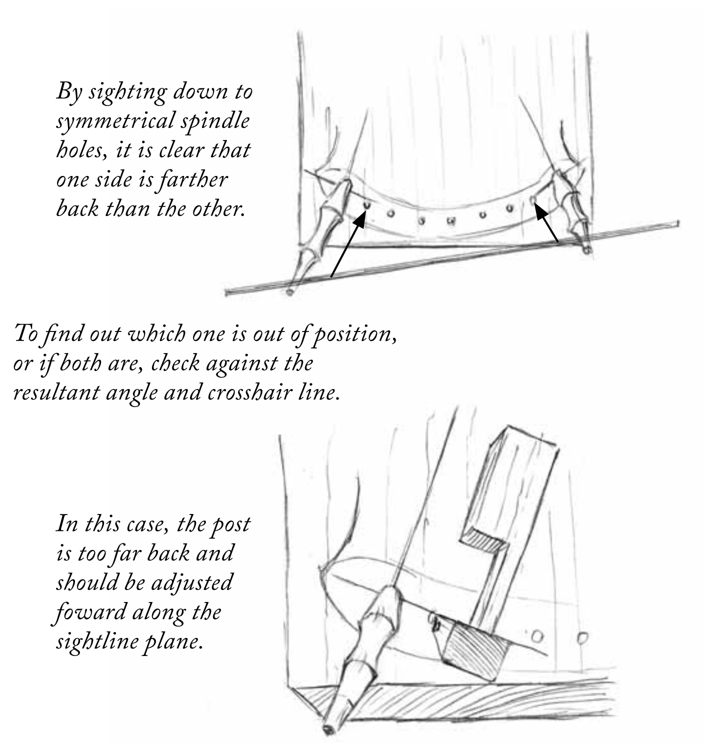



**FIG. 17.21** ***The first test for checking the angle of the rear posts.***

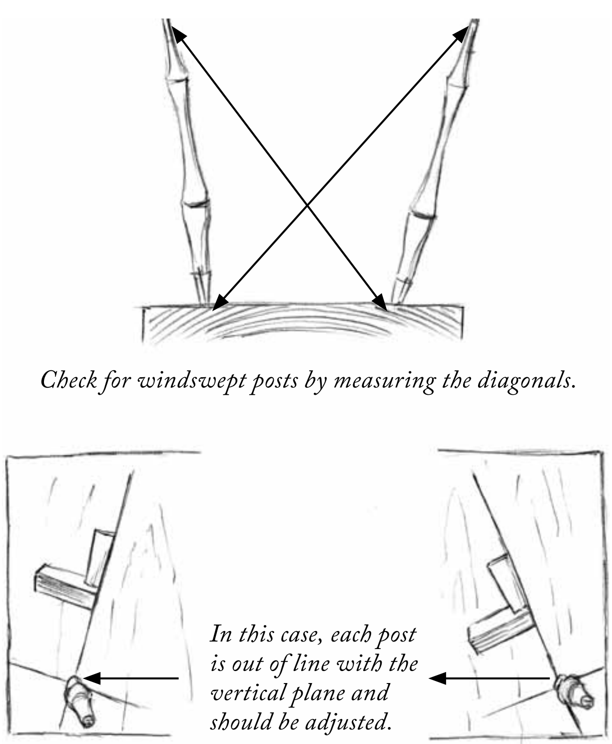



**FIG. 17.22** ***The second test checks for posts that are windswept.***

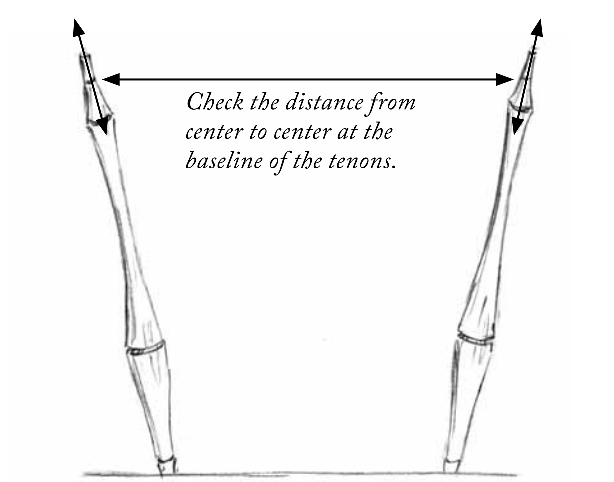



**FIG. 17.23** ***Check the distance between the tenons and compare to the plan.***

the crest is placed on the posts (instead of behind them). The goal of 9° or 10° will tell you whether they should be reamed forward or back.

Once again, check to see how the results of this measurement relate to the others.

You can also use the protractor to check that the center spindle is vertical to the seat in splay. If it isn't, then the posts are likely windswept. In this way, the problems found in one measurement will usually show up in many of the checks. Another example is if only one of the posts is too far back, then the center-spindle measurement will likely be too far back as well.

There are only two posts, but reaming them correctly is essential. So if you are unsure, take a moment to drill and ream them into a practice piece to get used to the process and the measurements. Once again, you will take a couple of turns in each mortise then repeat all of the measurement checks.

Once the posts are reamed, take a step back and a deep breath; you've passed one of the substantial hurdles. If the posts are too close or far apart, there is enough play

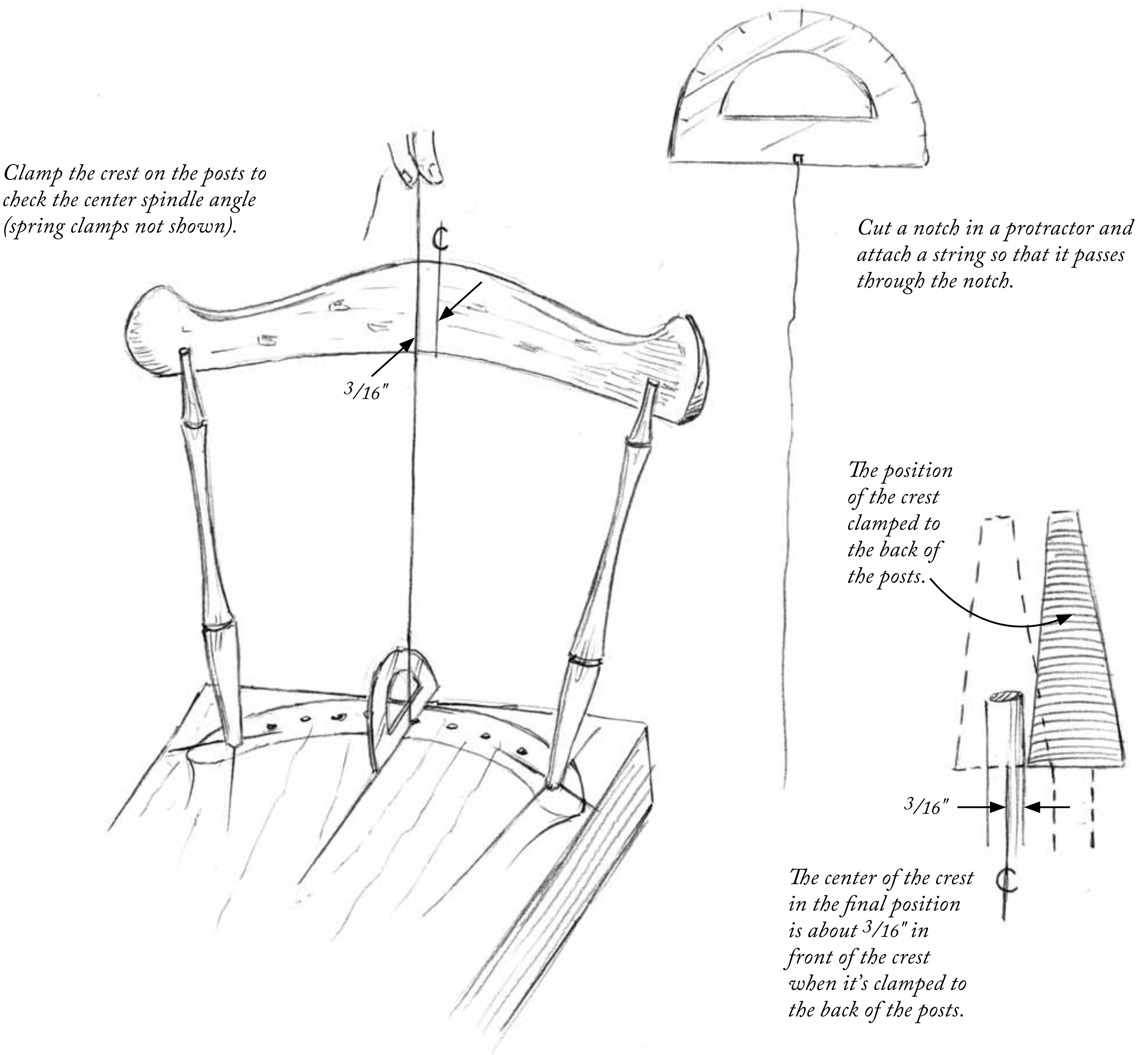
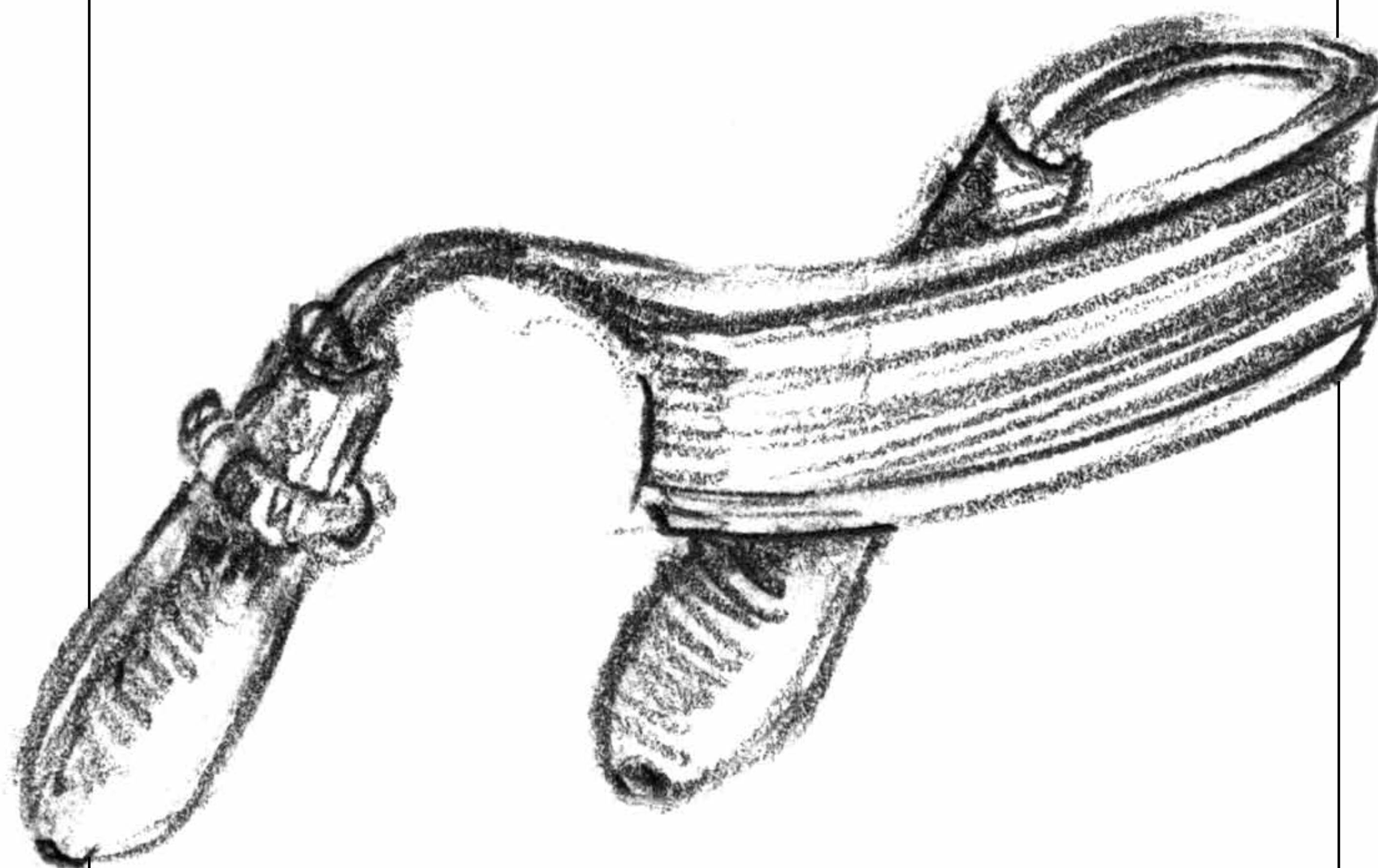



**FIG. 17.24** ***How to check the angle of the center spindle.***

in them to fine-tune them during the marking and drilling of the crest. If they end up dramatically windswept or at different rakes, you can use a heat gun to bend them slightly to make up for it. Sometimes, a slight warp in a post can be used to your advantage by rotating the post, while keeping the correct harmony with the seat. Be sure to have clear marks noting which post goes to each mortise, and the rotation for aligning during assembly.

## Conclusion

Good reaming is critical to ending up with a chair that meets your expectations. Reaming offers the ability to fine-tune the position of parts and reference them in such a way to greatly refine the construction. I've seen a great difference in the results possible with well-tuned reamers, yet it's easy to overlook these tools because you can't easily see the cutting edge in action. While reamers aren't the most glamourous tools, spending the time to understand and tune them will make your experience more pleasant and successful.



# 18

# Tools for Seat Carving

There are many ways to carve a seat and many tools that can be used to do the job. A good seat can be shaped with almost no tools, but you should expect to work a bit extra to achieve your results.

To those new to seat-carving tools, they can seem downright exotic, but all of these follow the same basic sharpening process as other tools. This chapter shows how to maintain the tools that I've found useful for carving a seat consistently and quickly.

I use a few different widths and sweeps of gouges for jobs such as carving the gutter and trimming the legs where they protrude through the seat. When I first tune a gouge, I polish the inside flute to a high sheen. For this, I use a carver's buffing wheel charged with honing compound, or diamond hones and dowels with sandpaper. Any combination of these that eliminates the scratch pattern and creates a polished surface is fine. The final stropping of the flute slightly dubs over the edge from the inside. This changes the geometry and strengthens the cutting edge, allowing me to lay the bevel back on the tool to a low angle, usually about 22° to 25°. I find that a low angle on the bevel cuts more easily.

As for the bevel, the gouge is one tool I don't hollow-grind. I prefer to keep the bevel flat by freehand-grinding

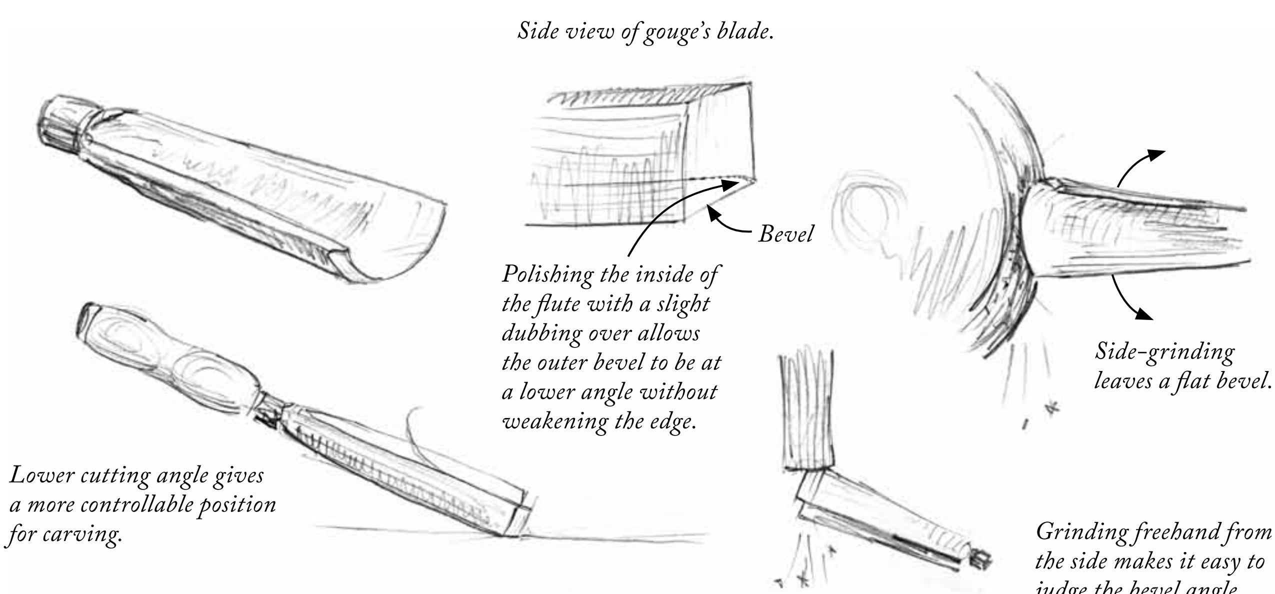



**FIG. 18.1** ***Polishing and grinding a gouge.***

it sideways, like an adze. It's not as difficult as it sounds because you can see when looking from above that the whole bevel is in contact with the wheel.

You might recall that I showed how flat bevels tend to round easily on stones; well in this case, it actually helps the tool function when carving. Think of carving into ice cream with a spoon.

I keep a flat profile at the front of the tool for consistent grinding and carving. Usually this entails blunting the edge to a flat then grinding the bevel until the blunted area disappears. It's easy to go too far and lose the flat profile.

Once the tool is ground, you can hone the bevel on stones then dub the edge slightly on the strop as described above. The amount of rounding will affect the cutting angle of the tool so proceed with care. When the edge becomes too rounded from stropping and use, regrind.

In my shop, I usually go straight from the grinder to the buffer that has a Bear-Tex wheel mounted on it. The Bear-Tex is a nonwoven-abrasive wheel that removes metal at a rate somewhere between the grinding wheel and buffer. It shoots small sparks as it abrades the metal and can heat up past the point of no return for the temper, so I take it slow and keep my pressure light.

The Bear-Tex can round the edge, so I take great care to keep the bevel tangent to the wheel. It's also critical to keep the edge of the tool pointing the same direction as the rotation of the wheel to avoid catching it, which can gouge the wheel and grab the tool from your hands.

The wheel removes material quickly but leaves a fine enough surface to go straight to the hard-felt buffing wheel. This second wheel is charged with honing compound and is mounted on the other side of the machine. I use a .5-micron green buffing compound to polish the bevel and remove the burr from the flute.

I find that I can sharpen a tool rapidly this way and the results are excellent. Faster sharpening means that I am more willing to stop what I am doing to tune my tool.

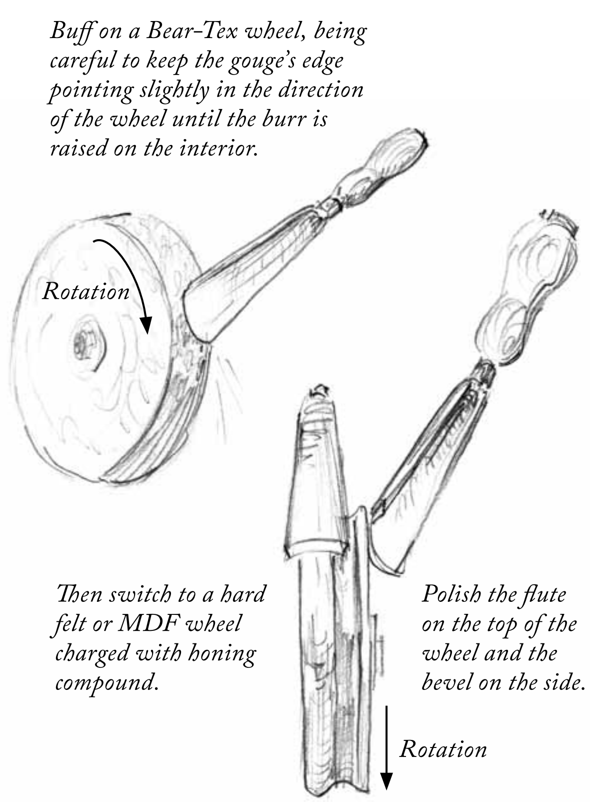



**FIG. 18.2** ***Finish-sharpening a gouge to prepare it for work.***

## Adze

The adze is like a gouge, but rather than striking the end of the tool with a mallet, the force is supplied by swinging it like a hammer. I use an adze to hog out much of the waste material in the seat. When correctly shaped and weighted, the adze can cut with surprising control and leave a clean surface. The trouble is that most adzes were designed for some task other than carving seats, so a little extra awareness of the tool and its geometry will help when tuning them for this use.

The adze is often soft steel that could be abraded with a hard file, but I don't recommend it. A finely honed adze will stay sharp longer and leave a much better surface. There are two configurations for adzes: one with the bevel on the outside (out-cannel) and one on the inside (in-cannel).

The adze process is called "hewing" and requires two steps. First, you make a series of consistent-depth cuts as shown at right in a pattern of rows resembling fish scales. When striking each row, the direction of the swing is toward the previous row. This leaves the chip unsupported and allows a weak layer to form at the depth of the cut. Then you clear the broken chips to the depth of the initial blows. When the geometry of the tool and the swing is correct, the adze follows a radius that will take and clear loose chips.

This is a controllable method, and practice brings speed and certainty to the process.

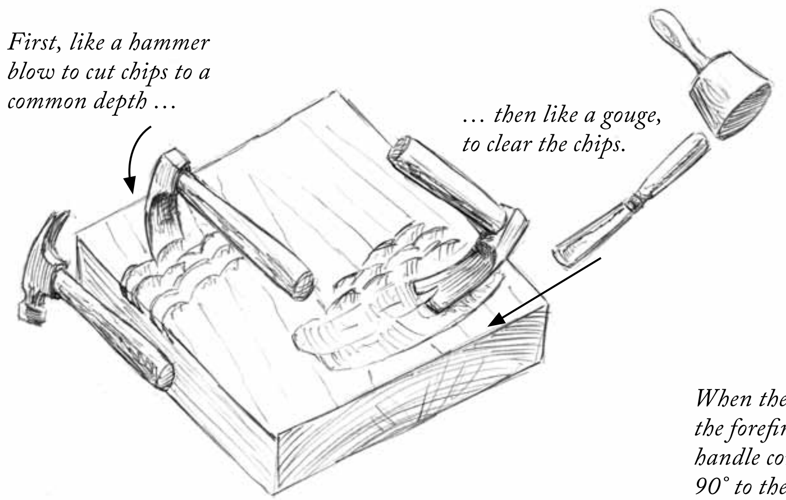



**FIG. 18.3** ***The two steps to hewing with an adze.***

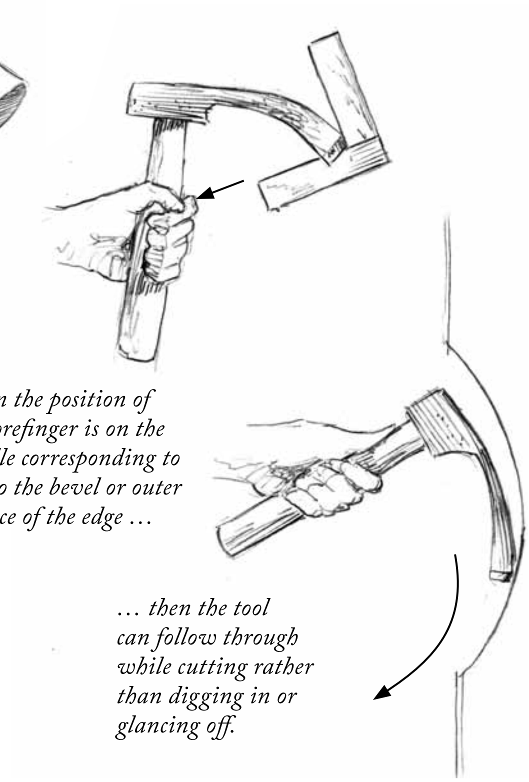



**FIG. 18.4** ***Understanding the geometry and hang of an adze.***

By removing material in successive stages with this technique, the remaining shape and surface can be refined. Clean-up cuts that travel across the grain while skewing the adze "downhill" can leave a polished surface.

Body position is critical to using this tool effectively. I've seen long-handled adzes used while standing on the seat. I prefer a smaller hand adze in conjunction with the workpiece on a podium platform or clamped to the seat of my shavehorse.

The shape of the adze and its relationship to the handle is key to its function. An adze works best when the most comfortable and balanced point on the handle corresponds to the outer surface of the edge of the tool as shown above. This relationship is called the "hang."

If your adze doesn't do this, then you can regrind the edge to get the geometry to work better. If your adze is ground in-cannel and the hang doesn't work well, you can either grind a bevel on the outer surface or make a new handle with a bend in it that will correct the issue.

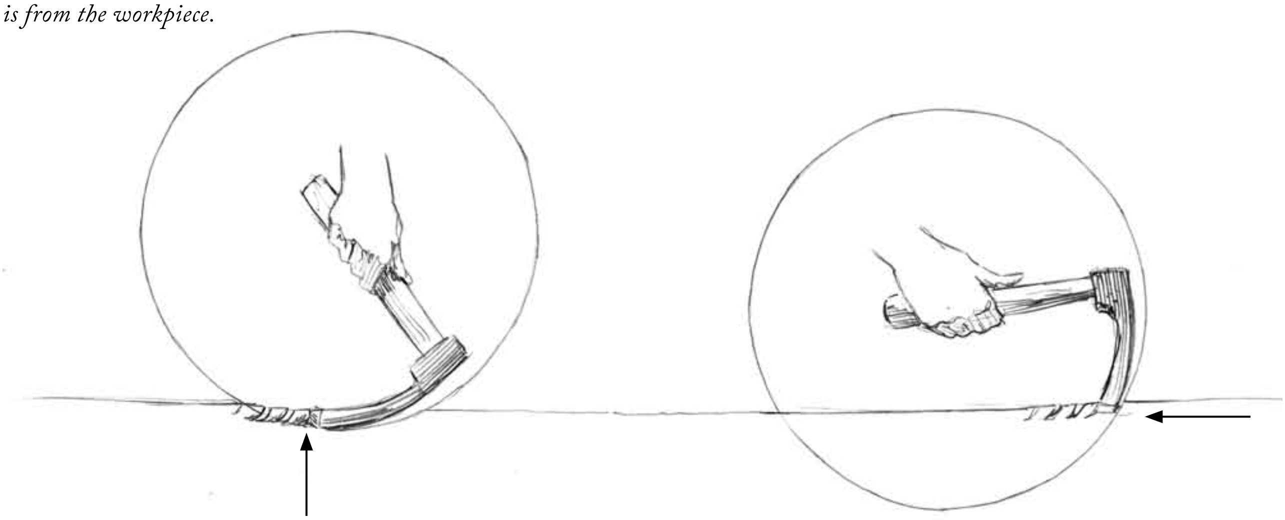
When evaluating the geometry of an adze, I assess how easy it is to control where it cuts. An adze with the proper hang and good balance will hit where you want and where you expect. If this isn't the case, you will have to exert excess energy to control the tool and it will become tiring to use.

I think of the adze head as moving around the circumference of a circle with my hand at the center point. If my hand is close to the work, the adze digs in for deep cuts and strikes like a hammer. If my hand is high off the work, I get a glancing blow for clearing chips. In each case, the center point shifts slightly in the direction that the tool is swinging as well.

Like any tool, the adze is going to perform best when it not only has proper geometry at the edge, but a high level of sharpness. Don't let the brutal impression the tool gives keep you from experiencing it at its sharpest. Grinding and honing the adze is certainly different than chisels or plane blades that have lots of flat surface to reference, but a little focus and creativity can yield controlled and repeatable results.

If the handle or head shape gets in the way of buffing the inside curve, I use a drum sander in a drill or a dowel with sandpaper wrapped around it. A dowel charged with honing compound will polish it up. When choosing the angle for the bevel, consider the point on the handle where you are most comfortable gripping as well as the thickness of the edge for durability.

*The type of cut depends on how far the center of the circle is from the workpiece.*



*When at its highest point, the blows will follow through while clearing chips.*

*When the center point is lower, the adze will strike hammer-like depth blows.*

**FIG. 18.5** ***The height that the adze is held off the surface affects the cut.***

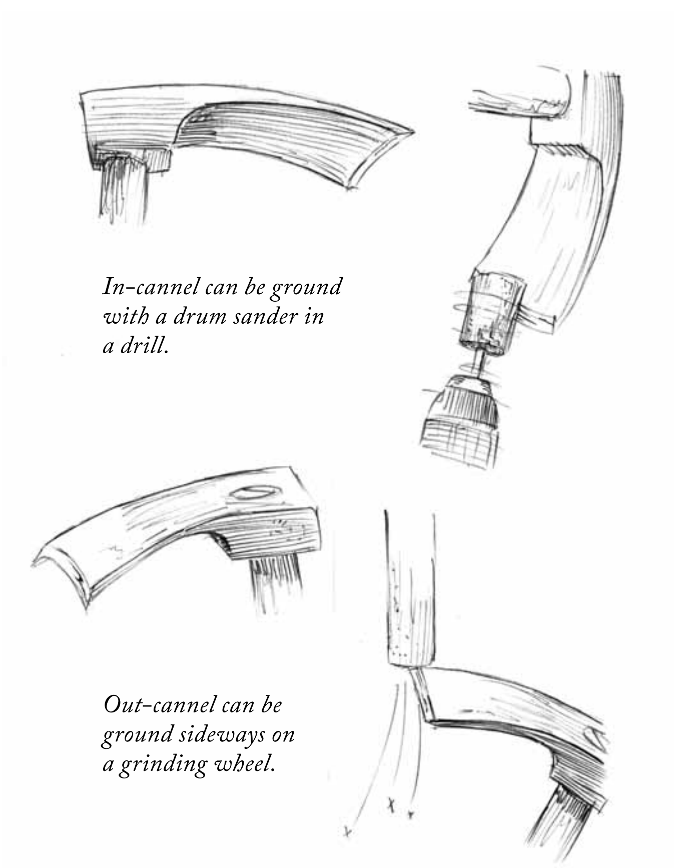



**FIG. 18.6** ***Preparing an adze for use on a seat.***

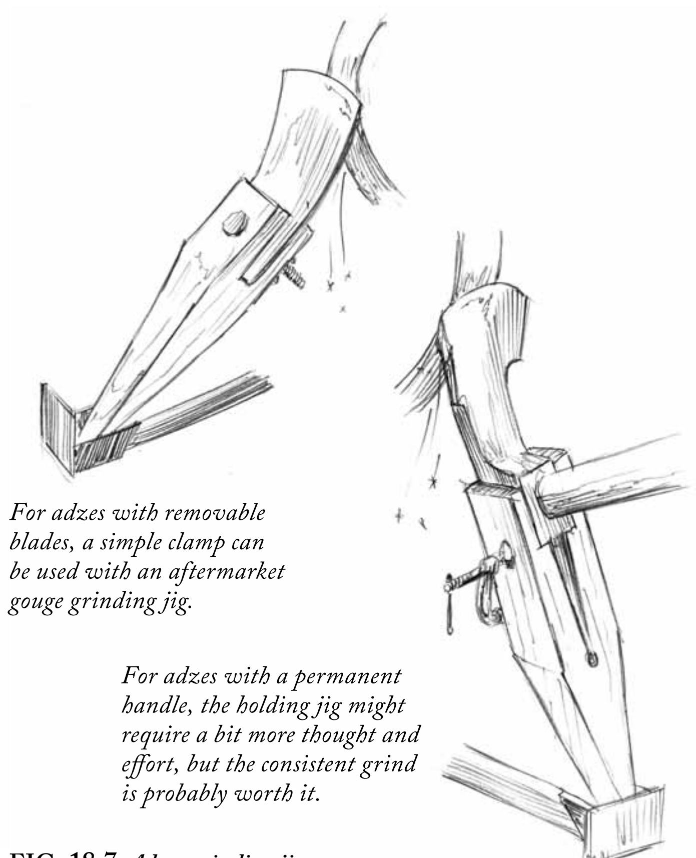
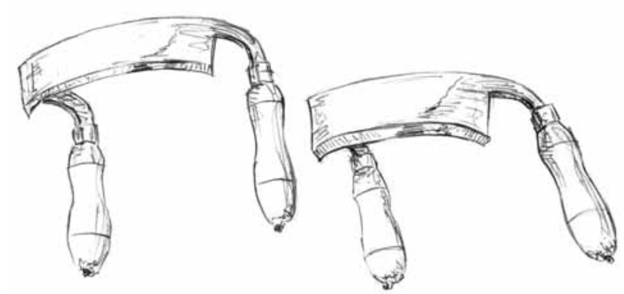



**FIG. 18.7** ***Adze-grinding jigs.***

For consistent grinding, a means for holding the adze head in a jig can be helpful. Remember, the adze is just a gouge, so thinking of sharpening your turning or carving gouges can help when conceiving of the best way to go about it. The holding jigs shown at left might take some effort to make sure that the position and movement of the blade contacts the edge properly when the tool is rolled, but the results will most likely prove it worthwhile.

The in-cannel adze is trickier to sharpen, and the location of the grip is dictated by the shape of the adze head, not the bevel angle. Polish the outer surface of the head and dub the edge a bit. Grind the bevel with a drum sander or grinding burrs in a drill or Dremel. I like to use diamond pastes of sequential grit to get my final polish. There are no rules about the grind – whatever works, be it in-cannel or out-cannel or a combination of the two. All are worth exploring.



*When the handle angle is too tight, they can be bent to solve the problem.*

*The handle angle should be open to allow easy cutting without having the handles in the way.*

**FIG. 18.8** ***The angle of the handles to the blade impact the usefulness of inshaves.***

## The Inshave or Scorp

The inshave, sometimes referred to as a scorp, is basically a curved drawknife. It's used primarily in carving and smoothing the bulk of material from the seat. The inshave can be used in place of the adze to remove the bulk of the material, especially if it has a tight radius.

While some inshaves were actually drawknives that a blacksmith bent, the majority that I've seen were intended to be inshaves. The angle of the handles and the curve of the blade are the most important factors when choosing a tool. If the handles are at too much of a right angle to the blade, they will hit the seat while you are carving. A good angle is a bend that is about 122°.

If the handles of the inshave are at too tight an angle, bend the handles as shown above, but be sure that the metal near the handles is annealed (soft) before attempting the bend. If the metal cuts easily with a file, then it is probably fine to bend it a bit; if not, you might need to heat the area until it glows a dull orange to eliminate the brittle hardness. Nothing is worse than ending up with a scorp in the vise while staring at its broken handle. (Ask me how I know.)

Some inshaves are made with a single radius and some have a flat portion in the center and a smaller radius where the blade turns toward the handles. A tight radius in the middle of the blade gives a lot of power by taking a narrow cut, which is helpful if you are not first using an adze to remove the bulk of the waste. But by the same token, a tight radius can dig quite an uncontrolled pit in the seat if you aren't careful to use it evenly across the surface. The tightly curved inshave could be likened to a scrub plane, which is great at shaping but poor at surfacing. I personally like a flatter curve, which helps keep me from digging deeply and leaves behind a more even surface.

## Sharpening Inshaves

Most inshaves have a flat inside cross section and a bevel on the outside. These are straightforward to sharpen and maintain. Again, I start by hollowing, flattening and polishing the inside surface. The bending process usually leaves the interior of the inshave a bit convex in cross section. Even though it would be desirable, flattening this is tough, so I focus on only flattening and polishing the area within 1/2" behind the cutting edge. I do this with a drum sander in a drill, a cone-shaped diamond hone and diamond paste on a dowel. It's well worth spending some time to get this right, because it's vital to the ease of maintenance.

Then I grind the bevel. If you are lucky, the back edge of the tool will sit flat and you can run it on a large tool rest to grind the edge. By inverting the tool rest to get the correct angle, you can safely get even results.

Another approach, which is especially useful if the back of the tool doesn't sit flat, is to use a jig or rare earth magnets to attach the tool to a board and ride the board on the tool rest. Until you get used to the handles, they can make the job awkward. Whatever method you choose, safety should be your first concern.

Once the grind is complete, use diamond hones and strops with diamond paste to finish the job of polishing the edge and removing the burr. The bevel rides on the surface of the workpiece and should have a slight dubbing, just like a drawknife.

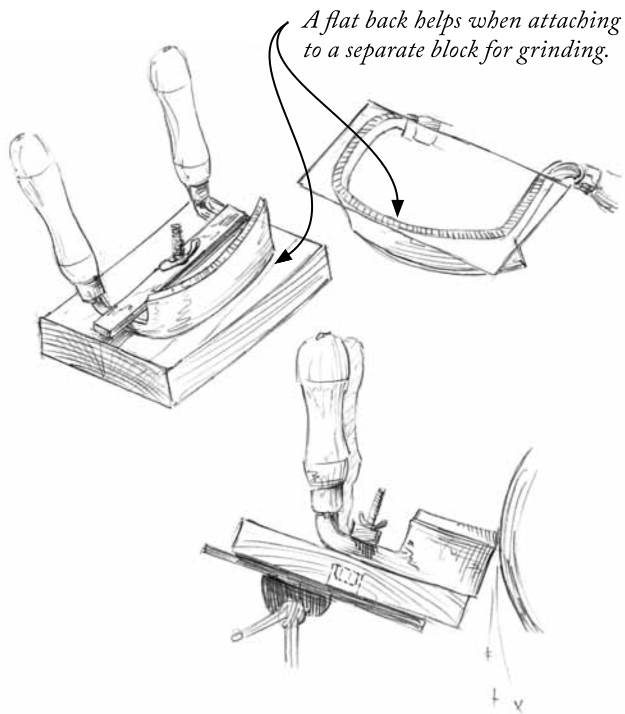



**FIG. 18.9** ***Grinding an inshave with the bevel on the outside of blade.***

During regular maintenance, avoid using coarse abrasives on the inside of the curve, which would scratch it up and make more work slow for you. Instead, use the diamond hone or #600-grit sandpaper on a dowel to help turn back the burr that is turned after honing the bevel, then finish off with a light stropping.

Like the drawknife, inshaves sometimes come "knife-edged." This is tough to maintain because any effort to stone the edge will either make only brief contact with the actual edge or will round it too much. I fix this by grinding a small bevel on the outer edge before honing as usual with diamond paddles and a diamond cone. Take care to grind only a small bevel that doesn't affect the cutting geometry of the tool.

## Travisher

Travishers are basically curved spokeshaves. Old ones in good shape are rare and usually have two tangs that fit into tapered holes in the body of the tool. These tangs can get in the way of sharpening. If the tangs make using a standard grinder difficult, a drum sanding wheel in a

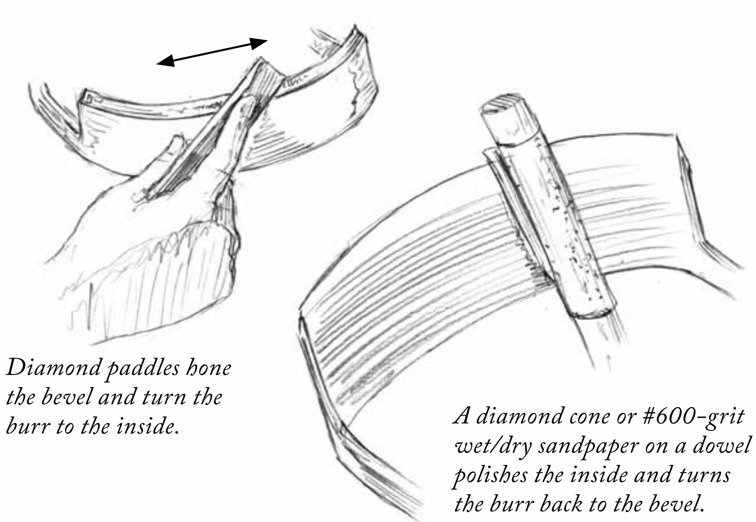



**FIG. 18.10** ***How to polish the inside and outside edges of an inshave.***

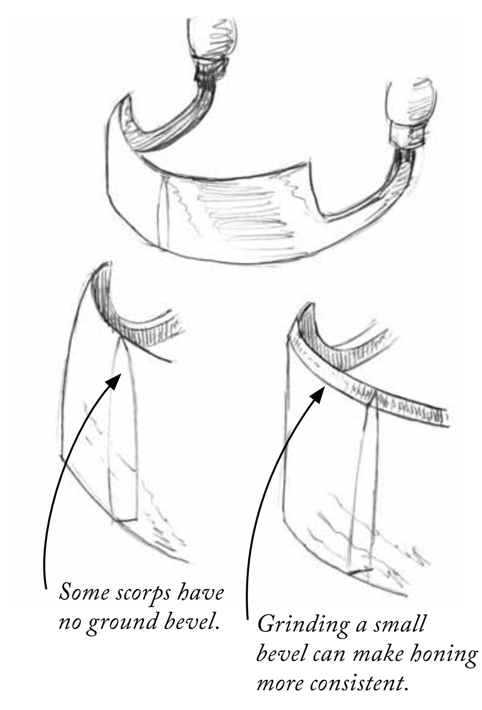



**FIG. 18.11** ***Grinding a knife-edged inshave.***

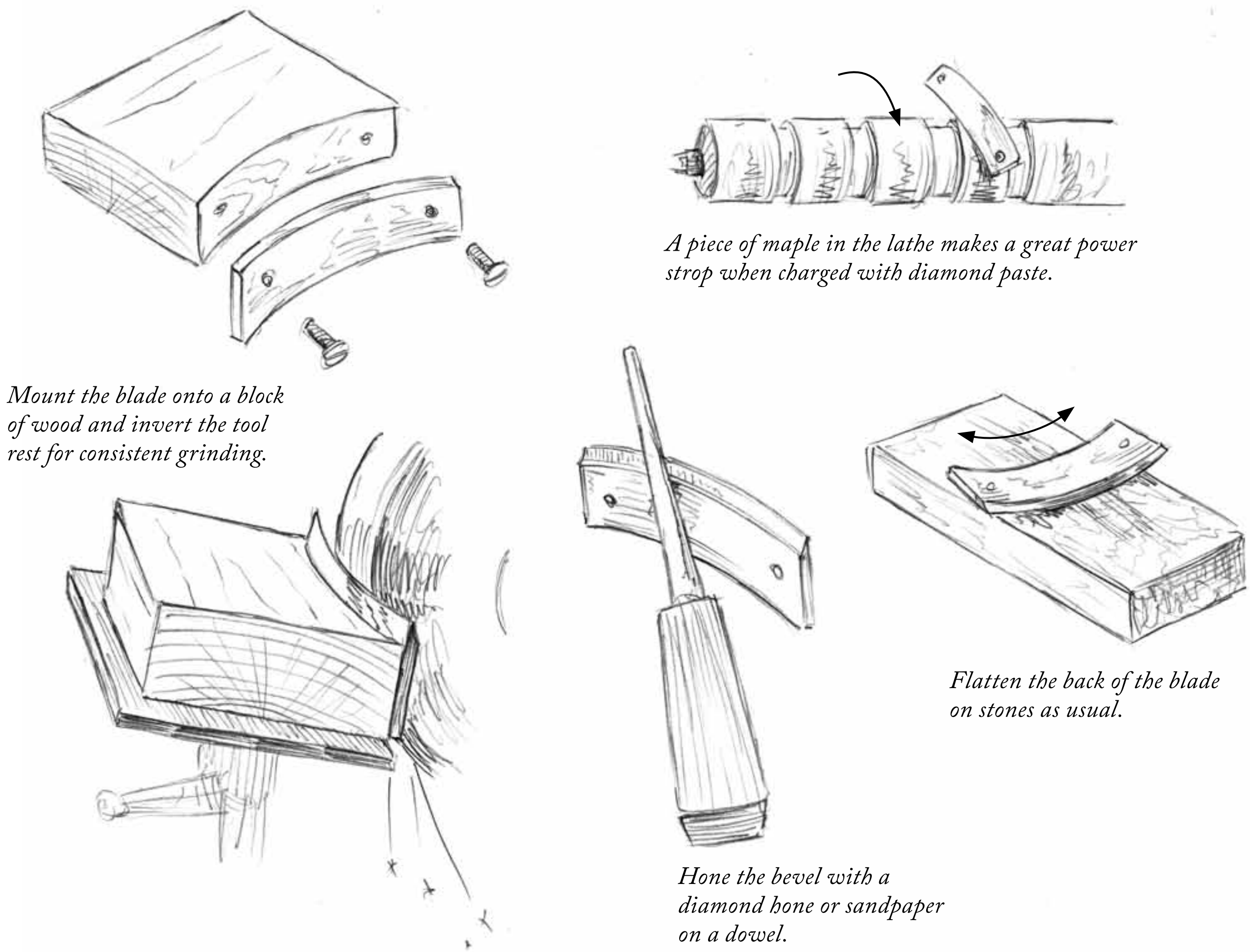



**FIG. 18.12** ***Strategies for sharpening a travisher's blade.***

drill can be used to shape the edge prior to honing. Some modern travishers are attached to the sole with screws instead of tangs, which allows for easier grinding.

Flattening the back of the blade of a travisher is usually easy because the bending process imparts a hollow to the back. Running the blade on the stones should touch only at the back and edge of the blade. To grind the bevel with a tang-style blade, use the same methods as with an in-cannel adze. For blades attached with screws, cut a block of wood to the profile of the outside of the curve and screw the blade to the block. Then invert the tool rest on the grinder and grind the blade's bevel with the block of wood riding on the rest. You can use all sorts of means to finish off the edge: slip stones, diamond hones or fine sandpaper on dowels. My preference is to create flats on the bevel using a diamond hone then use a blank of maple in the lathe with some diamond paste on it as a power strop. Then I return to my finest stone to hone the back. The back of this tool should be maintained dead flat. This is a fast and effective method, especially in easy-to-sharpen O1 steel.

## Wooden Spokeshave

I find that my favorite use of the wooden spokeshave is when carving the outside and top front of the seat. These areas are mostly short grain, and because of the low angle of the blade, I can take aggressive cuts. I use these tools by pushing them, which gives me the most control over

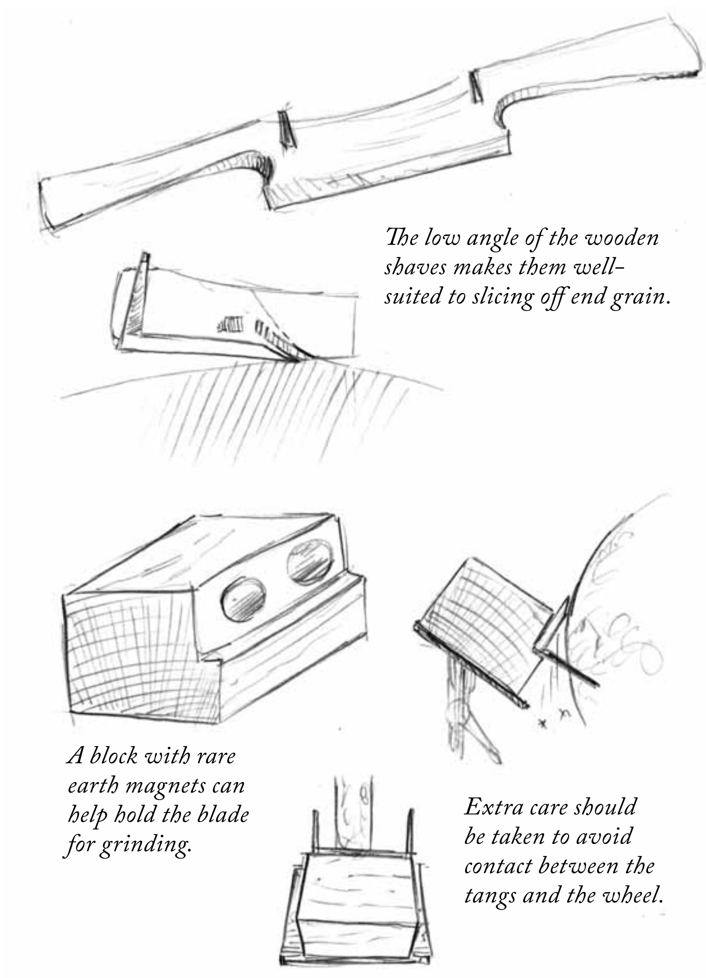



**FIG. 18.13** ***Grinding spokeshave blades with tangs.***

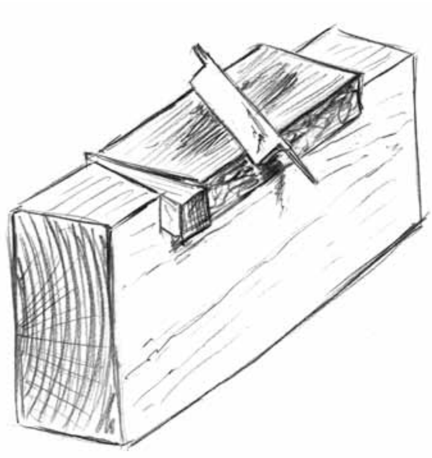


**FIG. 18.14** ***Honing a tanged spokeshave blade is easier if the tangs can straddle the stone.***

the depth of cut. Some modern makers use adjusters and flat soles to set the depth of cut. These tools can be used on the pull stroke, such as when shaving spindles. But I prefer the higher cutting angle of a metal spokeshave for this task.

Sharpening these blades can be tricky because of the tangs. I usually flatten the back of the tool and carefully grind the bevel either freehand or as shown at left. If that seems too daunting, use coarse stones to carefully shape the bevel. Once you have polished it on the finer stones, most of your maintenance can be done by removing material from the easier-to-reach flat.

## Sharpening Scrapers

Scrapers can be for aggressive or fine work, but either way they must be correctly sharpened to perform. Roughly tuned scrapers will dull quickly and leave a scratched surface, which leads to more sanding.

The hardness of the steel in a scraper plays an essential role in preparing it for use. Most planes and chisels are hardened and tempered to the point that the steel is brittle, and the only shaping that can be achieved is through abrasion.

Scrapers are different; they are soft enough to be deformed with pressure from a harder piece of metal. To deform the edge, a burnisher is rubbed along it until a tiny burr is formed. This burr is the cutting edge and can be rolled back and forth to resharpen it a few times until the material becomes overly compressed. With each pass of the burnisher, the metal becomes denser and less flexible. Once it becomes too hard to roll a burr, the edge must be abraded (filed) away to expose new, soft metal.

I look at the scraper as a three-act tool. In the first rolling of the burr, the edge is very sharp, but due to the softness of the metal, it won't last very long. The second rolling of the burr is my favorite; it's still very sharp, but the compression of the metal in the second rolling makes it harder and longer lasting. In the third act, the metal is quite tough and deforms less easily, so the edge is not as sharp, but it is very long lasting. Because of diminishing returns, I always joint (file) the edge after the third burr.

Jointing the edge usually consists of filing away the hardened metal until a fresh, flat edge is exposed. This can be achieved with a file or diamond stones. Most folks use a jig to ensure that the scraper is always at 90° to the

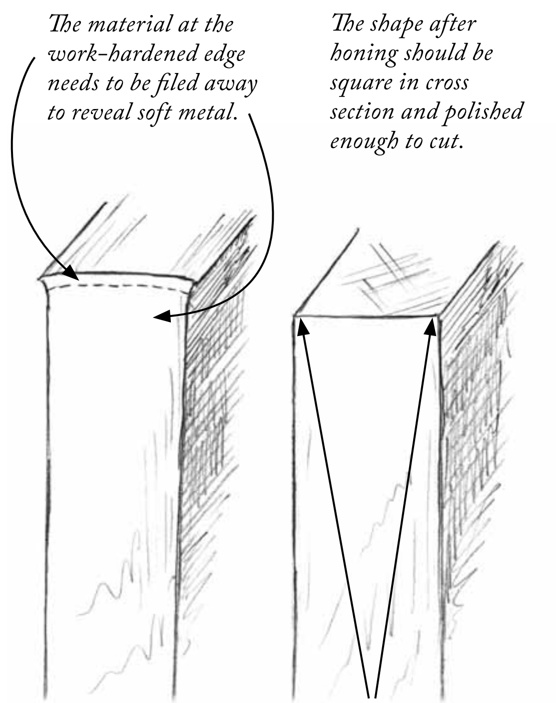



**FIG. 18.15** ***Filing a scraper.***

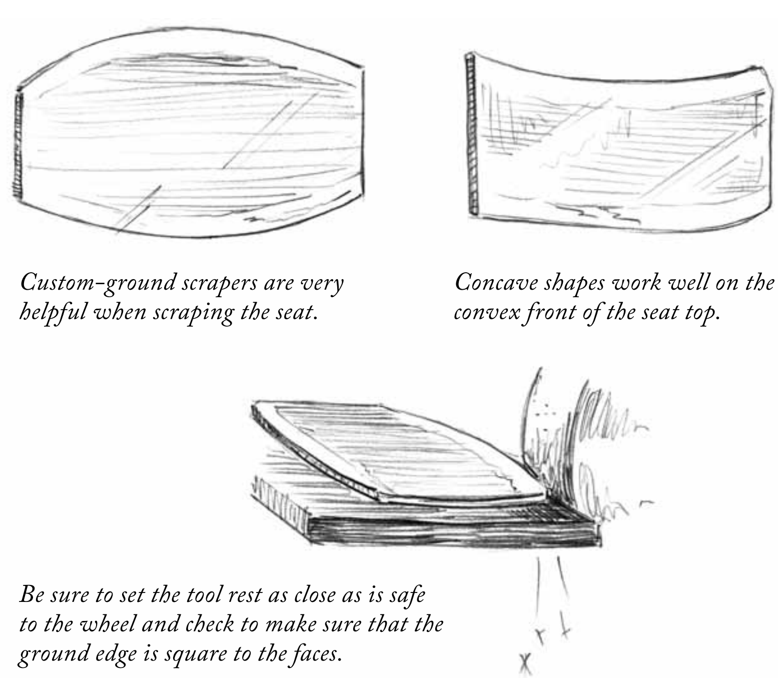



**FIG. 18.16** ***Useful shapes for scrapers.***

file or stone. The jig can be as simple as holding a block of wood next to the scraper as you file or hone it. Flexing a curve into the blade on the stone is another technique for keeping it flat. Take care to avoid grooving your stones while honing scraper edges.

In cross section my scrapers consist of two flat and polished sides and a flat polished edge at 90° to them. My first goal is to hone a scraper to cut wood cleanly even before a burr is rolled. I wish the word "roll" was eradicated from the scraper-tuning vocabulary. It gives the impression that the burnishing is dramatic and tends to lead folks to make a massive burr that's turned at way too much of an angle. It cuts for a couple of strokes and then deforms out of a useful shape. I try to form a burr that keeps the scraper as vertical as possible while cutting.

My favorite way of jointing scrapers is to use a simple little shop-made carriage that keeps a file or diamond hone at a constant 90° to the sides as it rides along the edge of the scraper. It takes a couple of minutes to make the carriage and helps ensure that you are always perfectly aligned on the small edge of the scraper, regardless of the shape.

I am not usually scraping large flat areas, so I don't worry too much about maintaining a dead-flat edge. If my flat-edged scraper becomes too misshapen, I joint it with a file before going on to use the carriage.

First I use the file to remove the work-hardened metal. At first, the file will skate across the surface without cutting much because of the dense steel, but after a few passes it will stop skating and take nice filings. Using the file sideways is similar to skewing a drawknife; the shavings peel sideways and the surface quality is finer. A light touch with the file will prevent the need for excessive honing.

Then I remove the carriage and lay the scraper flat on the bench to hone the flat sides with a fine diamond paddle and some water or oil. If "rolling" a burr that will cut has been a problem for you in the past, you should attempt to cut with the tool after this step. A sharp, filed 90° edge will scrape beautifully, but at this point, the condition of the edge is a bit coarse to expect fine surfaces. To remedy this, I return to the carriage and hone the edge with a series of diamond hones through to extra-fine, then I remove the blade to hone the sides again, but only

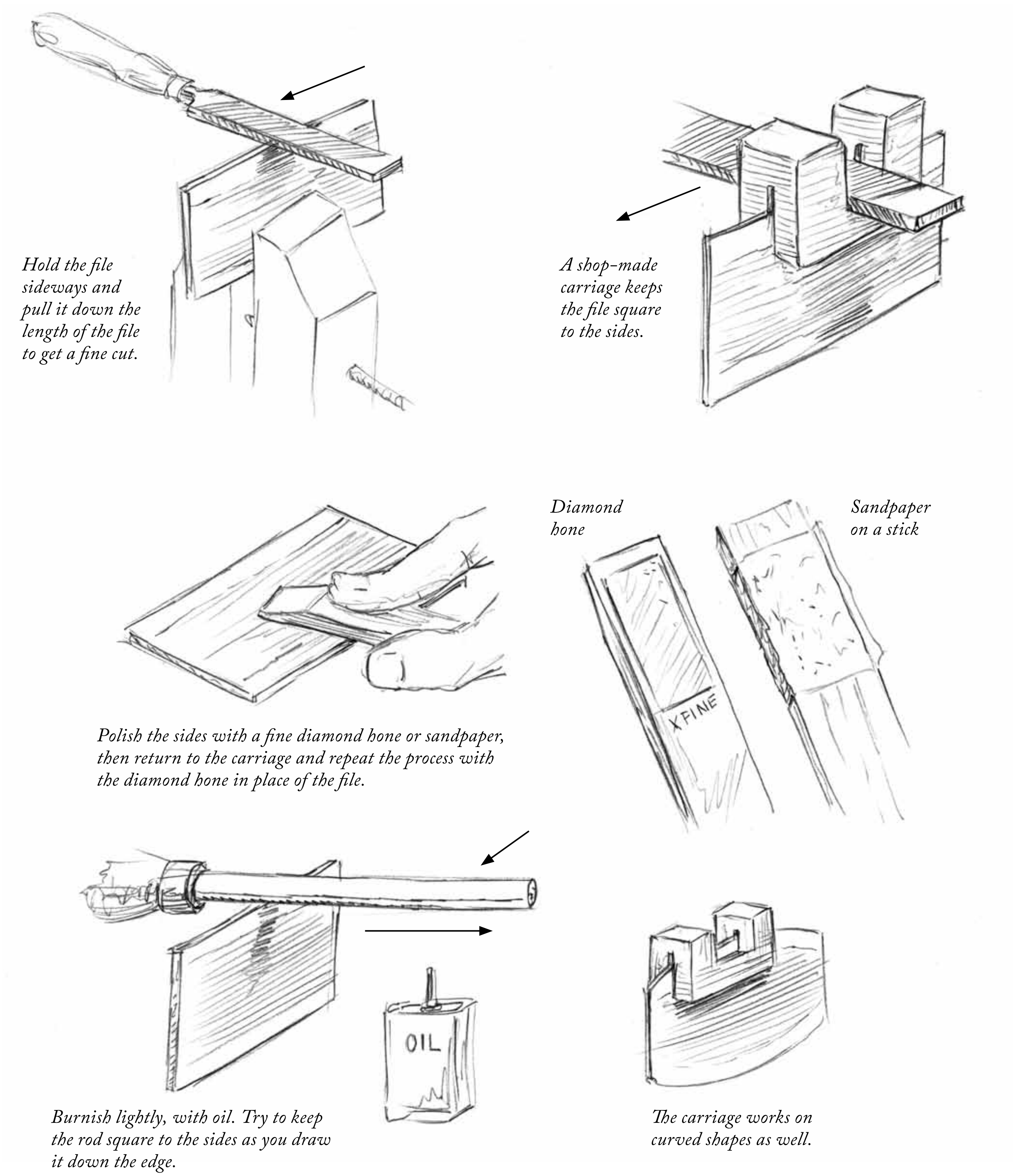



**FIG. 18.17** ***Steps for sharpening scrapers.***

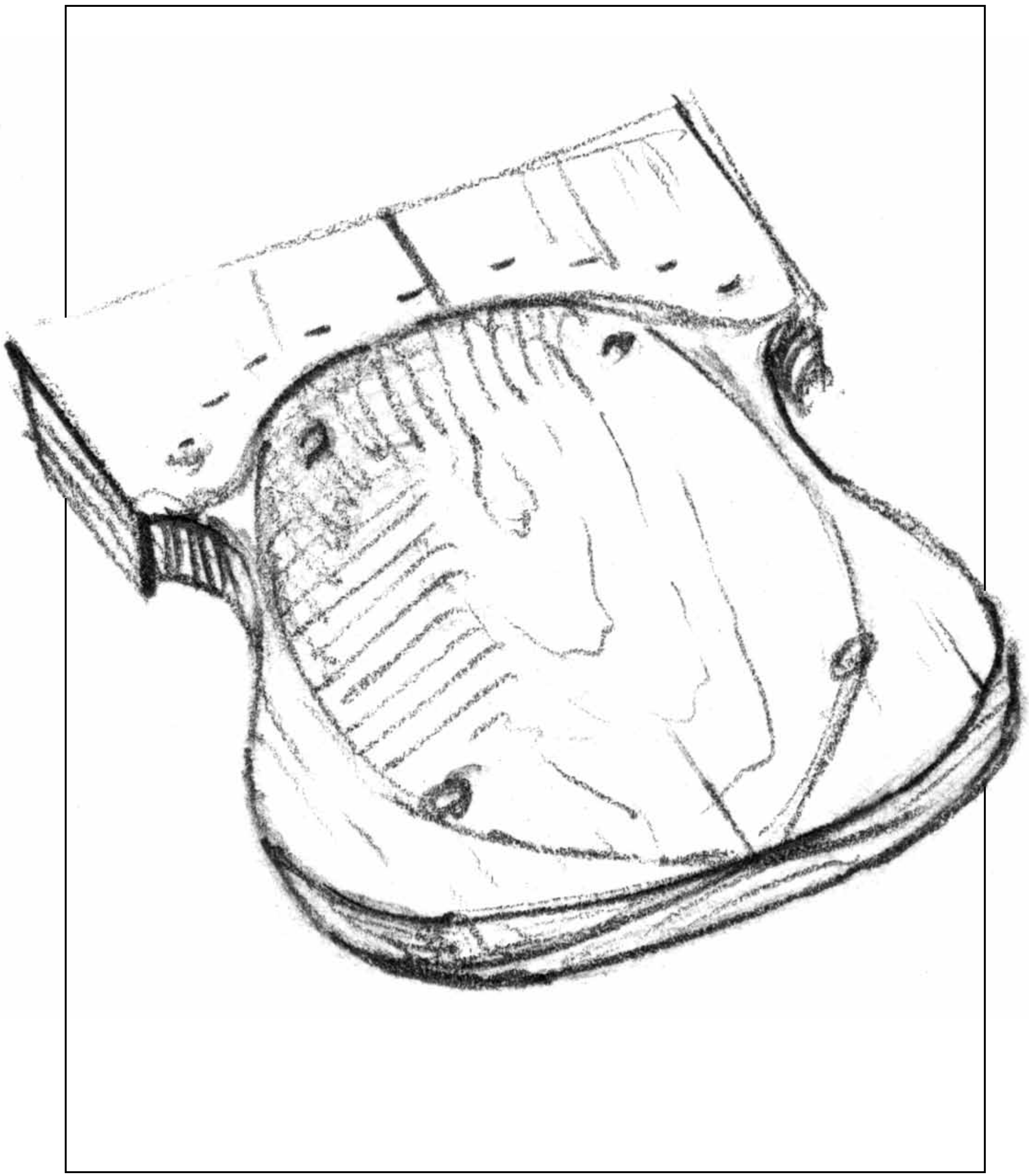
with the extra-fine diamond paddle. There is no reason to continually rough up the flat sides of the scraper once they are polished.

Once again, the sharp edge will cut, but a burr will make the tool more aggressive. I begin the burr-rolling process by placing the scraper flat on the bench and running the oiled burnisher flat on the polished sides to draw the metal toward the small edge. Then I hold the scraper in one hand as I run the burnisher down the edge to deform the burr and point it toward the flat sides. When I demonstrate this, folks are usually surprised at how little pressure I apply, how few strokes of the burnisher are required and how squarely I hold the burnisher to the sides. I use about two or three strokes with very light pressure.

Remember, it is a tiny piece of metal that you are manipulating. I strive to hold the burnisher at a perfect 90° to the side, and the degree to which I fail to do so is enough to "roll" the burr. If you run your fingernail toward the edge, it will catch slightly on the burr. If the burr is obvious, it's most likely too large.

## Conclusion

When I carve a seat, not only do I focus on the shape I am making, but on the quality of the cuts that get me there. Each cut can be clean and decisive. If you are tearing up the surface as you go, look to the condition of your tools as well as your technique. It can take some practice to learn to maintain the oddly shaped seat-carving tools, but the control and pleasure of carving with them in top condition is worth it.



# 19

# Carve the Seat

When I set out to make my first chair, there were parts of the process that I did not even know existed. But there was one part that I knew I wanted to do: carve the seat.

I got into woodworking for this kind of fun. Watching the shavings fly as the seat shape comes into focus is hypnotic and thrilling. Making a chair should begin with the various green wood parts so that they will be dry when the seat carving is done, but I suspect that most folks head right to the seat carving and build the rest of the chair around it. And when I started out, I was no exception. I couldn't even wait to build an actual chair, so I glued up a bunch of 2x4s and used a gouge and a bent piece of steel to hog out a crude seat.

Beyond referring to a seat as oval-, D- or shield-shaped, it actually is an "un-nameable" shape. While it has hollows and humps that follow a distinct logic, there is no simple way to describe it. I think of it as a landscape, full of hills and valleys. To arrive at this complex shape in a consistent and timely way requires a set of steps, each one paving the way for the next. No single step is ambiguous; in the end, the overall shape, while tough to describe, is consistent and clear.

Carving the seat affects just about every surface of the workpiece, so being able to hold the seat in a number of positions is critical. I always leave the extra material adjoining the back of the seat in place until the last step of carving the underside at the back. This way, I can always clamp the waste area without dinging the soft pine, and when I clamp it to the corner of my bench, I can easily move around the seat to come in from the desired direction.

Before I carve under the front edge of the seat, I can clamp the seat between the vise's dog and a bench dog because the material being compressed gets carved away later. For the initial adze work, I clamp the seat to my shavehorse, which puts the blank at a comfortable height to use the small hand adze that I prefer.

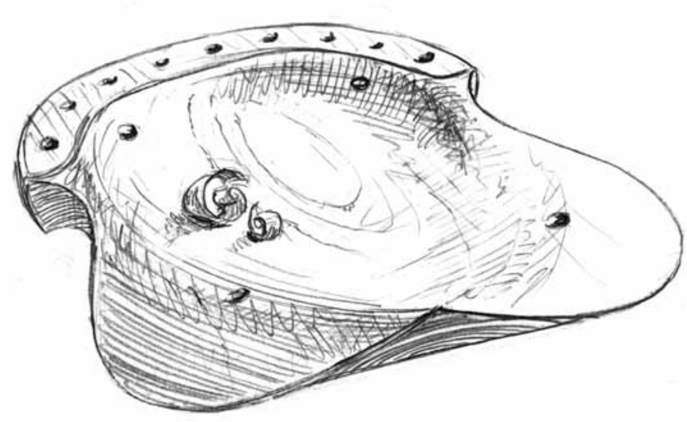


**FIG. 19.1** *Carving the seat.*

I've also had great success using a podium-type support that sits on my bench. This is great when using the small hand adze because you can flip the seat in various orientations without having to move clamps, plus the force of the blows is countered by the lip at the bottom of the holding platform.

## When Steel Meets Wood – Tips for Clean Cuts

Once you've begun to envision the wood as a bundle of fibers and understand how a tool is configured to cut them, it's time to put these two bits of knowledge together

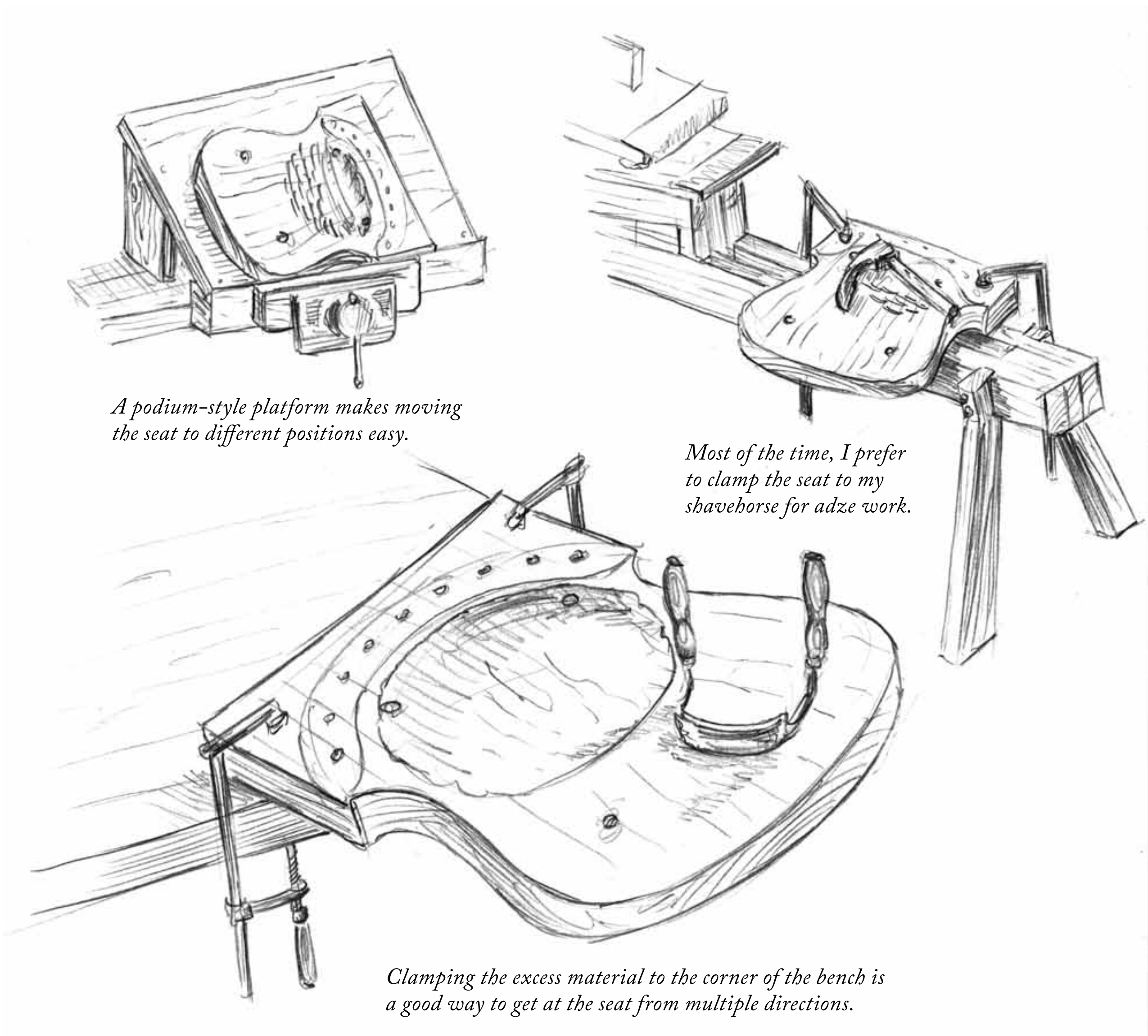



**FIG. 19.2** ***Clamping the work to carve the seat.***

to get proper results. Regardless of which type of tool you are using, it's important to know there is always a technique that can deliver clean, controlled cuts.

Clean results when carving are usually achieved by moving or pointing the tool in a specific direction. Cutting in the wrong direction usually leads to rough and uncontrollable results as the tool slips between the fibers and causes the wood to split in advance of the cutter.

In the chapter Shaving & Shaping Parts, I introduced shaving, which is like controlled splitting, but for now, let's focus on achieving clean cuts when cutting across the fibers.

Looking back to the structure of the wood, it's important to note that any time you see a surface pattern other than long strips running perfectly from one end of the board to the other, you are looking at exposed end grain. This is the common "cathedral" patterning seen on the surface of most sawn boards. Because the surface has exposed end grain, a specific direction of cut will yield good results.

Most folks encounter this concept when deciding which direction to plane a board. I think of planing a board as a form of carving because the same rules of grain direction apply – you are simply "carving" a flat shape.

When planing a board, the direction that the fibers ascend from the lower face determines the best direction to plane the surface. This is usually referred to as cutting "downhill."

When pushed "uphill," the cutting edge slides between the fibers, follows them and causes a splitting action to occur ahead of the cutter. The damage is limited by the depth of cut, the sole and the chipbreaker, but the increased effort and diminished surface quality are not desirable.

A favorite comparison when contemplating planing is to think of petting a cat or dog. If you stroke the fur from head to tail, it lies down smoothly and your hand never slips down to the skin. If you pet from tail to head, your hand slides under the fur, causing the fibers to stand up and the animal to get annoyed. I'm pretty sure we've all had a cat and board glare back at us after such a transgression.

While you can determine the direction of cut based on the orientation of the growth rings and the pattern on the faces and edges of the board, this can lead to confusion because boards from twisted or bowed logs can have multiple direction changes on each surface. In such cases a few light cuts are best to help determine the best cutting direction for each area.

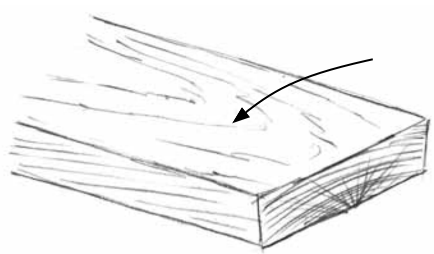
When assessing the direction when carving more complex shapes, I opt for a different comparison.

I like to think of running my finger along the edge of a slant-cut paint brush. There is only one direction to do it smoothly: from the shorter fibers toward the longer ones. This also holds true for shapes in wood.

For instance, take a look at half-circle shapes cut into a board in two places in Fig. 19.5. Take note of which fibers extend further into the area being cut.

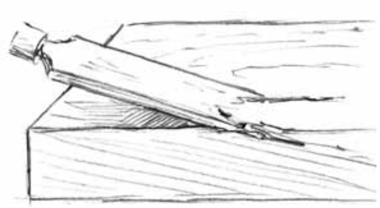
Even though the cutouts are the same shape, the cutting directions are opposite. When cutting the area at the end of board, the tool must start at the deepest point of the hollow and head toward the shallowest points, while the hollow cut on the edge of the board is the opposite.

To help visualize this, imagine the fibers as part of a paint brush. By imagining the brush aligned with the fibers and oriented so that the slant of the brush matches the shape, I can determine the direction to cut.



*Anywhere that the lines on the surface curve or angle in relation to the surfaces, there is exposed end grain.*

*Fibers need support when being cut or they will split away.*



*Cutting into exposed end grain can cause a split to run beneath the surface.*

**FIG. 19.3** ***Learn to read the fibers of boards.***

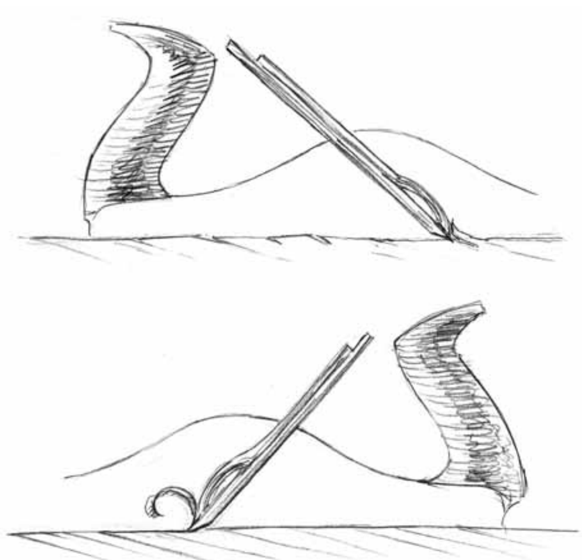


**FIG. 19.4** ***How to plane "downhill" (bottom image) by following the fibers in a board.***

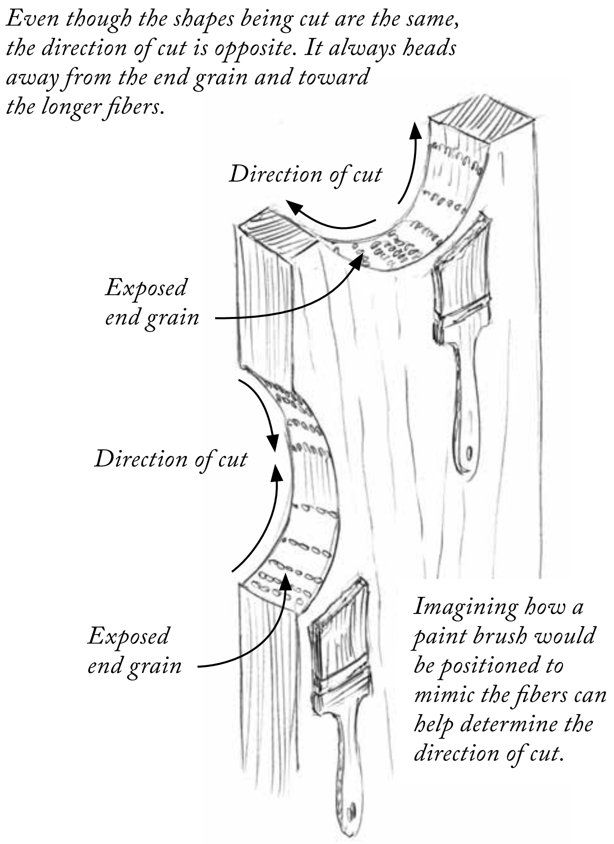



**FIG. 19.5** ***It helps to imagine a bevel-edge paint brush on the board to point out the correct direction of your cut.***

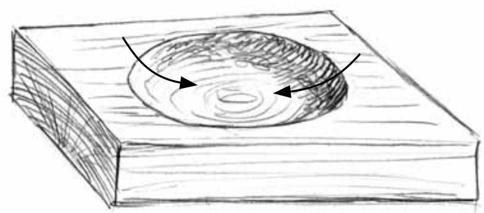
Another issue that affects the direction to cut arises in the regions of each shape where the direction of cut reverses. As shown in Fig. 19.6, you must change the direction of the cut before the fibers change direction. This transition creates trouble if you try to take a cut directly from one end of the shape to the other. You'll run into this issue when carving bowl shapes, such the one that begins the seat carving.

Ending the cut before you engage the fibers on the opposite slope is tough, and if you go past a certain point the tool will dig in and begin a split. You may find yourself in the unenviable position of trying to dig your way out of a hole.

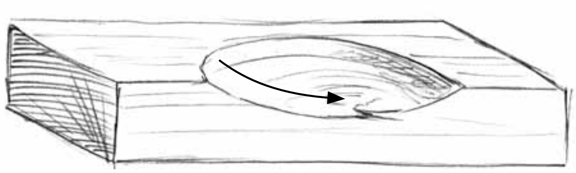
My preferred way to make these cuts is by cutting across the fibers while keeping the blade skewed in the orientation that I would cut if I were cutting "with the grain." While I am showing an inshave here, this applies to all carving tools.

### STEP 1. CARVE THE GUTTER

I'm often asked, "what's the point of the gutter"? While I might not have historical insight that would stand up to scrutiny, I have found practical reasons for including a gutter and I'm sure most would agree. The gutter provides a transition from the shapely seat carving to the flat spindle deck.



*Carving toward the bottom of a bowl shape, you will hit a transition area where the cut follows the fibers for a period, then runs into the exposed end grain of the fibers on the opposite slope.*



*Cutting past the transition area causes the tool to dive into the end grain, causing tear-out.*

**FIG. 19.6** ***Carving a bowl shape can be tricky at the point where the fibers reverse direction.***

*Pulling the tool across the grain while pointing the edge in correct direction yields clean cuts. Reverse the direction that the edge is pointing after the transition area.*

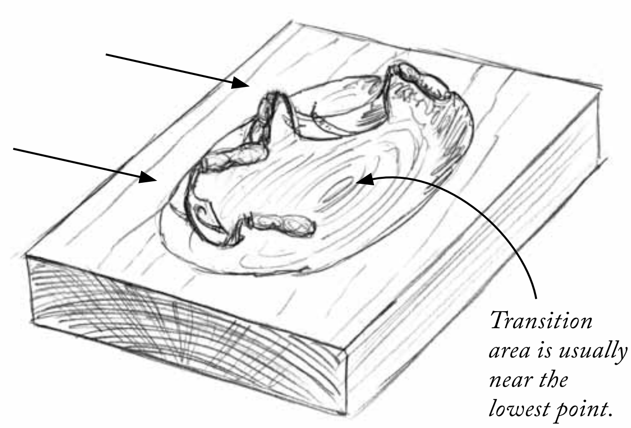



**FIG. 19.7** ***Cutting across the grain with the tool properly skewed will result in clean surfaces.***

It's like trim, providing visual interest while freeing you from the need to achieve perfect carving. On chairs that I make that don't include the gutter, only the shaping at the back of the seat carving defines the transition edge; that requires much greater level of exactness.

I use an 11/7 veiner to carve gutters, but there are a variety of sweeps and widths that work fine. Chairs don't fall apart because of the shape of the gutter, so work with what you have. Besides the gouge, good lighting is key to carving the gutter. I set up a raking light, and I dim the shop lights to get a clear view of my results.

I like to carve my gutter before carving the seat, but I'm sure there are others who wait. Carving the gutter requires a gouge that is well-sharpened at a low angle, around 17°. To ensure that the edge is strong enough, I gently round the interior of the gouge, which brings the included angle above 20°.

If you are new to carving, practice in the excess material outside of the pattern. Start by drawing a curved line. Then draw a parallel curve that's 1⁄4" outside of that line. These are the limits of your gutter's width. The depth will be determined by your gouge. The gutter will be a consistent depth when the groove reaches the lines.

I begin carving the gutter by taking a light cut in the center, between the lines. This light cut allows me to steer the tool easily, and when I take a second pass, I can then smooth and refine the groove.

I like to work the whole gutter to one depth, then return for additional passes, which makes it easier to keep the curve fair. I hold the gouge in both hands, but each hand plays a different role. I always keep one hand in

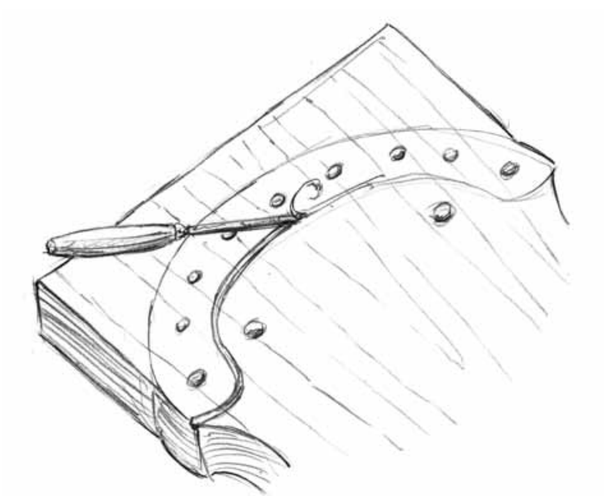


**FIG. 19.8** ***Carving the gutter in front of the spindle deck.***

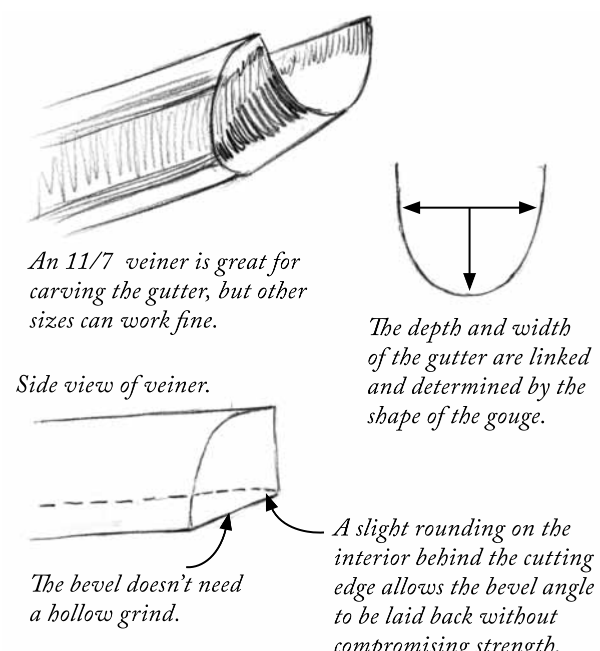



**FIG. 19.9** ***Veiner geometry.***

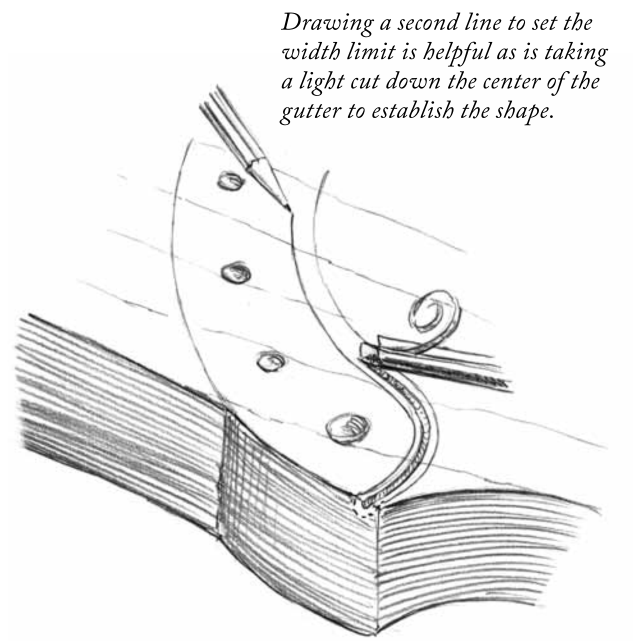



**FIG. 19.10** ***How to begin carving the gutter.***


**FIG. 19.11** ***Body position while carving.***

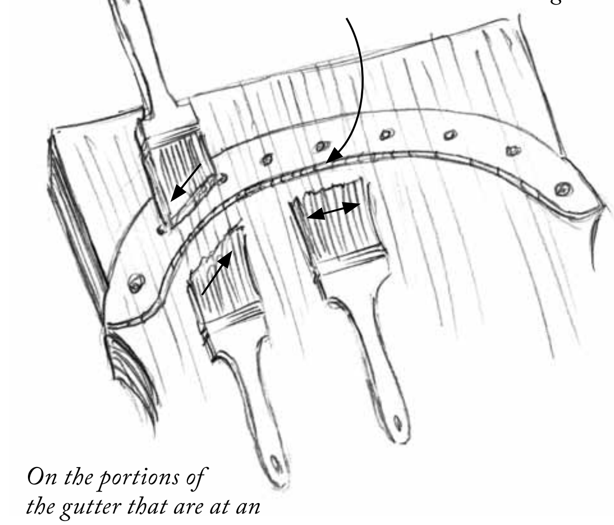



**FIG. 19.12** ***How to deal with the changing grain while carving a gutter.***

contact with the seat, which helps me control the trajectory of the tool. I push and steer the tool with the other hand. Keep your arms close to your body and use your whole body to move the tool.

While carving, you will likely notice that cutting directly across the grain is the easiest, because the fibers don't pressure the tool to drift. Once you begin cutting along the fibers, which will happen somewhere on a curved line, the tool will try to slide between the fibers and follow them, rather than follow the path you want. Besides keeping the tool in the correct path, you might notice that the surface quality on the side that is heading into the end grain wants to grab or tear out. You can avoid this by shifting the handle slightly toward the side that is tearing and focus on cutting the other side of the groove. Then come from the other direction to cut the problem side, which will then have support to shear cleanly.

I carve the gutter right off the end of the pattern at the sides. Once the gutter is established, I take light cuts until it is as deep as it can be without going beyond the limits of my lines. If you are cutting and the tool starts following the fibers or gets bogged in a deep cut, a slight wiggling and rotating of the handle can help it slice its way free. My goal is to make the gutter look as though it was cut in one pass.

Assuming that I'll do something perfectly isn't much of a plan, so whenever possible, I try to leave room for another chance. There is a second chance to refine the gutter after the seat is carved and legged up when I plane the spindle-deck area. This reduces the depth of the gutter and gives me another shot to clean up the shape and depth.

## STEP 2. Carve the Bowl

Shaping of the seat begins with carving a "bowl" shape at the rear. I drill holes at the locations marked on the seat pattern to locate the deepest part of the bowl (see the pattern for the depth-hole locations). I drill those with a regular 1/2" twist bit and make 7/8"-deep holes. I use a black marker to mark the deepest point of the holes after drilling so I know when I am close to reaching final depth. The deepest part of the seat will end up at 15/16"

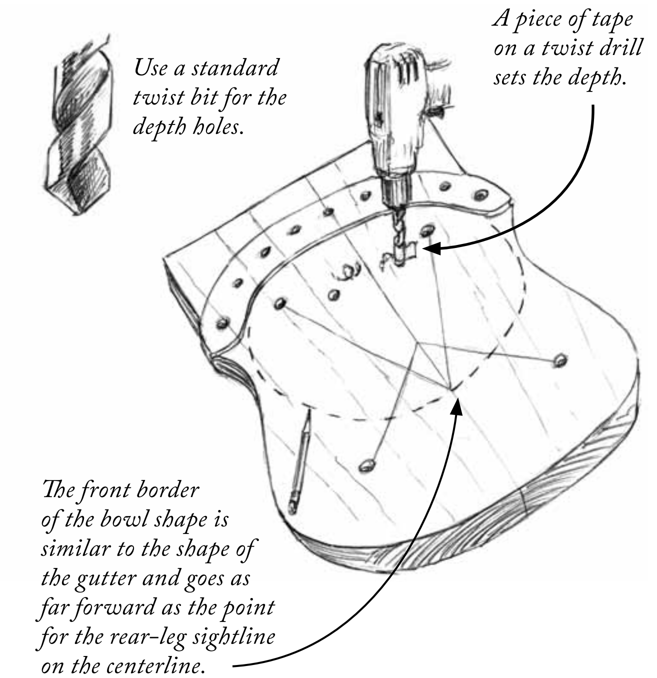



**FIG. 19.13** ***Drill holes to set the depth of the bowl.***

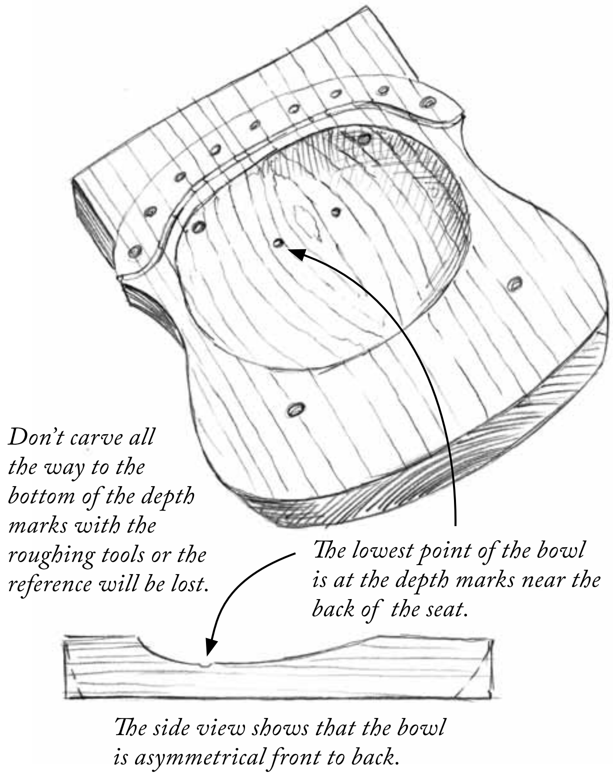



**FIG. 19.14** ***The lowest point of the bowl is off-center and toward the back of the seat.***

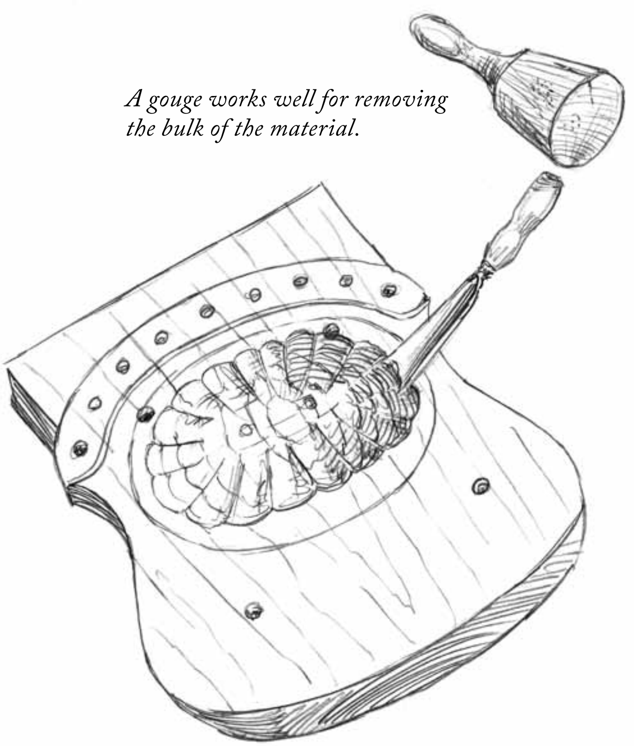



**FIG. 19.15** ***You can use a gouge and mallet to rough out the bowl.***

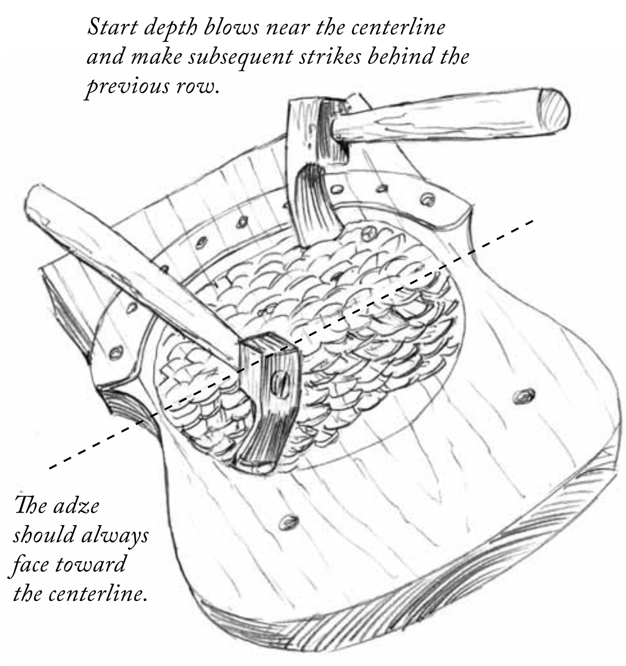



**FIG. 19.16** ***Adzing the seat by working with a centerline in the bowl.***

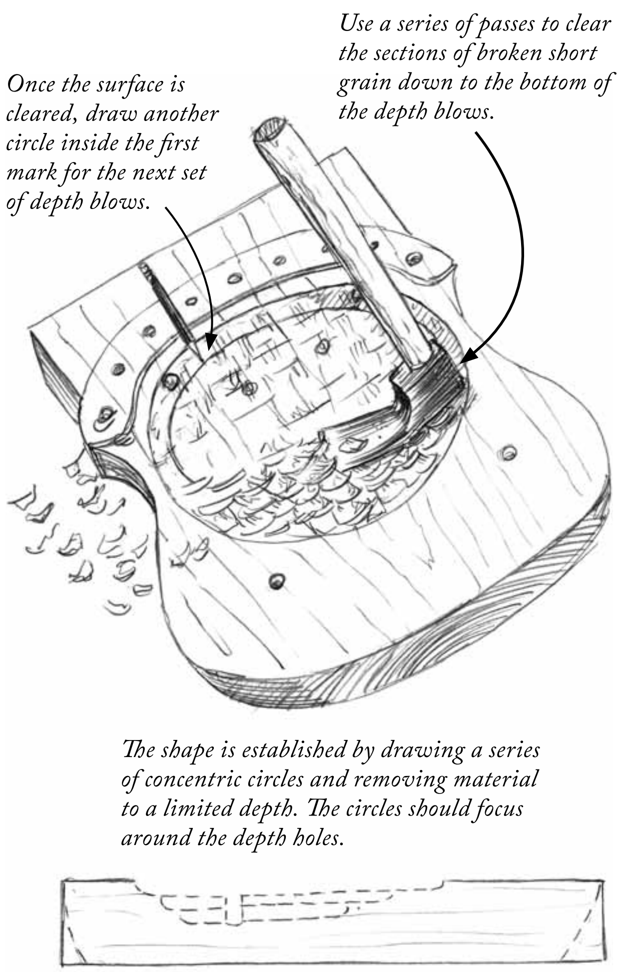



**FIG. 19.17** ***Following a series of steps creates a consistent shape.***

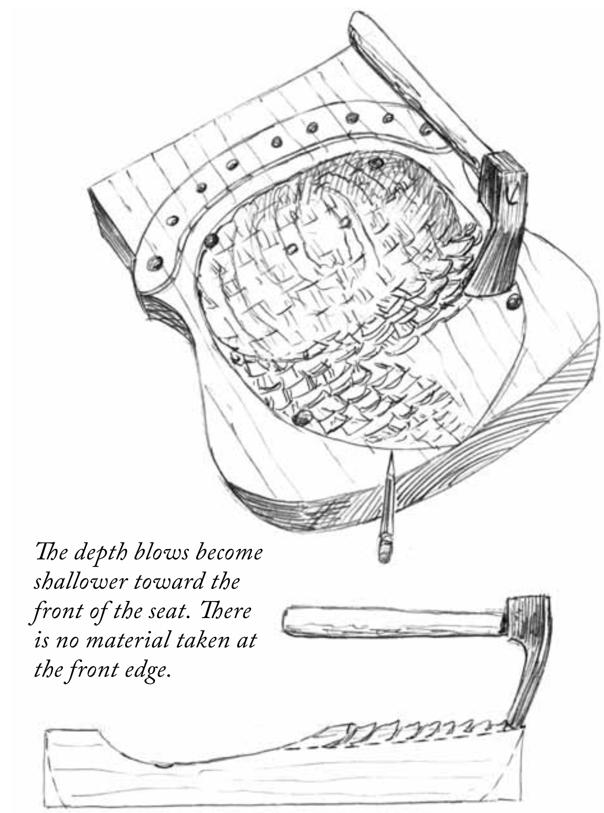



**FIG. 19.18** ***After creating the bowl, adze a ramp up to the front edge of the seat.***

or 1" deep after carving down to the marks and scraping the surface.

The gutter defines the back of the bowl, and by drawing a line that echoes the gutter in the area to be carved, you create a perimeter for the other edge of the bowl. Note that the lowest point of the bowl is off-center (shifted to the rear of the seat) and take care not to carve the portion near the front of the bowl as deep as the depth holes.

While I use an adze to remove the bulk of the material and refine the shape, it's also reasonable to do this step with a mallet and a gouge, or an inshave.

Regardless of which tool you use, always face your cuts toward an imaginary centerline that goes across the grain in the center of the bowl; this will keep the tool from breaking out beyond the perimeter. Then make a series of depth blows in rows behind the first row.

The depth cuts are similar to hammer blows, coming in nearly perpendicular to the surface, but using a slight angle toward the previous row will help break the chips. This allows the tool to dig in to the surface. It's vital that each row of depth cuts is behind the previous one, because the gap created during the cut of the first row allows the second to break.

Once this "fish scale" pattern is complete, reposition the adze in relation to the seat so that it can swing in and out of the cuts and clear the chips by swinging cross-grain. The uncut layer should be exposed and any short grain cleared. If the tool digs or glances off the surface, adjust the height of your hand to suit.

The next series of cuts will stop about 1/4" in from the border, and the process repeats until you have a bowl shape. Don't worry about getting right up to the lines at the edge when clearing the material. Once the bulk is

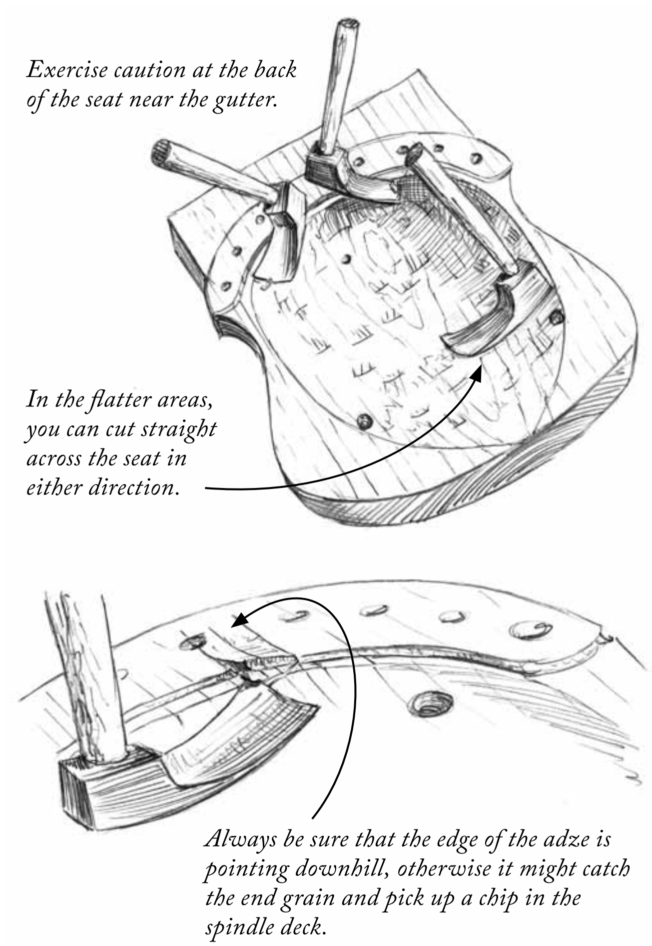



**FIG. 19.19** ***Refine the surface with the adze.***

removed, you can fine-tune the shape and get closer to the edge by cutting across the fibers.

Most newcomers to the adze usually prefer to use the inshave to sneak up to the edge, but with a little practice and daring, the adze can be effective there as well.

## STEP 3. CARVE THE RAMP

Once the bowl is carved, it's time to remove material from the front half of the top to make a shovel shape. The shape is like a flat ramp leading from the bowl to the front of the seat as shown. Make a series of cuts in rows that decrease in depth toward the front.

Remove no material from the very front edge. Then clear the shavings and refine the shape until it has a clear geometry.

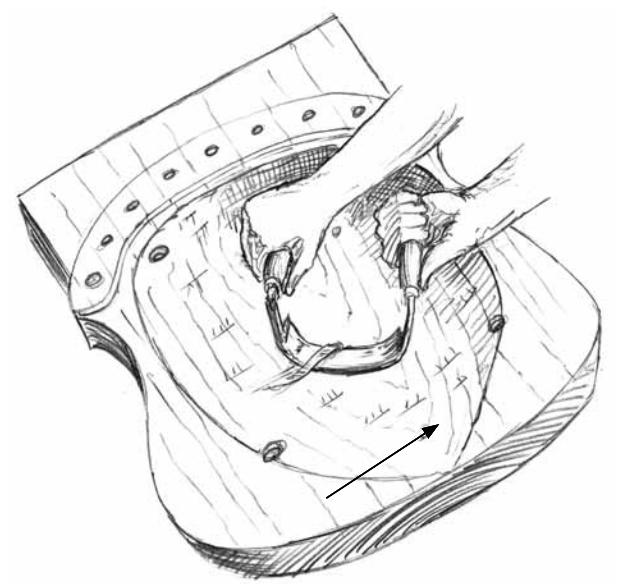



**FIG. 19.20** ***Correct hand position helps when skewing the inshave.***

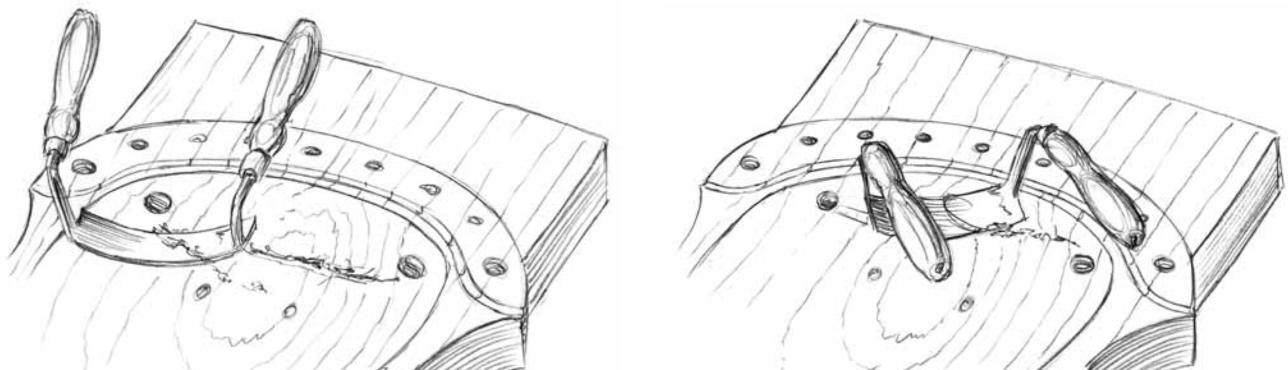
## STEP 4. REFINE THE SHAPE WITH THE INSHAVE & TRAVISHER

### THE INSHAVE

The inshave can do all the work of the adze, though more slowly, and it can leave very little cleanup for the travisher or scraper. I stay slightly above the bottom of the depth holes in the center of the seat when using the inshave. Later, with the travisher, I cut all the way to the bottom of the depth holes.

The inshave is a carving tool, but the path that the tool follows is not intuitive. As a symmetrical tool with two handles, it's easy to get the impression that the tool should be evenly pulled along the fibers. But the most effective way to use the inshave is to let one hand lead and skew the tool as it's drawn across the fibers. Awkward at first? You bet. But there are multiple advantages to this technique.

Unlike split and shaved parts, where cutting direction is always thick to thin, inshaves carve seats that are sawn from the log. So the direction of a successful cut along the length of the fibers will depend on whether the fibers are ascending or descending on the surface. And as is usually

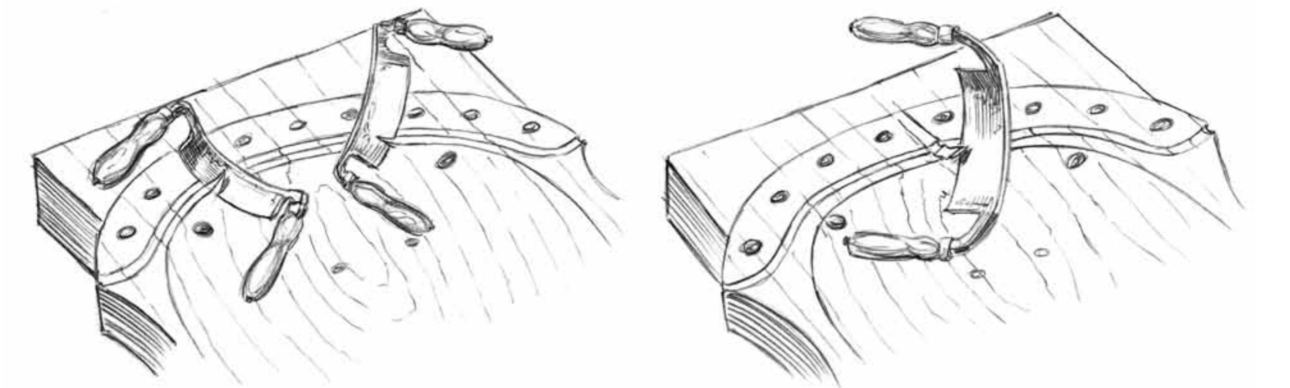


*If you cut beyond the transition area with the blade facing the exposed end grain, the surface will be rough.*

*Reverse the direction of the blade and the cut will be clean.*

*Note: It's not the direction that the tool is pulled in this instance, it's the direction that the edge is in relation to the end grain exposed on the surface.*

**FIG. 19.21** ***The quality of the cut depends on the direction the cutting edge is facing.***

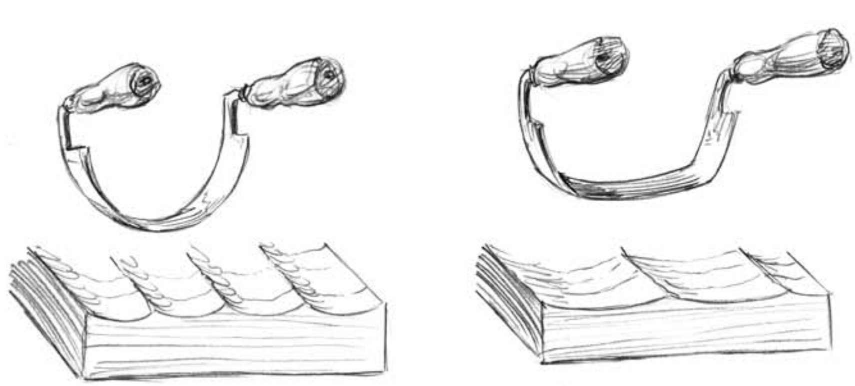


*Cutting close to the gutter is fine as long as you face the edge of the inshave downward and work away from the center.*

*If you point the edge up, or work toward the center, it is likely to dive into the end grain and pick up a chip from the spindle deck.*

**FIG. 19.22** ***Cutting the cove at the back of the seat with the inshave.***

*A tight radius is great for hogging out material, but takes more strokes to achieve a smooth surface.*



*A flatter shave with rounded corners is the best of both worlds, capable of hogging and smoothing.*

**FIG. 19.23** ***Different inshave radii affect the results.***

the case when hollowing a seat, there will be a transition where it will reverse, driving the tool head-on into the end grain of the opposing fibers. This calls for constant interpretation of the shifting surface and fibers, and can also lead to some tear-out in the transition areas.

When the tool is pulled across the board, the position of the user is always the same; only the skew direction of the inshave changes. The direction of skew will always be the direction of the descending fibers. A light pass and examination of the surface quality will get the ball rolling. When the tool starts to pick up the end grain of fibers coming the other direction, simply change the skew and continue across the seat. The skewing will leave a clean surface.

Deeper cuts can also be made with more control and power across the fibers without fear of a split running ahead of the cut. As the seat carving progresses, the shape of the surface will require slightly more care in choosing the direction of cut, as well as the skew angle, especially at the back of the seat.

The effort to smooth the shape will depend on the shape of the inshave. If your tool has varying radii, you can use the flatter portions to your advantage at the end of the process to fair the surface. If it has only a single tight radii, you will spend more time taking smaller cuts to reduce the size of the scalloping, or simply do more work with the next tool, the travisher.

**SMOOTHING WITH THE TRAVISHER**

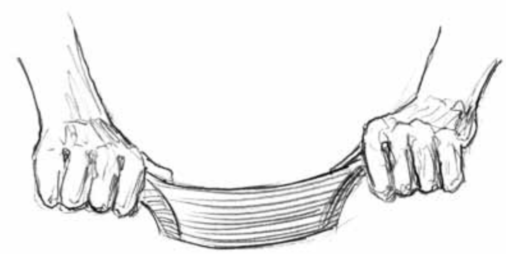
The next job is to smooth the carved portion of the seat until there are no distinct bumps or transitions, leaving a surface ready for scraping. For this, I reach for a travisher.

Some users prefer a compass plane, and when I started I made and used one. In my experience, the travisher is a more versatile tool, so my compass plane sits rarely used. The compass plane does excel, however, at getting even curves at the back of long settees.

The travisher can be tough to get used to because folks often roll the tool back while pushing it to find the cutting edge; this makes the tool take a heavy cut and jams the throat with shavings. Using a travisher or spokeshave requires a movement that is counter-intuitive and must be practiced.

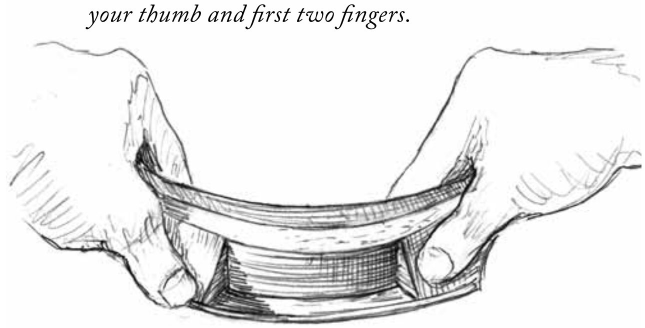
Unlike when using a carving tool, where lowering the handle actually raises the edge out of a cut (like a spoon in ice cream), these tools take a deeper cut when the handles are dropped back. To come out of the cut with control and not have the thick end of the shaving clog the throat, the tool must be rolled forward at the end of each stroke. This is a strange action and no one should expect it to feel normal at first. Practice this "stroke" without engaging the blade, just riding on the surface and exaggerating the rolling forward at the end of the stroke, jutting your wrists forward. I know it feels wrong, but it's right. To see the illustration of this motion, refer to the section on pitch-adjusted tools in Hand Tools: Sharpening & Use.

Like the inshave, I use the travisher across the fibers while skewing it in the direction that the end grain descends. This allows me to traverse the transition areas without getting hung up in the end grain of the opposing side. A subtle crisscross pattern will help create an even surface.



*It's common for new users to grip the handles and hold them very tightly. This is not the best way to hold the travisher.*

*Hold the body of the tool lightly between your thumb and first two fingers.*



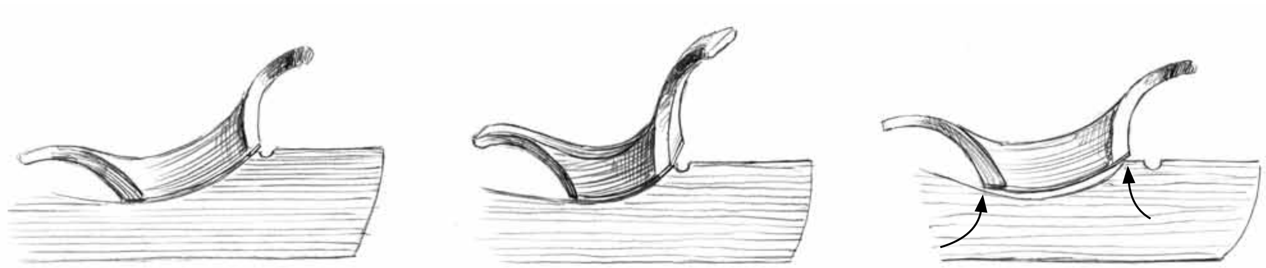
*Position your thumbs low on the flats at the back of the tool for the best feedback and control.*

**FIG. 19.24** ***Hand position and pressure is essential to travisher technique.***

The shape of the travisher is also helpful in creating a consistent curve at the back of the seat. Cut in front of the gutter until the shape of the seat matches the shape of the travisher. If you want to make it deeper, skew the travisher. If the tool won't cut in the center of the curve any longer, check to make sure that there isn't material holding it up in the surrounding areas.

The travisher is one of my favorite tools. I use the various portions of the blade to refine the curves of the seat with a speed that allows me to "see" the seat take shape and make subtle adjustments as needed.

Rubbing your hand with its palm flat across the seat's surface can help to detect any bumps or dips. At this point, the initial depth holes should be barely visible, if at all.



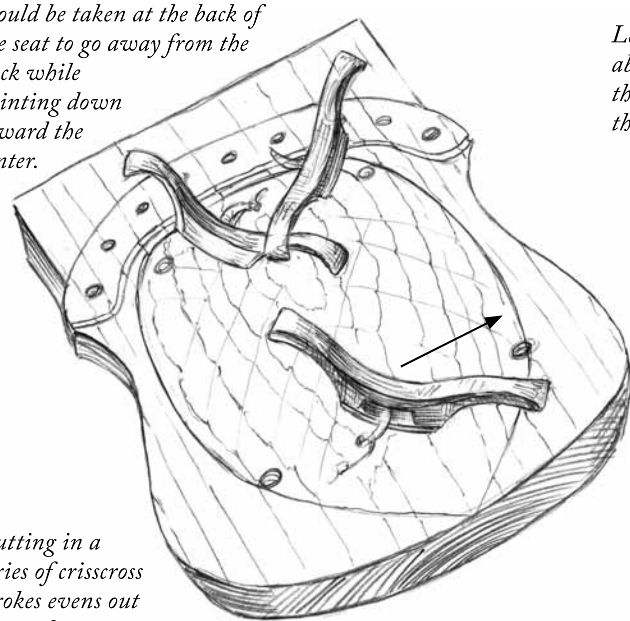
*The travisher can be used to form a consistent shape in the curve at the back of the seat.*

*Skewing the tool makes a tighter radius.*

*If the travisher won't cut in the middle of an area, remove material from the adjacent areas.*

**FIG. 19.25** ***Cutting the back of the seat to match the travisher.***

*Just as with the inshave, care should be taken at the back of the seat to go away from the back while pointing down toward the center.*

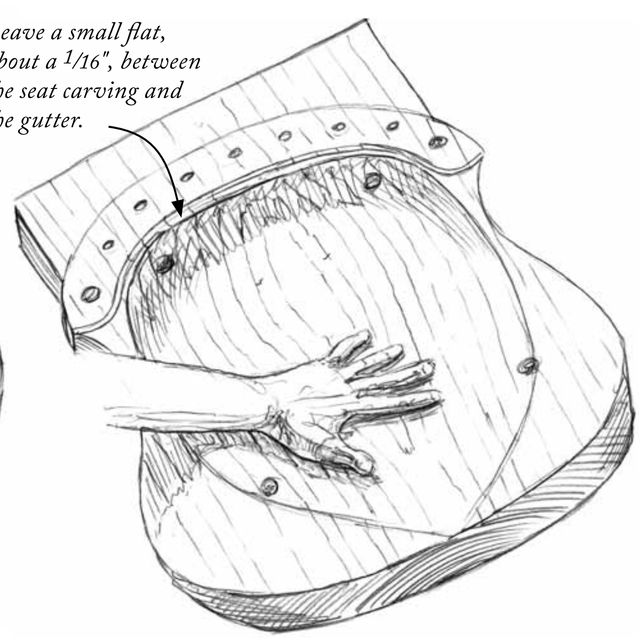


*Cutting in a series of crisscross strokes evens out the surface.*

*Skewing the travisher at an angle to the direction of the cut is helpful.*

**FIG. 19.26** ***Smoothing the surface with the travisher across the grain.***

*Leave a small flat, about a 1/16", between the seat carving and the gutter.*



*Rub your hand flat on the surface in all directions to detect any humps or hollows.*

**FIG. 19.27** ***Examine the surface for areas that need refining.***

## STEP 5. REMOVE MATERIAL FROM THE TOP FRONT OF THE SEAT

The next step is to remove material at the front edge of the seat. Following the layout shown, create the line on the front of the seat that separates the top from the bottom.

Next, draw a line on the top of the seat that is equidistant at any given point from the corner of the seat and carved area. By cutting the material between this line and the layout line on the front and side of the seat, you will form a bevel on the front edge of the seat. I begin by cutting the material at the widest point of the seat, finding and following the fibers. Then I know the transition point for my direction of cut. It takes a bit of nerve at first, because the shape of the shaving gets thicker and wider at is follows the fibers. This causes the material to "POP" off when you pull the first couple of times. Don't be too

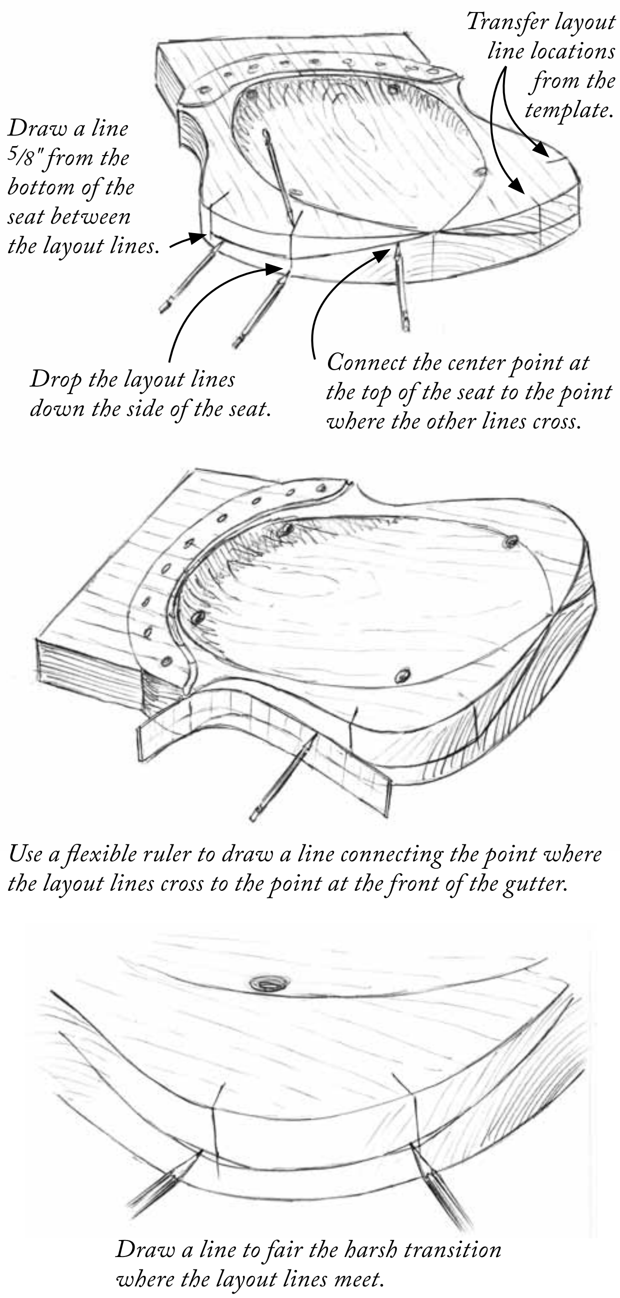



**FIG. 19.28** ***Layout lines on front and side of seat.***

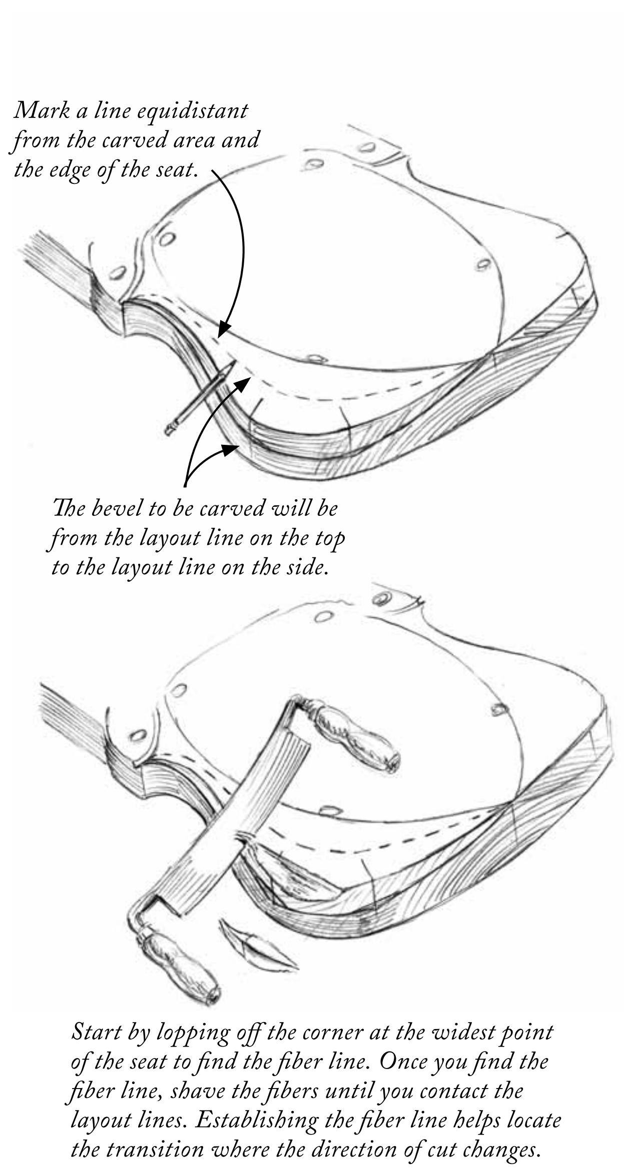



**FIG. 19.29** ***Completing the layout and finding the fiber line.***

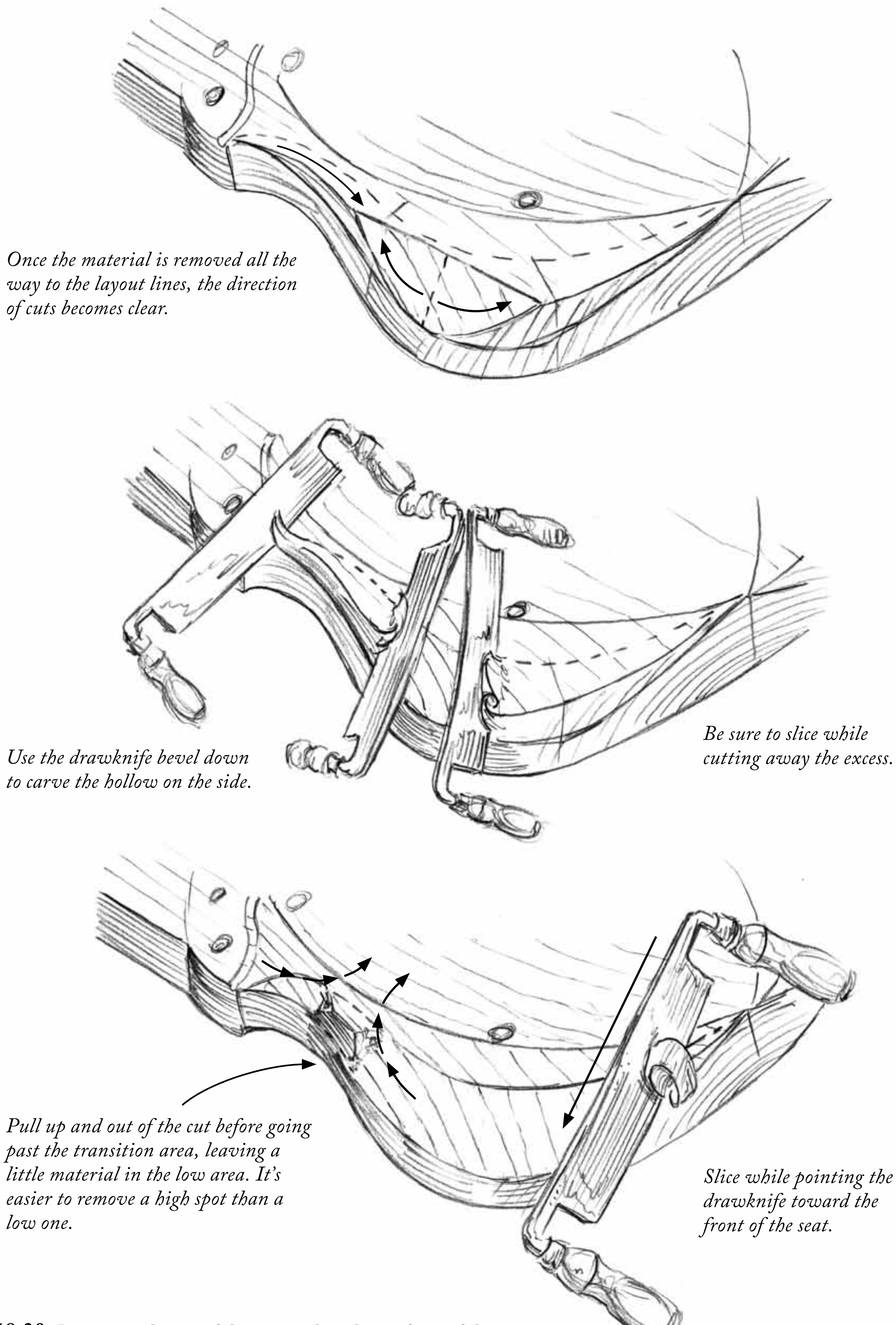
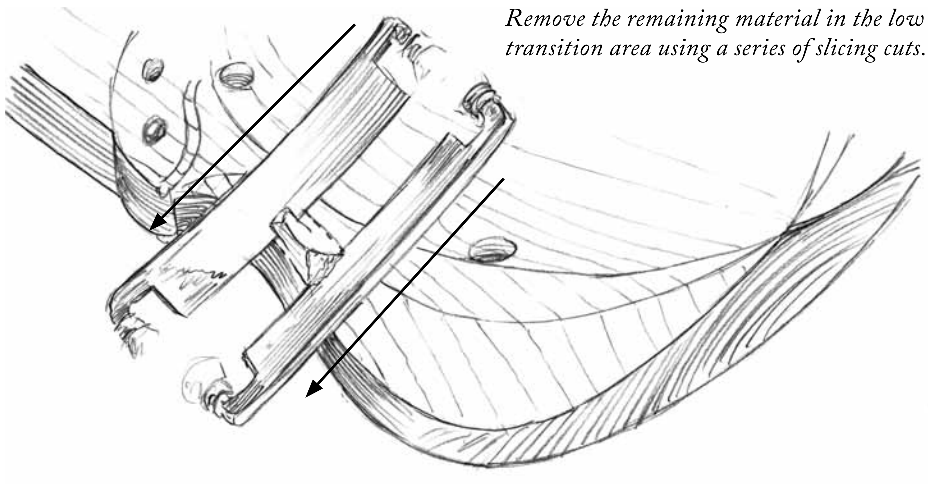



**FIG. 19.30** ***Removing the rest of the material on the top front of the seat.***

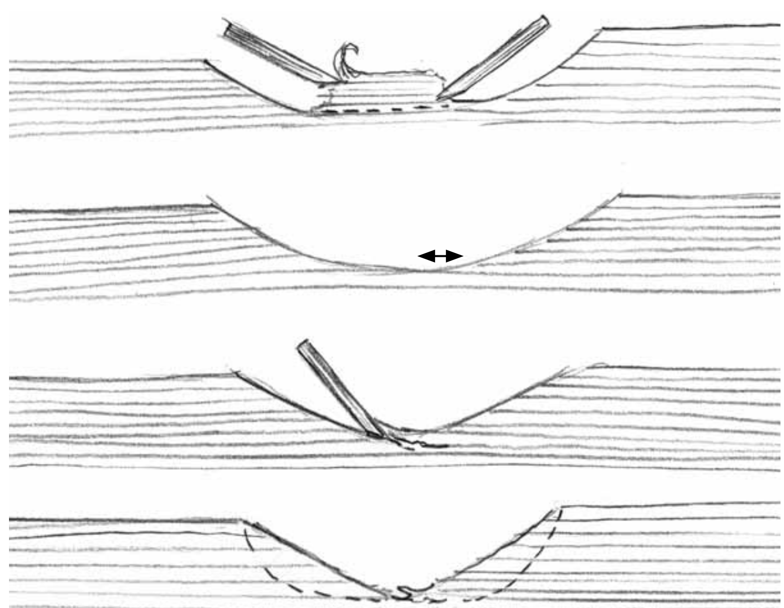
concerned; soon the shavings will start curling away and give a sense of control as the depth of cut reduces and approaches the layout lines.

When cutting the material on the side of the seat, be aware of the transition where the grain direction changes. It's helpful to remove material from either side of the transition, leaving it as a high spot that is then easy to remove with a series of light slicing cuts. Don't be alarmed if the hump is a bit ragged, it's simply the result of pulling out of the cut. Using a drawknife bevel down in hollows is helpful, and often, the only way to get good results.

If you cut at a straight trajectory to the middle of the transition and attempt to emerge from the other side, you will likely create a V in the middle that makes it nearly impossible to exit the cut. This is a common mistake in a transition area, and it can be remedied by removing material from either side until the transition is a high spot, as pictured. If your drawknife technique needs a little practice, don't worry. This is not the last process that will be touching this area, so a little roughness in the transition is not a problem.



*Remove the remaining material in the low transition area using a series of slicing cuts.*



*This is shaving, not carving, the idea being that you don't want to cut below the fibers at the bottom of the hollow.*

*The final shape has a small area in the center that follows the fibers.*

*If you don't remove enough material from the sides of the hollow, the blade will come in too steep and run into the end grain on the opposite face.*

*To remedy the issue, cut the material away from both sides to make a longer transition area.*

**FIG. 19.31** ***Removing the remaining material.***

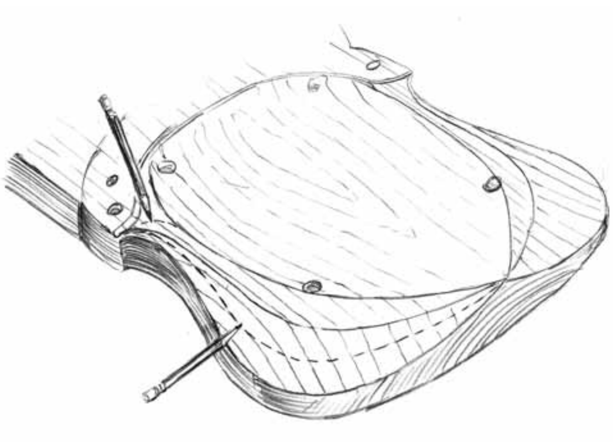
This facet should be flat in cross section. Once it's established, draw a line directly down the middle of it as shown. You will be cutting the material from this line to the line where the carving in the center of the seat ends. Depending on your drawknife, the handle might prevent you from cutting all the way to the line toward the center; don't worry about it, this can be addressed later with the inshave or travisher.

Next remove material from the sides in front of the gutter as shown below right, continuing the curve at the back of the seat around the edge of the spindle deck.

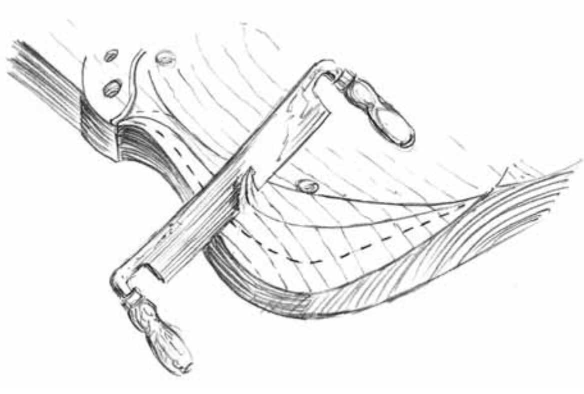
It's important for comfort to remove material where the sitter's legs will be so that circulation isn't cut off at the back of the thighs. This material is on either side of the center; when you hold a straightedge from the center point at the front to the spindle deck near the end of the gutter, it should reveal a 7⁄16" or so gap.

This step establishes the rough shape of the seat; the next step is to knock off the visible edges on the top surface and make all the shapes flow without any distinct transitions. I begin this process with the drawknife and inshave, and I finish with the travisher and spokeshave.

The travisher and spokeshave are complementary tools for smoothing the shapes. The convex areas of the seat are best worked with the spokeshave, and the concave ones with the travisher. This is because the surface contact of



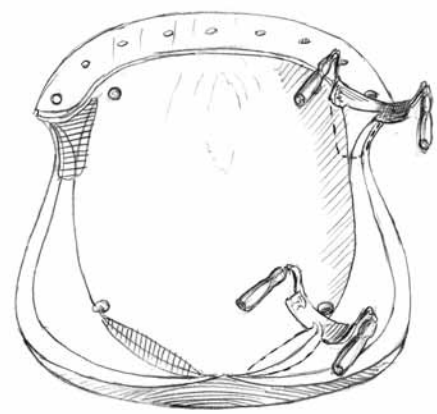
*Draw a line splitting the newly formed facet in half.*



*Carve a new facet from the line to the perimeter of the bowl area using the same steps and cutting directions as before to remove the material.*

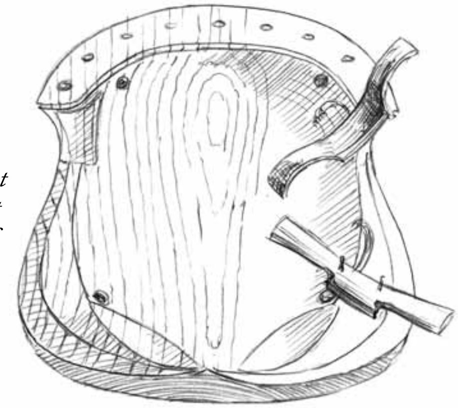
**FIG. 19.32** ***Lay out and cut another facet on the top of the seat.***

*Use the inshave or spokeshave to remove the material in front of the gutter at the sides of the seat and at the front of the seat where the thighs of the sitter pass.*



*All the edges of the facets are now small enough to be faired, making the top of the seat a fluid shape with no distinct transitions.*

*The travisher works well to bring the hollow at the back of the seat around in front of the gutter.*



*Take light cuts and be aware of the transition areas where the cutting direction reverses.*

**FIG. 19.33** ***Fair the top surface of the seat.***

the sole on convex parts of the chair will be greater with a flat tool and give more feedback when leveling the shape.

I leave the top of the seat alone after using the travisher and spokeshave. You will still be able to fair the surface after the legs are glued in place. I wait to scrape and sand the seat until the undercarriage is in place, otherwise the empty leg mortises make scraping difficult. I don't leave any tool marks on the top of the seat. To my eye, this obscures the shape and overstates the handmade nature of the chair. I prefer the tool marks to be "discovered" through closer examination. Details on scraping are shown in the chapter Complete the Undercarriage.

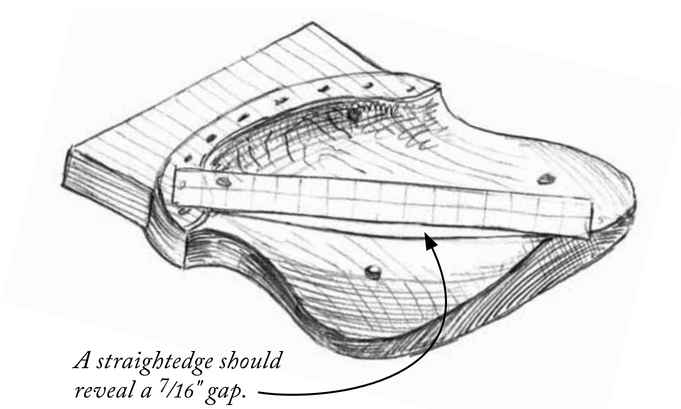
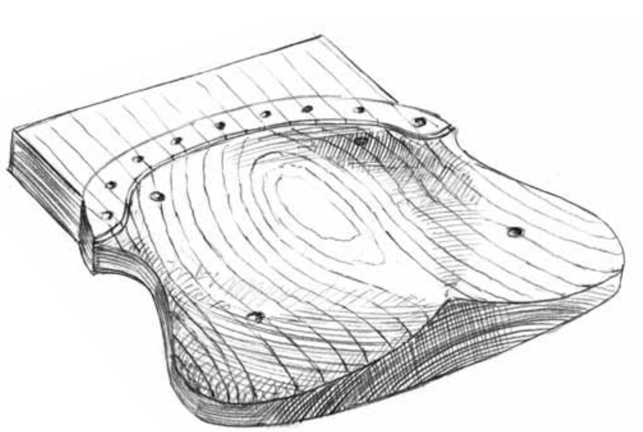



**FIG. 19.34** ***Check the seat for the gap to ensure comfort.***



*There should be no distinct transitions. Wait until the seat has been legged up to use the scraper.*

**FIG. 19.35** ***The completed seat shape.***

## STEP 6. Carve the Underside Front of the Seat

Shaping the underside of the front of the seat is a great job for the drawknife. It is crucial to avoid clamping the carved portion of the seat because the forces applied to

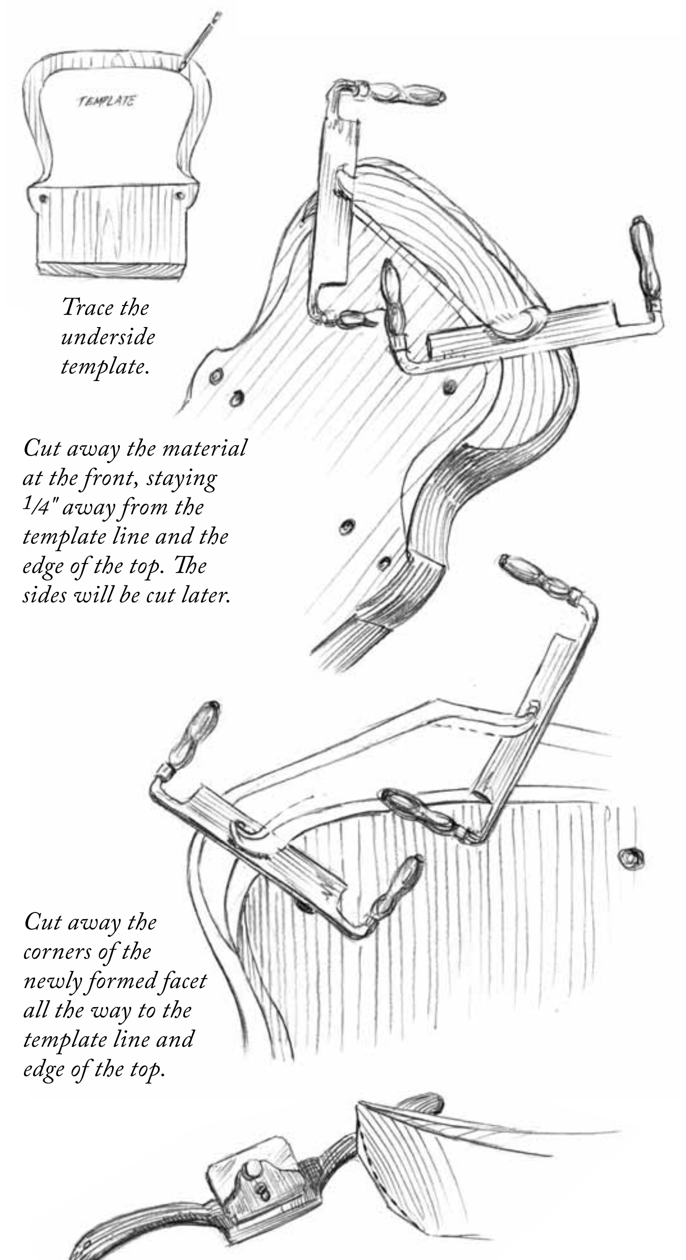



**FIG. 19.36** ***Carve material from underside of the seat front.***

the high spots on the soft pine will crush the carving. To prevent this, I position the seat in my vise so that the flat underside of the seat and the spindle deck are pinched.

Begin by tracing the pattern for the underside onto the seat. Then follow the steps in the drawings to remove the material from the front of the seat.

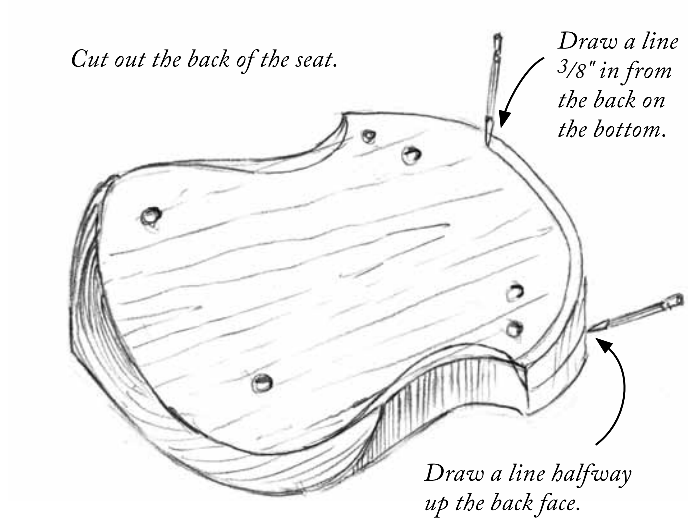
I like to start at the sides by peeling away material at the widest point of the seat along the sides, just like on the top of the seat, then pull toward the center. I always keep the drawknife edge facing away from the seat, which is the correct position for shearing without the blade grabbing the end grain.

Once all the material is removed to within 1⁄4" of the layout line and front edge, carve away the corners of the facet as shown. This will establish the convex shape of the underside. Then use a spokeshave to fair the surface into a shape with no distinct transitions, as shown below.

## STEP 7. SHAPE THE BACK OF THE SEAT

The shape of the back of the seat is similar to a quarter of an oval. I make this by drawing a line half way up the back face of the seat and a line 3⁄8" in from the corner on the bottom of the seat. Then I cut the material away from between these lines, heading from the sides of the seat toward the middle.

Next, I knock off the hard corner between the facet and the flat. Finally, I fair the curve with a spokeshave, leaving the tool marks as the final surface. It's important to cut from the sides toward the back. The end-grain area at the back of the curve will allow you to cut a bit beyond center – but not much without the surface quality suffering. Skewing and slicing with the spokeshave are essential to getting clean, waxy facets.



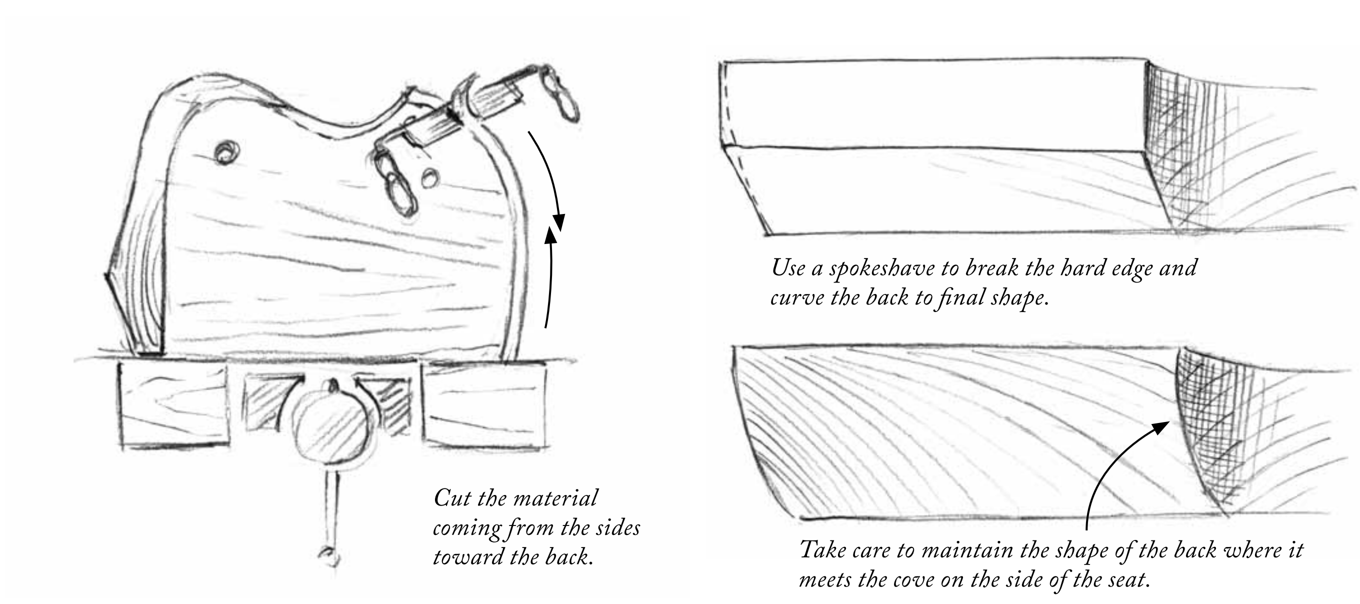




**FIG. 19.37** *Carve material from underside of the seat back.*

## STEP 8. SHAPE THE RELIEFS ON THE UNDERSIDES OF THE SEAT

Next, I remove the material from the concave portion at the sides of the seat. This shape is like the inside of a doughnut, both convex and concave. The difficulty in cutting this section is that the fibers run along the shape, which makes the transition a bit trickier than on the front of the seat. You can't cut all the way from one end of the shape to the other with one motion because you will run headlong into the exposed end grain on the opposite slope.

While you could remove this material with a rasp and avoid the trouble, I like using a bevel-down drawknife for speed and clean tool marks. They are a lovely point of discovery as sitters explore the seat with their hands.

At the very least, I encourage you to remove the bulk of the material with the drawknife before turning to abrasive tools. You will find that a thin, bevel-down drawknife with a rounded bevel will perform best here because of its ability to follow the curve without getting pushed out of the cut by the bevel. If you don't have such a knife, use any bevel-down knife, but hone away any hard edge at the back of the bevel first.

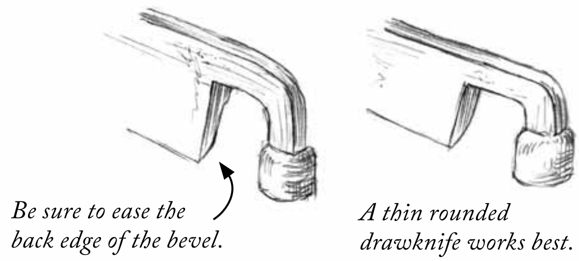
The key to cutting in this area is to make sure that you always cut so there is a high spot left in the transition area. Then you can shave the high spot down safely to the level that the cuts are entering from each side. The type of cut to avoid is one that dives toward the center, which will cause the knife to dive into the end grain of the fibers on the opposite slope. Slicing is essential to controlling this cut, and once you remove the high spot in the middle, you will find that lots of slicing even lets you cut "uphill" just enough to fair the curve. Think of the drawknife as a saw, because all the pulling in the world won't give you control, while slicing will.

Another key to cutting in this deep cove is to keep the width of the cuts narrow. Wide shavings become difficult to control and cause the knife to dig. By keeping the shape convex, you ensure that the width of the shavings stays narrow.

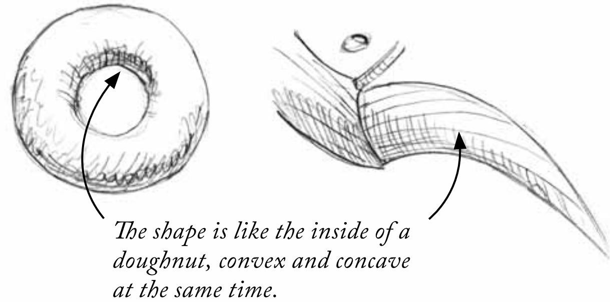
I break the cutting in this area into three sections, and I focus first on removing the bulk of the waste.

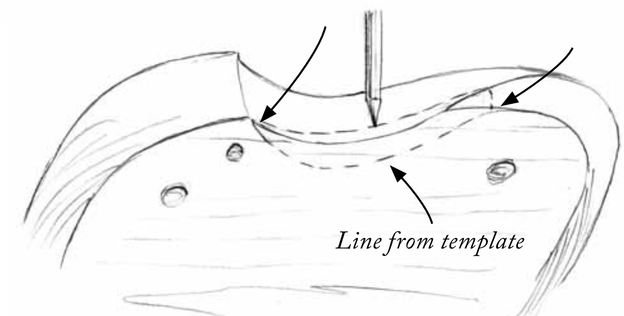
The final cut is more for cleaning the surface than making a deep carving because removing material from this area would change that shape of the seat.

Then I return to the first area that I cut and carefully refine the shape. And then the second area.

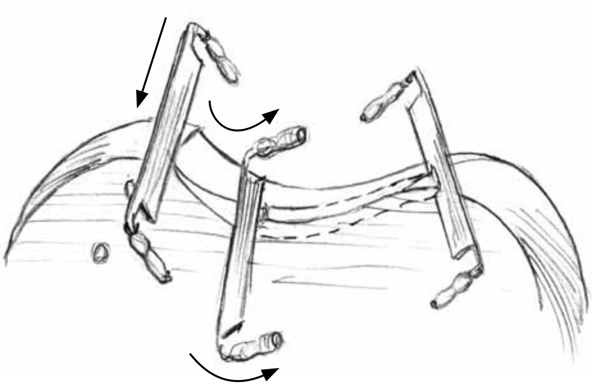



*A bevel-down drawknife is essential to cutting the cove.*




*Draw a line from the point at the back of the cove to the area that was cut from the front.*



*All of the cuts in this area require a lot of slicing action. Be sure to come up and out of the cut before the transition area.*

**FIG. 19.38** ***Carving the underside of the seat sides.***

*Pull out of the cut from both directions, leaving the transition area in the bottom of the hollow.*

*Just as with the hollow on the top of the seat, carefully shave away the remaining material with a slicing cut.*

*Don't worry if the surface isn't perfect; it's more important that you don't carve into the end grain on the opposing slope.*

*For the layout of the next cut, split the two facets in half and repeat the process, cutting the material between the two new lines.*

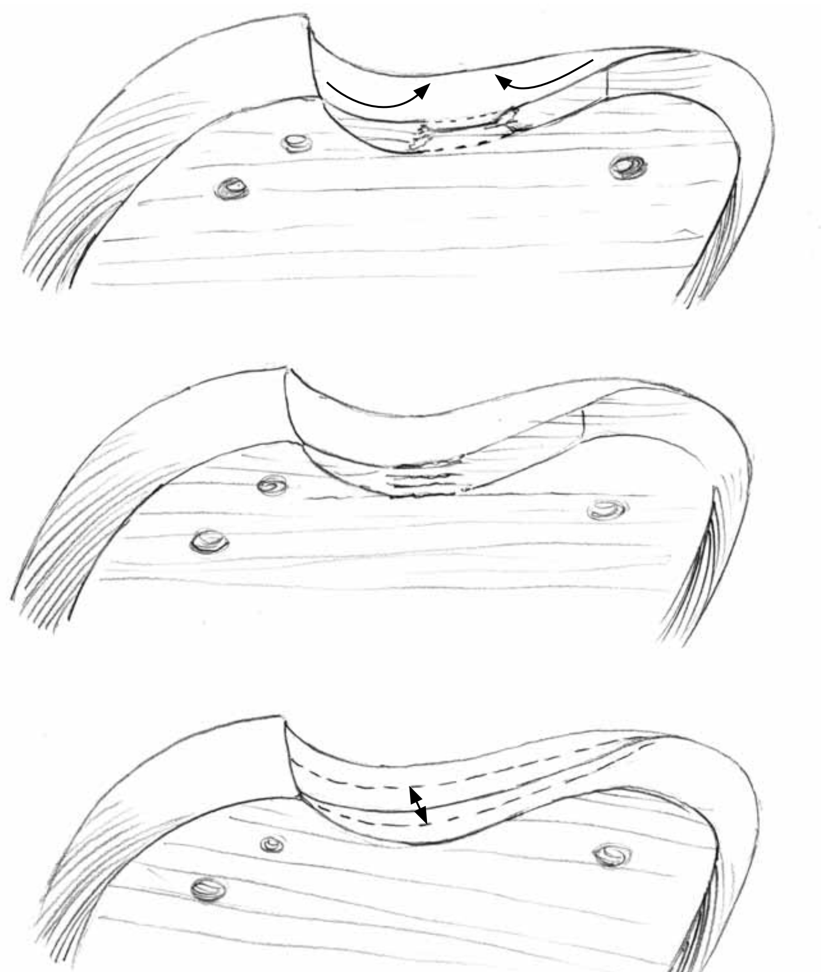


**FIG. 19.39** ***Refining the underside of the seat sides.***

Finally, I knock off the hard edges between the facets, being careful to obey the same cutting technique that kept me out of trouble while removing the bulk. Leave a hard edge where the side meets the top and bottom of the seat.

This area can also be cleaned up with a curved spokeshave, such as a Millers Falls cigar shave, but note that the same trouble with the transition area can plague this tool if you aren't careful. You can also scrape and sand the area.

At this point, all of the carving on the underside of the seat should be complete because the assembled undercarriage will impede access. If there are any issues that still need addressing on the top of the seat, they can be easily taken care of once the legs are in place before the uppercarriage assembly.

## Conclusion

I follow a very clear process each time I carve a seat, both to eliminate guesswork and to keep my results consistent and fast. While it might seem like lots of steps, they quickly become second nature as you understand the role each one plays.

*Once the middle facet is carved, draw a line down the center of it.*

*Carve the material from the new line to the top edge of the side. Be careful not to remove more than a tiny bit from the top because it will change the shape of the seat.*

*Finish the shape by taking narrow shavings off the high spots and fair the surface with spokeshaves and, if necessary, a rasp and file.*

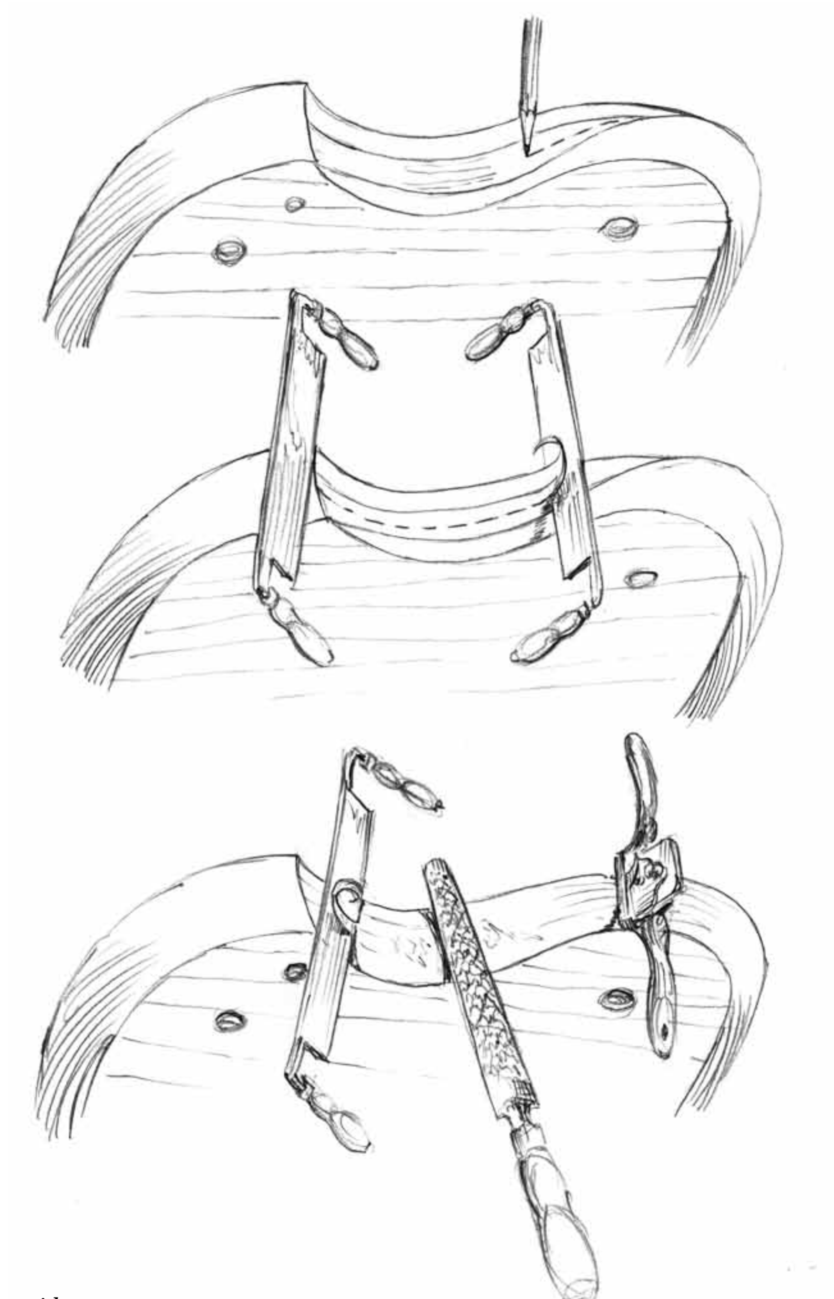
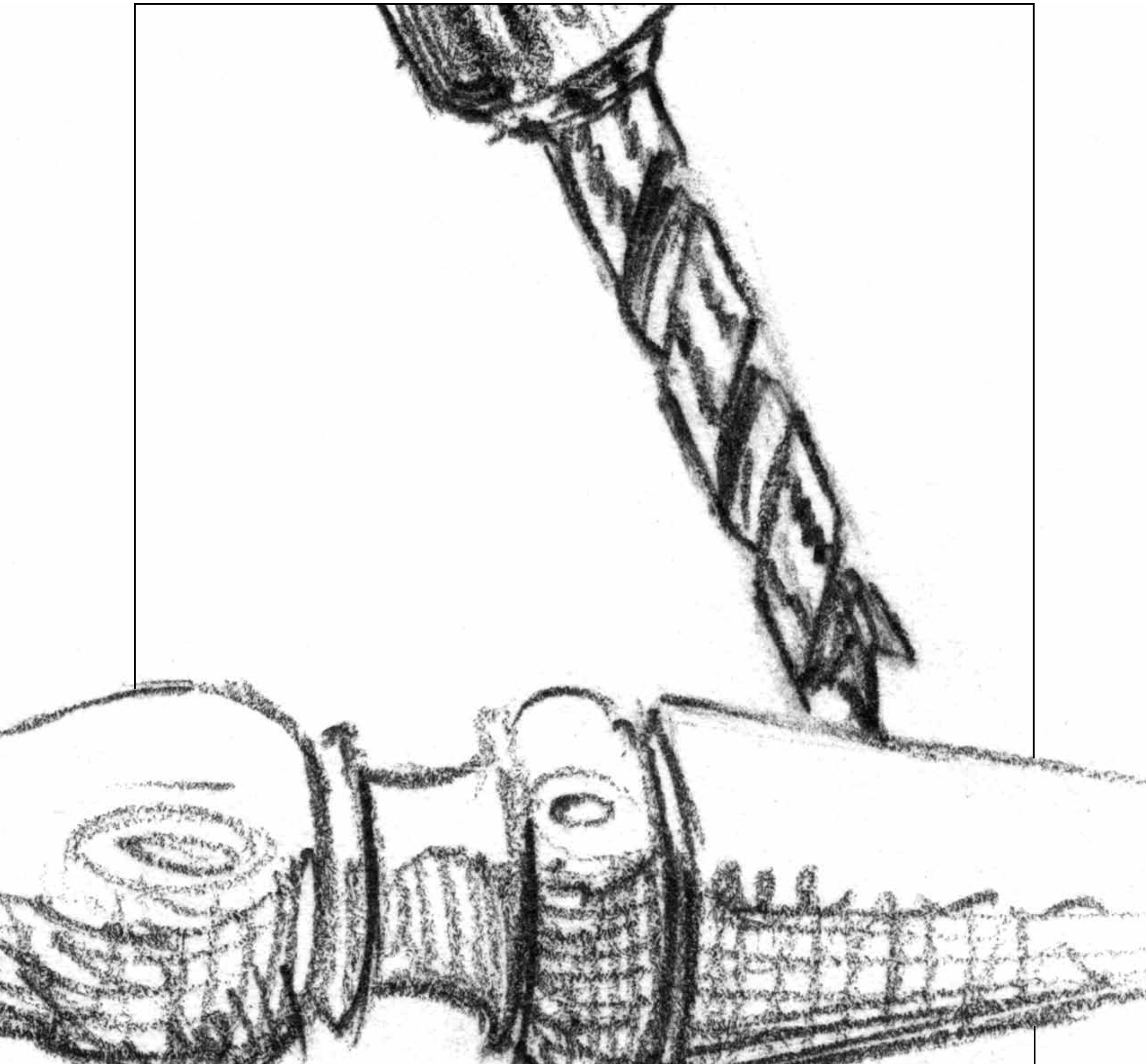


**FIG. 19.40** ***Finishing the underside of the seat sides.***



# 20

# Undercarriage Joinery

Woodworkers who think chairs are beyond them usually cite the complex angles as the reason. I can understand this because the "square" types of joints that are used in most furniture become more daunting when the parts that they connect aren't "square." I recall feeling brain lock when I first delved into joining parts at angles other than 90° or 45°.

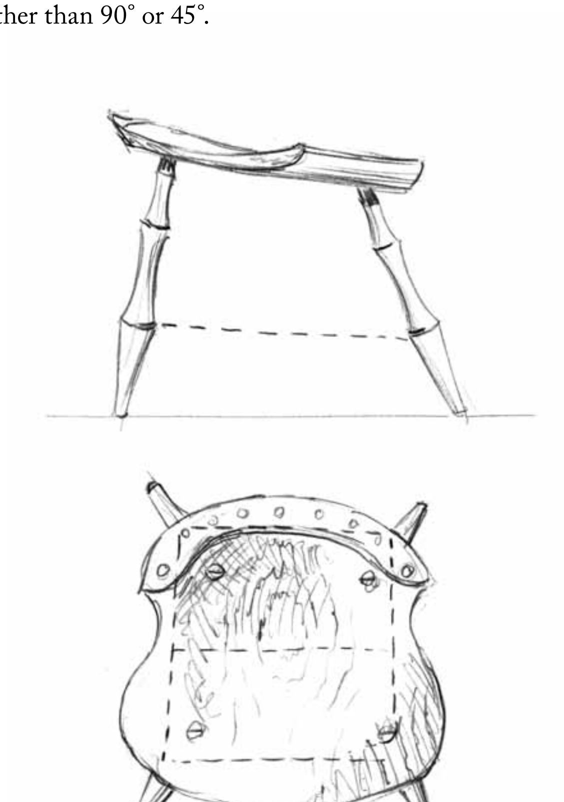


**FIG. 20.1** ***The geometry of Windsor chairs is different than cabinetry, but it's not overly complex.***

Dealing with angles in chairs doesn't have to be traumatic. Unlike square-joint chairs, such as Chippendale style, the round joints in Windsors make forming the joints at various angles easy. I use a method to drill the angles and assemble the undercarriage that doesn't use any numbers. And while precision is an important part of making a successful chair, all of the mortises can be drilled accurately with a hand-held drill. Geometry is always present when building furniture, but given the right tools, you can learn to tackle geometry beyond right angles using simple references instead of numbers and formulas.

So why not set up a drill press with a jig or moveable table for the drilling?

While a drill press offers stability and repeatability, I prefer to work with a setup that is easier to change. And because I am not producing a large number of similar

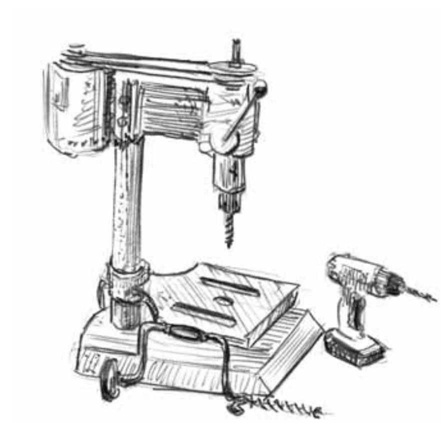


**FIG. 20.2** ***There are many options for making mortises. Your choice will be based on your tools and preferences.***

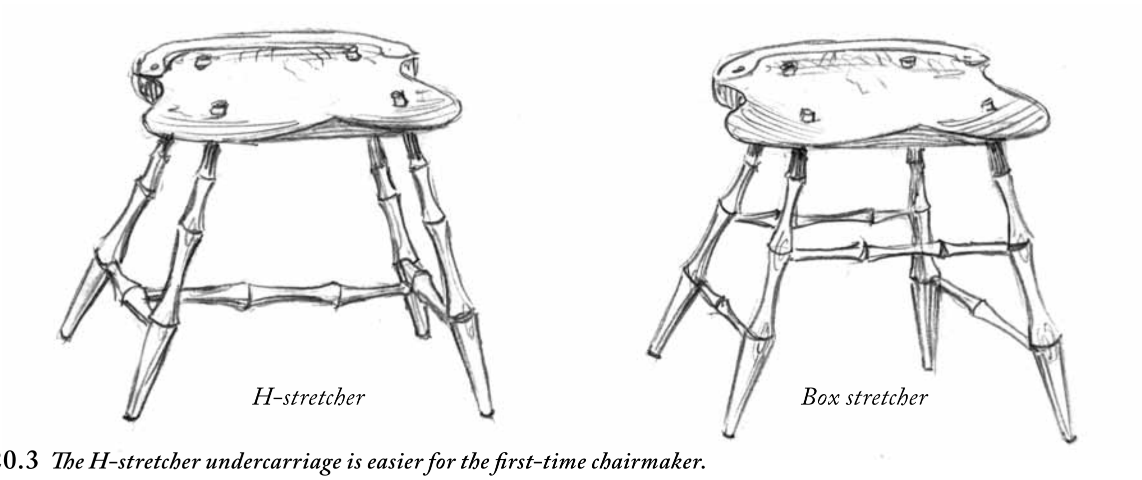



**FIG. 20.3** ***The H-stretcher undercarriage is easier for the first-time chairmaker.***

chairs at any one time, repeatability is not as critical. The accuracy required to make a solid chair using a hand-held drill is easily attainable, even for newcomers to the tool and chairmaking. I also like the portability of the drill; it keeps my process simple and easily keeps up with me as I change and design.

Then why not use a bit and brace?

A bit and brace is effective in certain applications, but the tight tolerances required for blind mortises and the density of the hard maple make the bit and brace a challenge. Of course, the bit and brace have a long history in successful chairmaking, so if those are the tools you have or they interest you, explore their potential and perhaps you will enjoy making your joints with them. Extra attention to the condition of the bit will be essential to making good mortises.

There are probably as many techniques for putting together an undercarriage as there are chairs, and there is lots of flexibility and room for slight discrepancy in the undercarriage. I often think of making a Windsor as being a "humane" way of building because there is room to work with tolerances established by our eyes and hands. The process quickly becomes natural, even to the first-time chairmaker, and there is much room for forgiveness. That said, I strive to be as accurate as possible. Plus, I've found that learning to precisely drill these parts has improved my abilities and made me more confident in other drilling tasks.

There are two typical styles of undercarriages found in most Windsors. There is the H-stretcher, which has a stretcher running from the front to rear leg on each side, and a single "center" stretcher that connects them to each other. The other is the "box" stretcher, which has a stretcher connecting each leg to an adjacent leg. I've chosen to feature the H-stretcher because it is easier to achieve and has a greater degree of forgiveness.

Before I start making the undercarriage of a chair, I make sure that I am finished with all of the cutting and surfacing on the underside of my seat. Reaching these areas becomes tricky once the chair is legged up.

## STEP 1. ORIENT THE LEGS IN THE SEAT

During the reaming process, the rotation of the legs was determined so that the seasonal movement of the seat and legs are coordinated to harmonize movement within the joints. Return the legs to the seat in this orientation to start the undercarriage-assembly process.

## STEP 2. MARK MORTISE LOCATIONS

Locating the mortise locations vertically on the legs is slightly different for the baluster and the bobbin-leg styles. The bobbin legs have V-notches that determine the height of the mortises on the legs. Plus, the front and rear legs will be different patterns, with the rear legs being somewhat shorter.

The balusters are a bit different. First of all, the front and rear legs are turned to the same length, which I do for a reason that I'll explain below. I prefer to mark the stretcher height on the balusters after they are reamed into the seat, which washes out any difference in the depth that they are reamed.

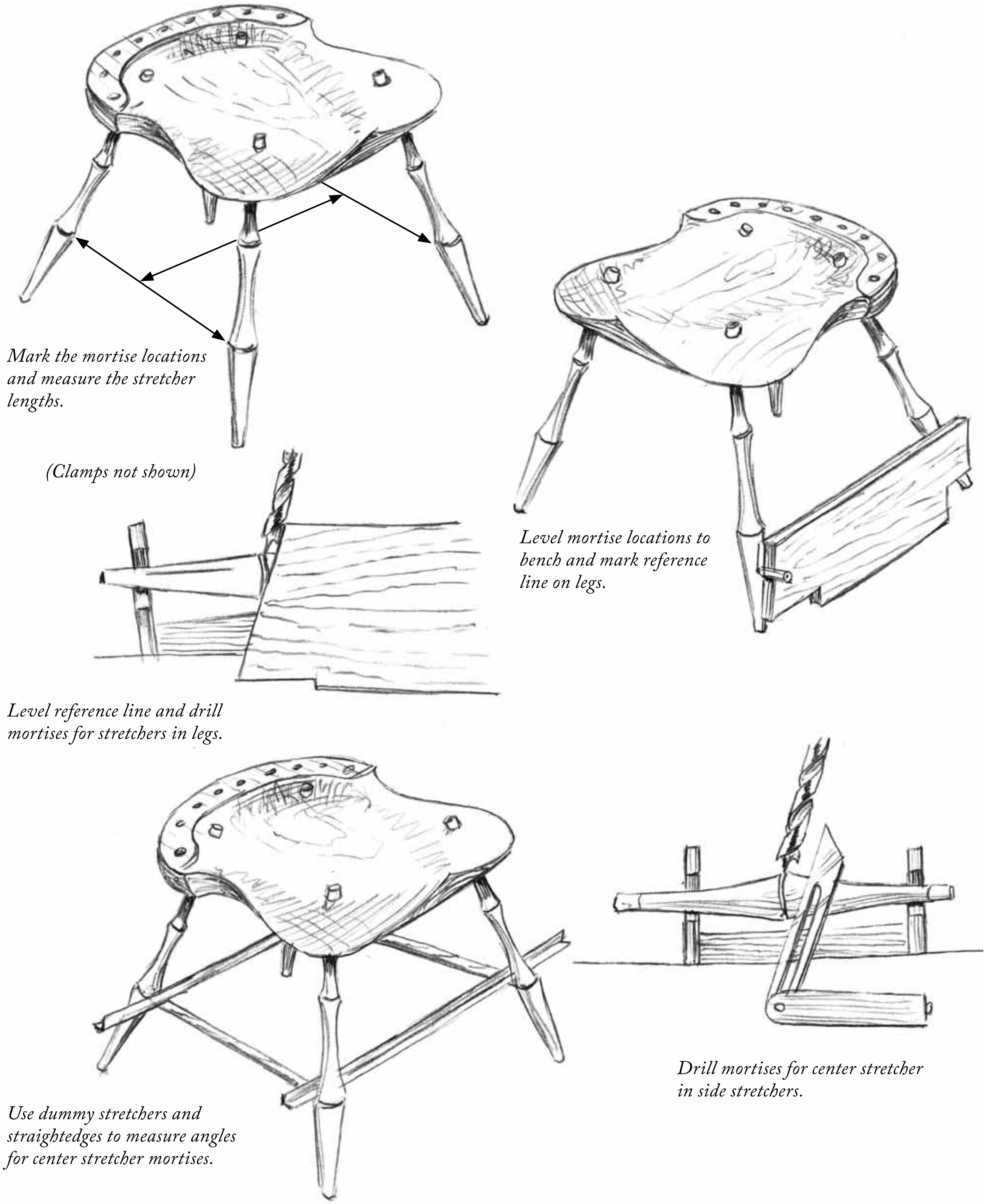



**FIG. 20.4** *An overview of the steps to create the undercarriage of the chair.*

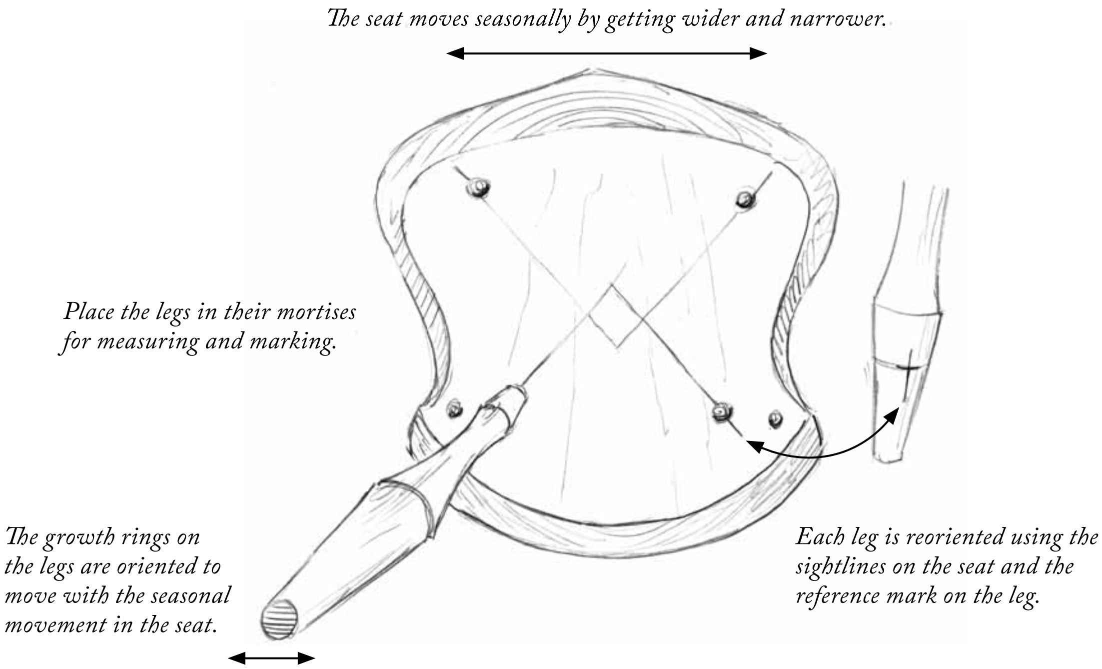



**FIG. 20.5** ***With the legs in this position, movement of the seat and leg are harmonized.***

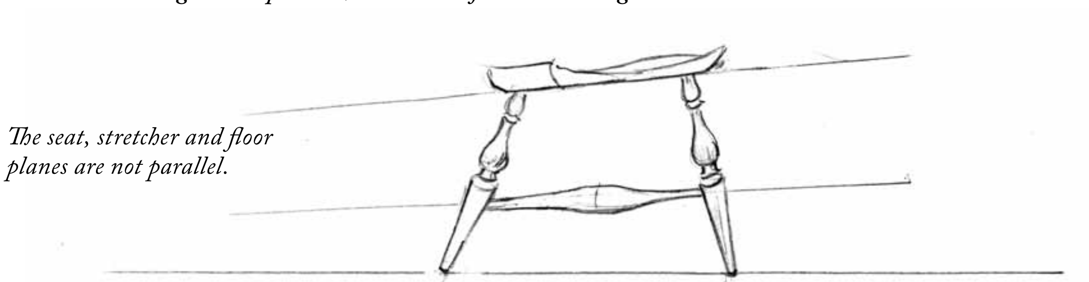



**FIG. 20.6** ***The planes of the floor, stretchers and seat should all converge behind the chair.***

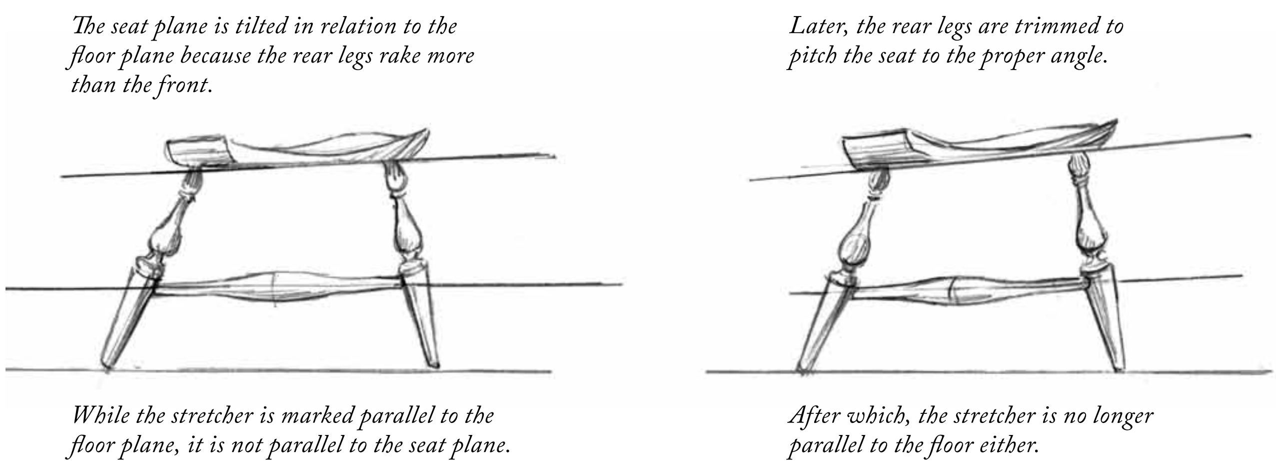



**FIG. 20.7** ***How the rake of the rear legs, and the way you trim them at the end, makes layout easier and the final chair more dynamic-looking.***

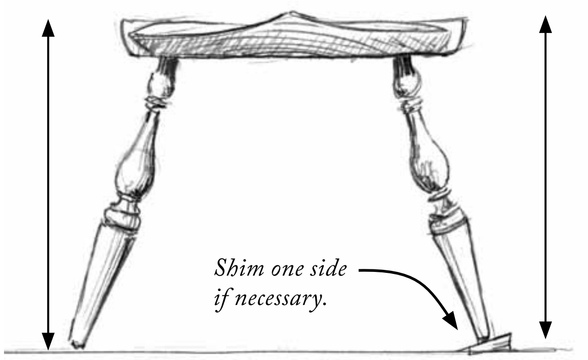



**FIG. 20.8** ***Level the seat side to side using the gutter as a guide.***

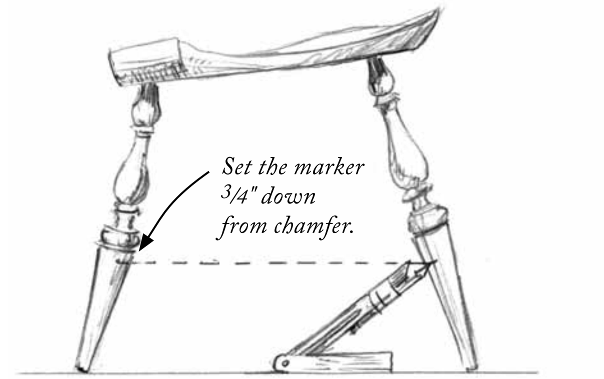



**FIG. 20.9** ***How to mark the location of the mortises in the front and rear legs.***

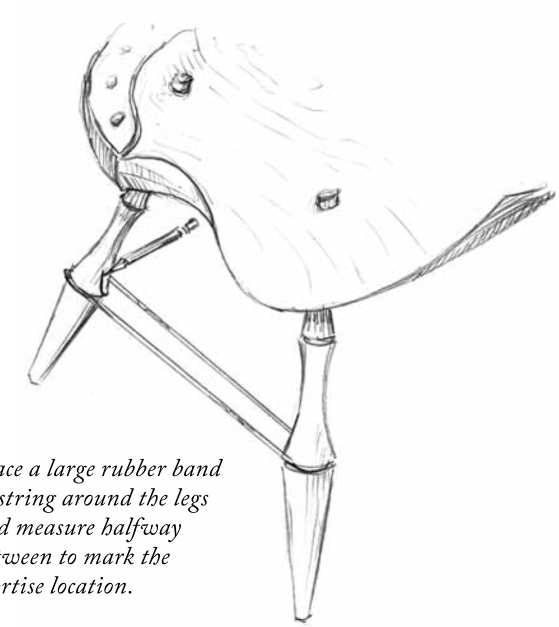



**FIG. 20.10** ***A rubber band stretched across the legs reveals the location of the mortise in the legs for both styles of legs.***

I mark my stretcher heights all at an equal distance off the benchtop (which is helpful in later steps, especially in the marking and drilling method that I'll be showing). But the end goal is that the seat, stretchers and floor plane appear as though they would intersect if they were extended, which gives the chair a dynamic appearance.

Even though the front and rear legs are turned to the same length, the seat will sit slightly tilted back because the rear legs have more rake than the front. This ensures that the seat and stretcher planes aren't parallel in the finished chair. Later, after the rear legs are trimmed to get the final pitch on the seat, the stretchers will not be parallel to the floor plane, either. It's a small detail, but marking the height of the stretchers parallel to the bench cuts out a step from the process.

If so desired, you could set the height or angle for the stretchers at something other than parallel to the floor and simply follow the rest of the process as you would for the bobbin turnings.

**MARK BALUSTERS**

To mark the position of the mortise height on the baluster legs, first level the seat side to side by measuring the distance from where the gutter carving emerges from each side of the seat to the bench.

If the four legs don't all touch the workbench, slip a shim under one of the "high" legs and measure the gutter height. If the gutters aren't an equal distance from the floor, usually moving the shim to the other "high" leg will make the difference. If not, shim both front and rear on one side to raise the seat so it is parallel to the workbench.

(Note that you aren't concerned with leveling the seat front-to-back; the rake of the legs is different, so the seat will tilt slightly back.)

Then I mark the mortise locations on the legs at the same height off the benchtop using a pencil taped to a bevel square. The height of the mark should be 3/4" below the chamfer under the bead on the rear leg. This isn't a detail handed down from on high; it's just a reasonable

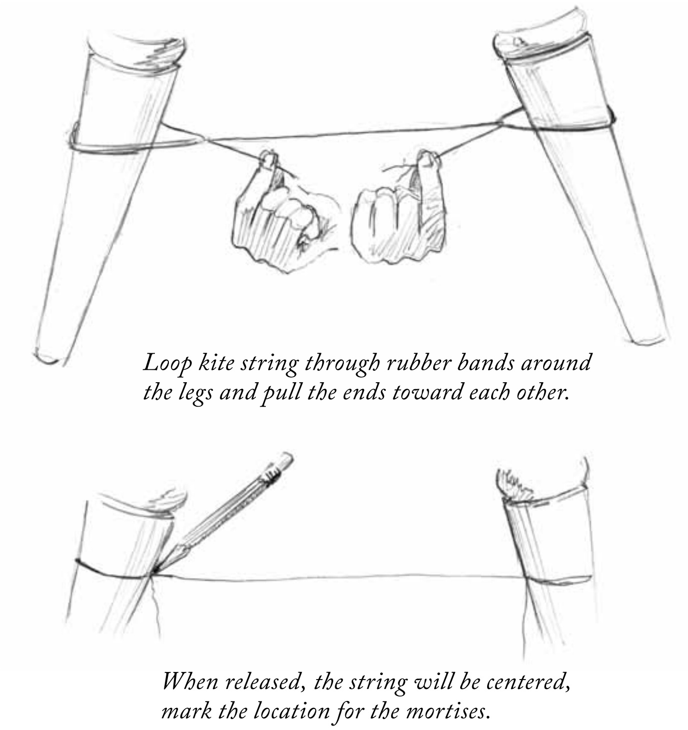



**FIG. 20.11** ***String and rubber bands are helpful when finding centers.***

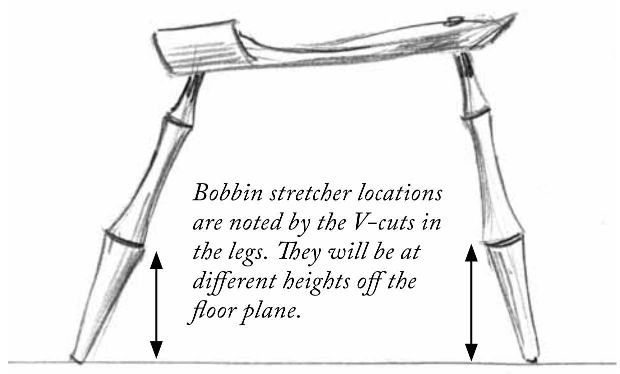



**FIG. 20.12** ***With bobbin legs, the location of the mortise is determined by the turning pattern.***

height for strength and appearance. You could lower it as long as there is enough material for strength in the mortised piece.

Next, I place a large rubber band or string around the front and rear legs and measure halfway across the gap to find the mortise location around the leg.

Another method is to wrap a rubber band around each leg and feed a length of string from one to the other. When you pull the ends of the string toward each other, the string will snap back to center on each leg.

#### BOBBIN MARKING

For bobbin stretchers, the height of the mortises is predetermined by the turning pattern, I only have to orient the legs in the seat and mark the location of the mortises around the leg.

Just like the balusters, I place a large rubber band or string around the front and rear legs at the mortise height and measure halfway across the two sides; it's the same technique as shown for the baluster.

### STEP 3. MEASURE LENGTHS FOR THE SIDE STRETCHER

Now that the mortise locations are marked, I measure my stretcher lengths from them. I do this by measuring the distance from shoulder to shoulder of the tenons then add 1" to each side to account for the length of the tenons.

Because the mortises are drilled into the legs at an angle, there will be a long and a short side of the mortise.

To ensure that I set the tenons a full 1" into the mortise, I bury the shoulder line at the top. It should be noted that I don't actually leave a shoulder on the tenons, but that I turn them to the same diameter as the mortise so that I can bury them in the angled mortise to reach full depth on the short side.

To get an accurate measurement of the shoulder-to-shoulder distance of the stretchers, it's important to measure the stretcher's length using the short, bottom side of the mortise.

I do this by drawing a ⅝"-diameter circle around the mortise's centerpoint (⅝" is the diameter of the mortise and the tenon).

I then measure the length from the bottom of one mortise to the other using a folding rule that has an extending leg. If you don't have an extending rule, you can use two rules that you overlap.

If you choose, you can simply mark the center of the mortise locations on the legs and complete the leg-drilling process, then take the measurement directly from the bottom of the actual mortise.

Make sure to add 2" to the shoulder-to-shoulder distance to account for the tenons. I always write down

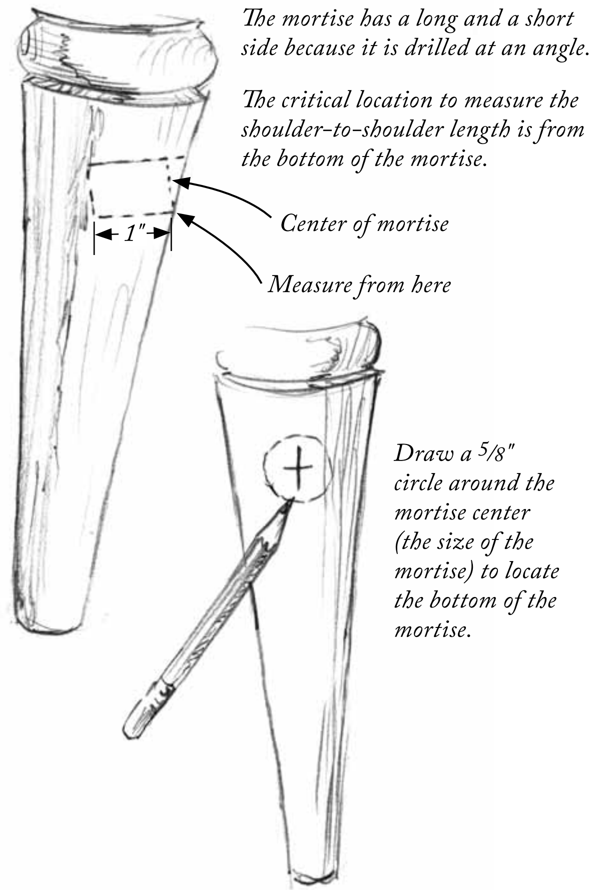



**FIG. 20.13** ***Use the short side of the mortise to determine the final length of the stretcher.***

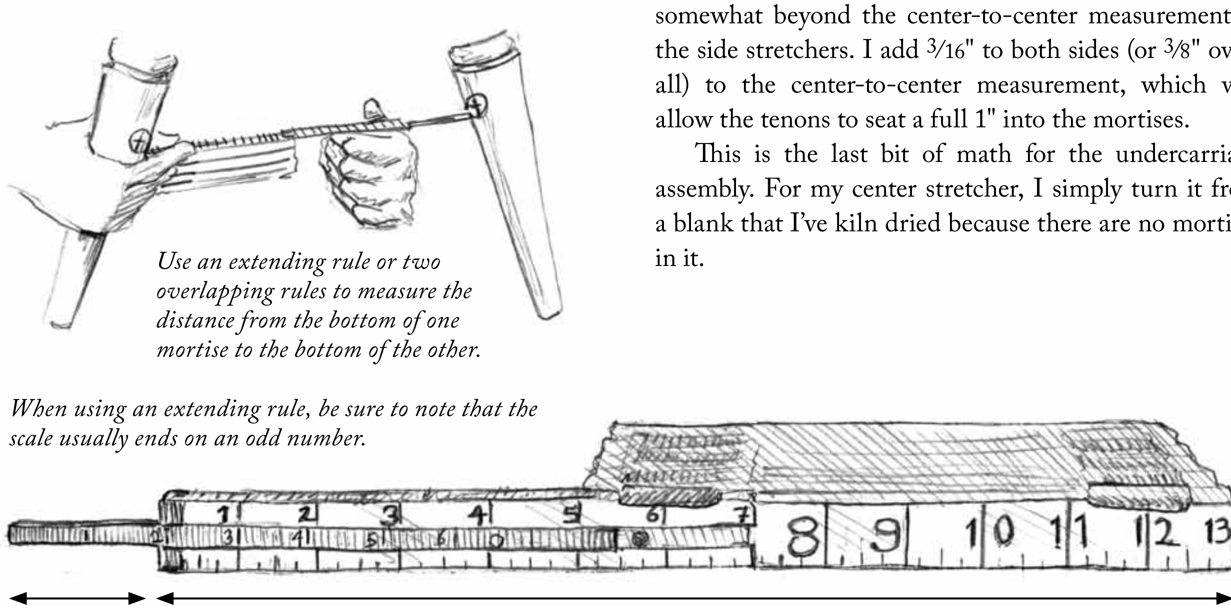



**FIG. 20.14** ***Measure from the bottom of each circle. Add 2". That is the length of your stretcher.***

the shoulder-to-shoulder measurement then write "+2"" to avoid confusion when I get to the lathe. See the section on turning for additional instruction on making the stretchers.

## STEP 4. MEASURE THE CENTER STRETCHER'S LENGTH

The simplest method I've found for measuring the center stretcher's length is to use the same large rubber bands as before, but to twist them as they pass from the front to the back leg.

The location of the crossing band will be the center of the side stretchers. Measure the distance from one side to the other at the crosspoints, being careful not to press on them.

Just as with the side stretchers, you must be sure that the length includes enough to sink the tenons. Measuring the rubber band crossing gives you some of the tenon length because it goes to the center of the stretchers, but it doesn't give the overall length to the bottom of the mortise.

I want my center stretcher tenons to seat a full 1" deep into the side stretchers.

But in most cases, I turn my side stretchers 1 5⁄8" in diameter. So if I measured the overall length from where the rubber bands cross, the tenon would go only 13⁄16" deep (which is half of the 1 5⁄8" diameter).

So to get full 1"-long tenons to seat, I need a length somewhat beyond the center-to-center measurement of the side stretchers. I add 3⁄16" to both sides (or 3⁄8" overall) to the center-to-center measurement, which will allow the tenons to seat a full 1" into the mortises.

This is the last bit of math for the undercarriage assembly. For my center stretcher, I simply turn it from a blank that I've kiln dried because there are no mortises in it.

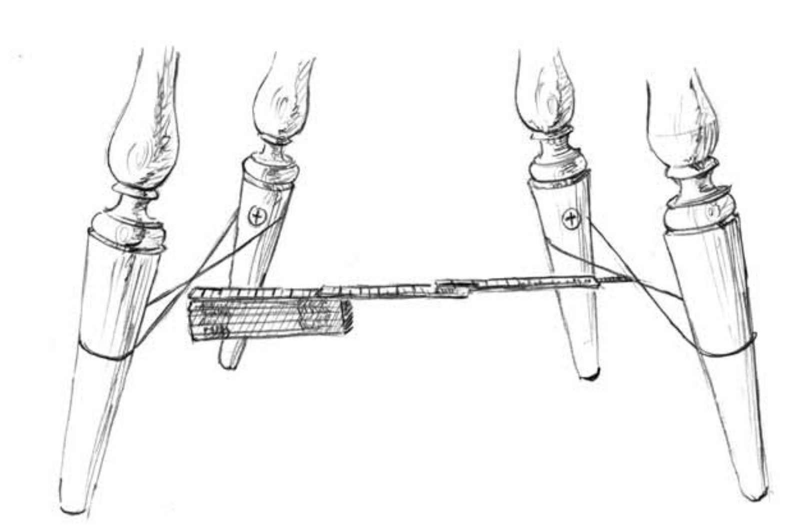


**FIG. 20.15** ***Add a single twist to your rubber bands to find the distance between the centers of the side stretchers.***

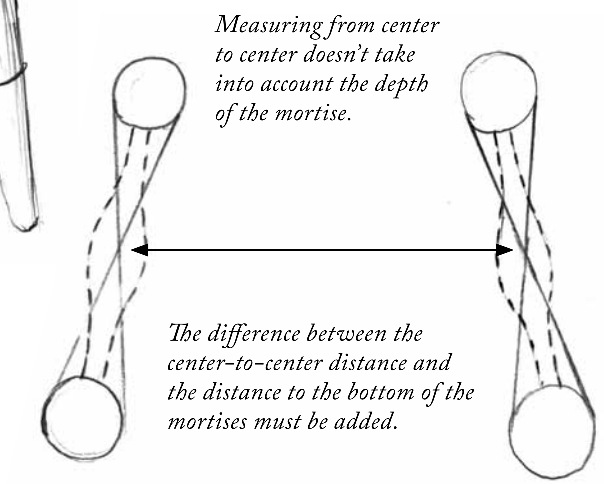



**FIG. 20.16** ***The twisted rubber bands give you a measurement from the center of each side stretcher.***

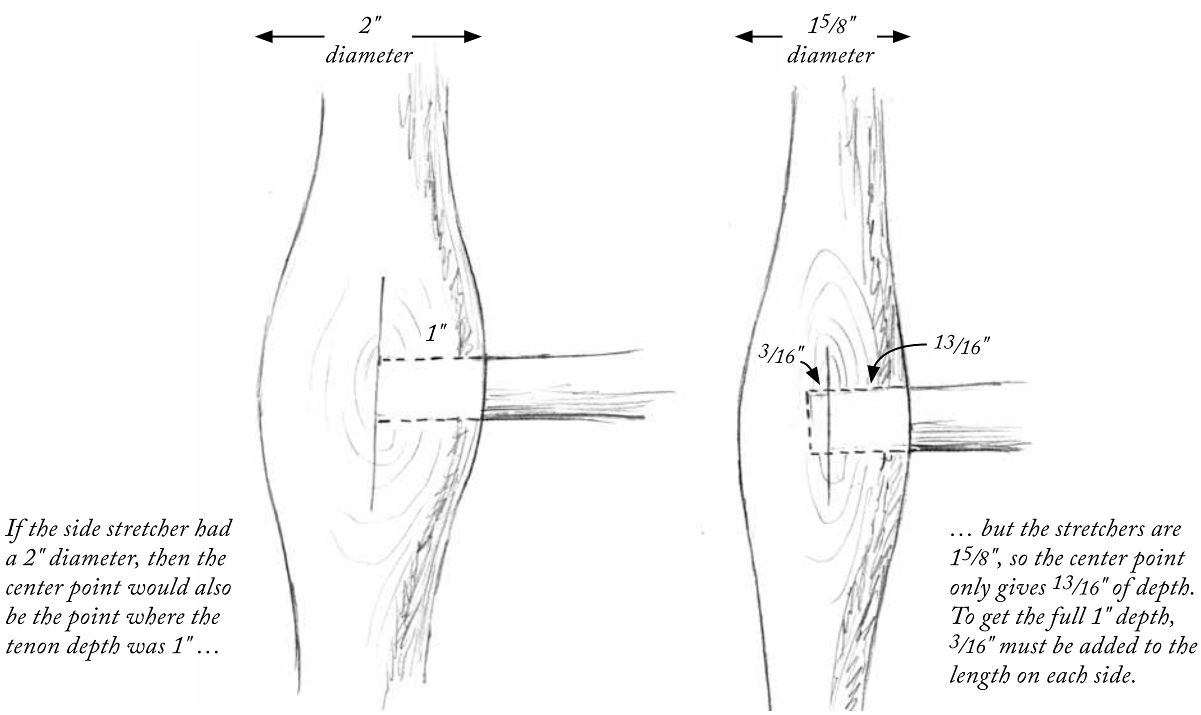



**FIG. 20.17** ***By adding 3/8" to the center-to-center distance (3/16" to both sides), you ensure you will have enough length for a full 1" buried in each side stretcher.***

## STEP 5. DRILL THE LEG MORTISES FOR THE SIDE STRETCHERS

To drill the angled mortises in the legs, the drill bit must be positioned at the same angle and orientation to the leg as the assembled stretcher will be.

The side stretcher's axis follows a straight line from the mortise location on the front leg on one side of the chair to the mortise location on the back leg on the same side.

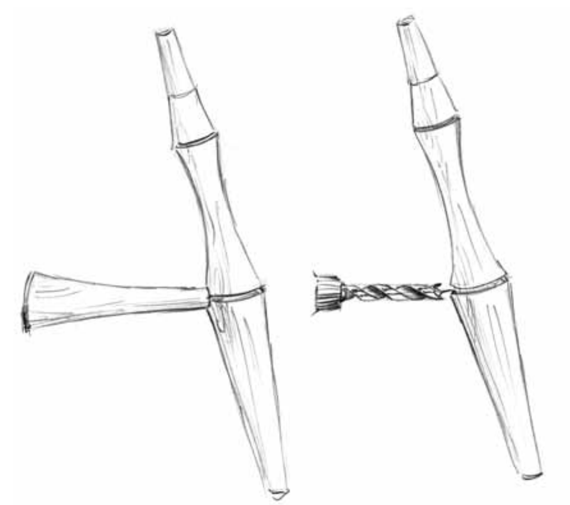


**FIG. 20.18** ***The drill bit must be oriented in the same way as the assembled stretcher will be.***

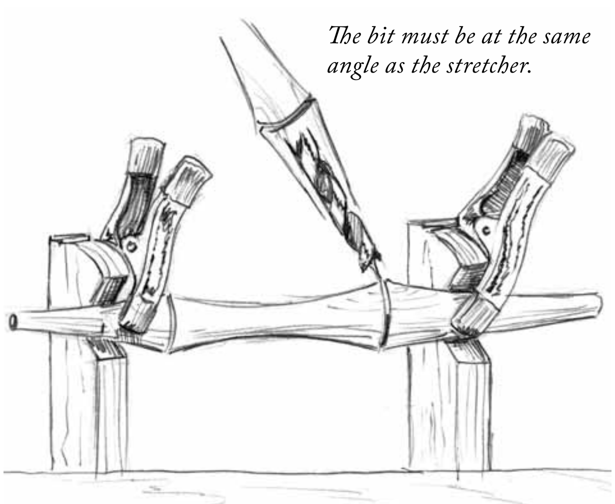



**FIG. 20.19** ***The mortises in the legs are drilled while using a holding jig.***

Each leg will be removed from the chair and drilled while held securely in a holding jig in a bench vise.

I use a visual guide and a mirror to make sure that the drill bit is in the correct position during drilling. The method I use for establishing this relationship requires no numbers or measuring of angles. While it might not be obvious at first glance, in practice, it is simple, fast and accurate.

Before I show the details, I think it's helpful to explain the concept that underpins the process.

The way that I first learned to measure and drill stretchers was to use string as a stand-in for the stretcher's axis and to measure the angle of the string to the axis of the leg using a protractor.

This sounds simple, and it is, but there are many places for error to creep in. Plus lots of angles, tool settings and legs and to keep track of. Experience, especially in large classes, revealed this to be a real problem.

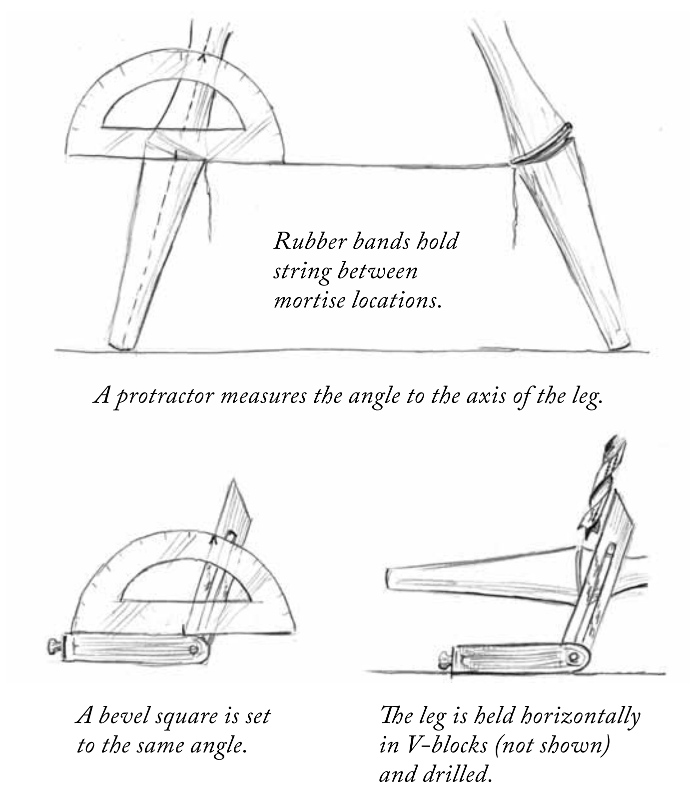



**FIG. 20.20** ***One method for establishing the relationship between the stretcher axis and drill bit.***

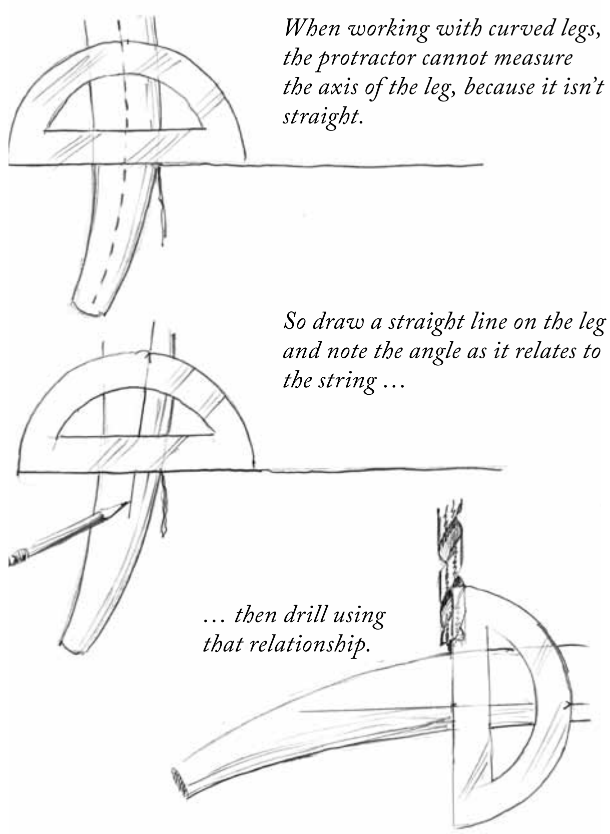



**FIG. 20.21** ***A method for dealing with bent parts.***

This process worked reasonably well in my own practice, until I had to join a stretcher to a curved leg. While I could still use the string as a stand-in for the stretcher axis, I couldn't measure an angle to the "axis" of the curved part.

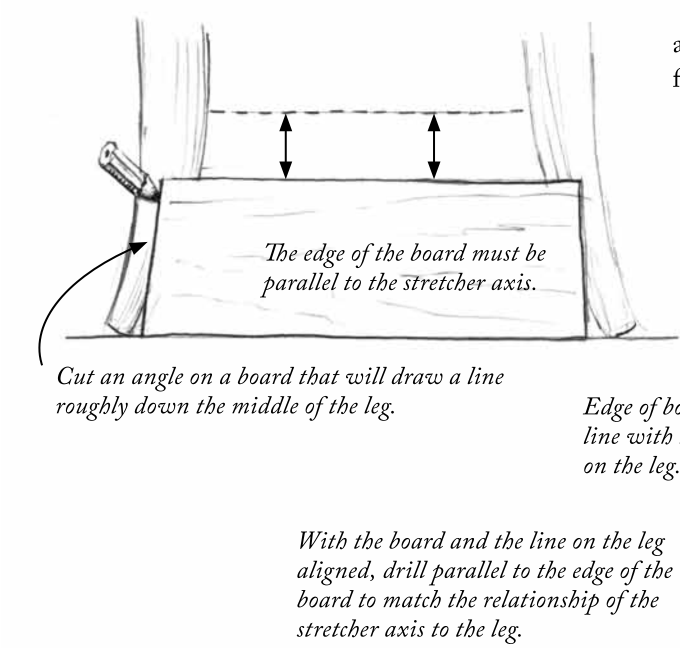
My solution was to draw a straight line on the curved leg, sort of an applied axis, and use it as a reference for noting the relationship to the stretcher. I measured the angle of the string to the reference line, then I used that angle to position the drill bit in relation to the line, just as I would with the axis of a straight leg. It worked great.

It's important to remember that the axis of the leg and the angle you measure have no magic powers, they are simply a way to note a relationship so it can be reproduced while drilling.

The new method solved my problem when working with curves, but then it occurred to me that the process could be made even simpler and used in all my stretcher-to-leg drilling. Instead of drawing the line on the leg and then measuring it, I could use a set angle to draw the reference line then use the same angle for the drilling. This eliminates both measuring and setting tools for drilling each leg.

The images on this page show the concept at play when using the "fixed-angle method" and the following sections show the details involved.

Simply put: Apply a reference line to the leg using a fixed angle, then use that reference line and that same fixed angle to orient the drill bit.



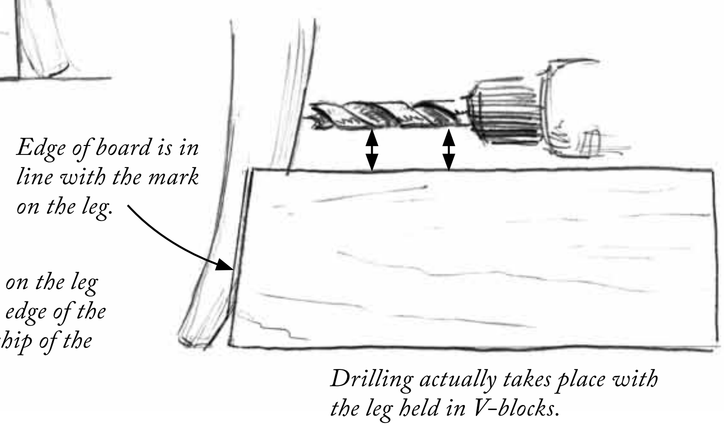




**FIG. 20.22** ***Using a fixed-angle board to create a reference on the leg.***

There are a couple of extra details to the process, but that is the basic premise.

You may wonder, "But isn't each leg and stretcher at a different angle than the others? How can one angle on a board work for all of them?"

They are all different, which will be visible in that the reference mark that you make on each leg will be at a slightly different angle to the axis of the leg. This is where the variation is noted and by later aligning to the reference mark, each leg will be at a slightly different angle when drilled.

One of the great benefits of this process is that once each leg has its reference mark, they can be drilled by following the same simple process without regard for which leg is being drilled. While this may seem like a lot to wrap your head around and the protractor method seems so clear, the angle board has proven to be much more accurate and simple in practice.

Here is the whole process spelled out in four steps. I'll spell out the details involved in each step in the section following.

**ABOUT THE ANGLE**

By now, you may have wondered, "But what angle is cut on the edge of the board?"

It can be a mental leap to realize that the angle cut on the board doesn't actually matter to the accuracy of the process. The angle simply serves to create the reference line so that you can reposition the board and leg to the same relationship when drilling. It is helpful if the angle is roughly the average of the front and rear legs'

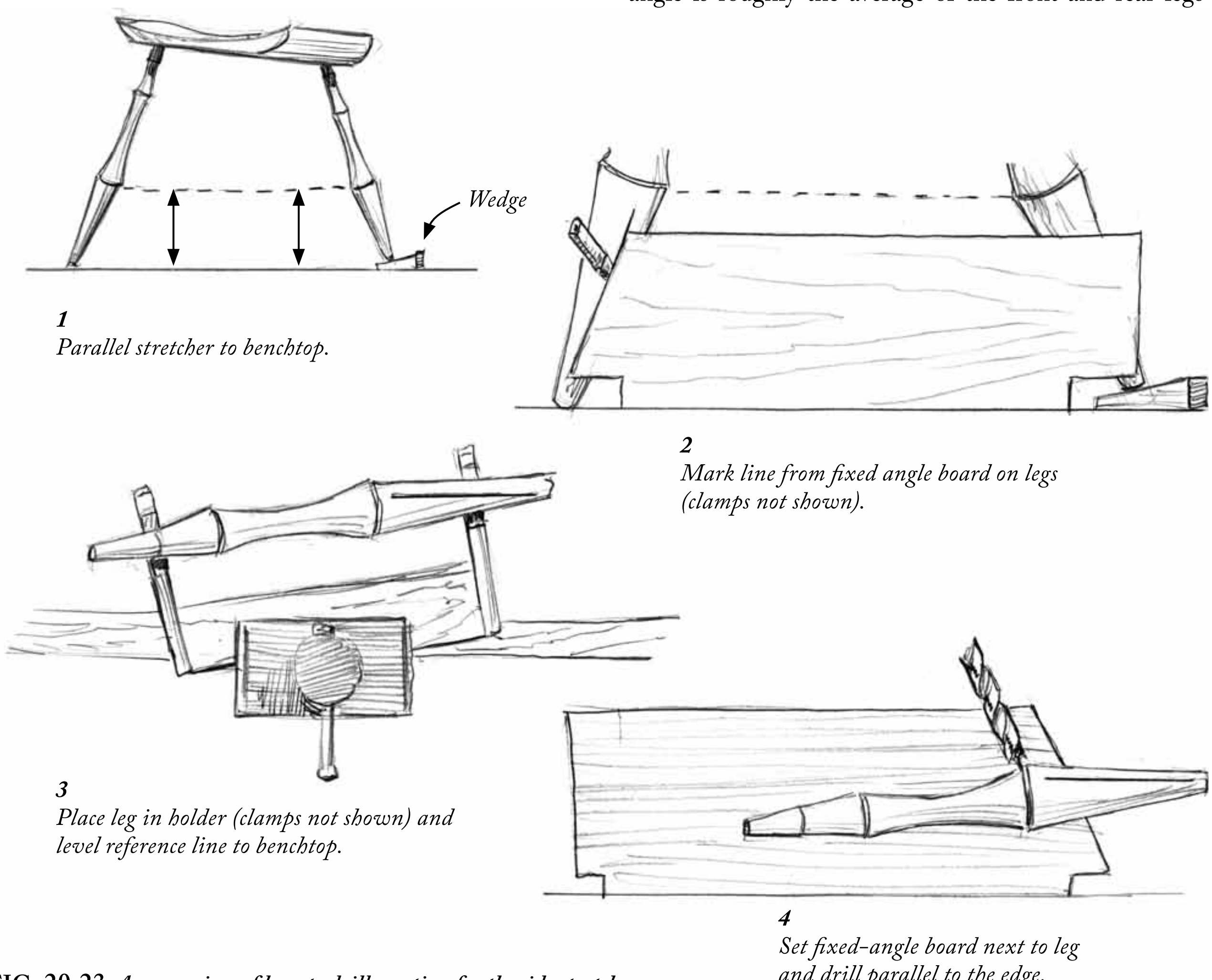



**FIG. 20.23** ***An overview of how to drill mortises for the side stretchers.***

relationship to the benchtop. This makes marking the leg and leveling it to the benchtop easier. I've found that one board with the angle cut at 17° works for just about every chair that I build.

### THE FIXED-ANGLE BOARD METHOD

***Step 1.*** The first step is to level the mortise locations to the benchtop using shims. This allows the benchtop to be a solid stand-in for the stretcher's axis, eliminating the need to play with string.

If the chair has baluster turnings, this is simple because I've marked the mortise location using the benchtop as the reference, so the heights are already parallel to the bench. Just be sure to keep any shims used to level the seat in place for the next step.

If the chair has bobbin turnings, then the location of the mortises in the V-notches determines the height. Therefore, each side will have to be leveled in turn and dealt with independently, because any variation in the depth that the legs were reamed will make it impossible to level all four mortises to the benchtop simultaneously. Coins do a great job of shimming the legs.

***Step 2.*** The second step establishes the reference line that will be used to reorient the board and the leg for drilling.

Place the board with an angle cut on one end set on the benchtop and up against the legs. Use a flat carpenter's pencil to make a mark on the leg along the angle. It's important to keep the flat of the pencil on the flat of the angle. You might want to put a piece of light-colored masking tape on each leg to help make a clear mark that can be easily removed. Be sure to scribe a single clear line.

***Step 3.*** After marking all the legs, remove the legs and place one in the V-block, which is held in the vise, with the reference line facing the benchtop side. Rotate the leg until the mortise location is at the top of the leg. Tilt the jig and leg until the reference line is parallel to the workbench. Use spring clamps to hold the leg firmly to the jig.

Tilt the V-block until the reference line on the side of the leg is parallel to the benchtop. I use a bevel square to ensure that the line is level to the bench.

***Step 4.*** Once the reference line is parallel to the benchtop, placing the fixed angle board used to make the reference line on the benchtop puts it in the same position as when the reference mark was made on the leg. Balancing the board on its end is a bit precarious, so simply place it on its long edge, which doesn't change the angle.

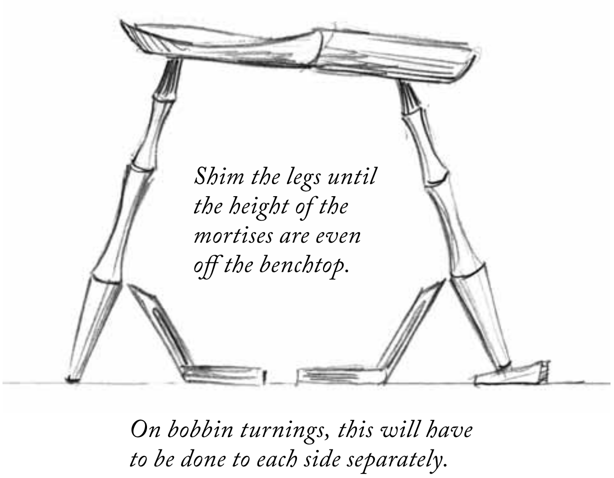



**FIG. 20.24** ***Level the stretcher axis to the benchtop.***

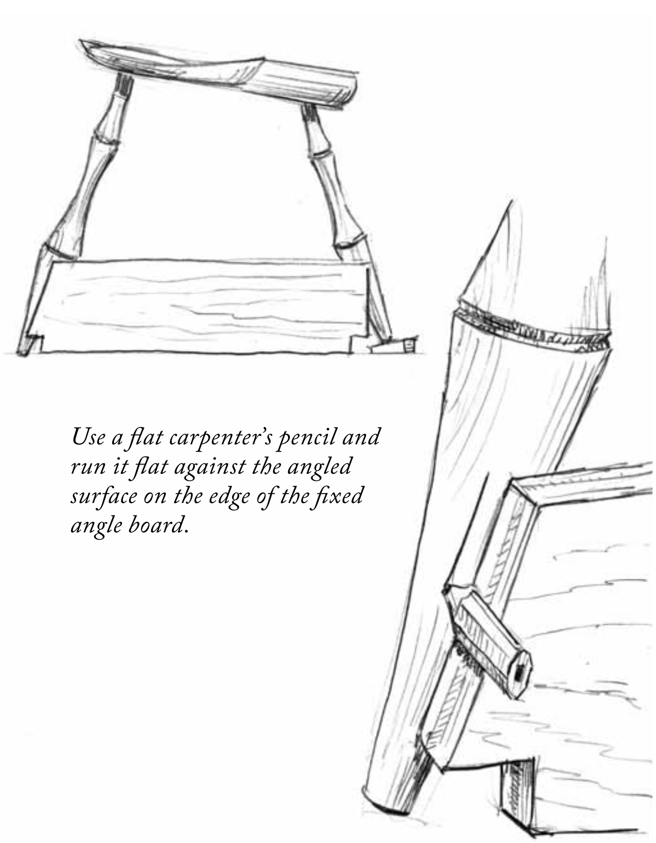



**FIG. 20.25** ***Scribe a reference line on the leg using a carpenter's pencil.***

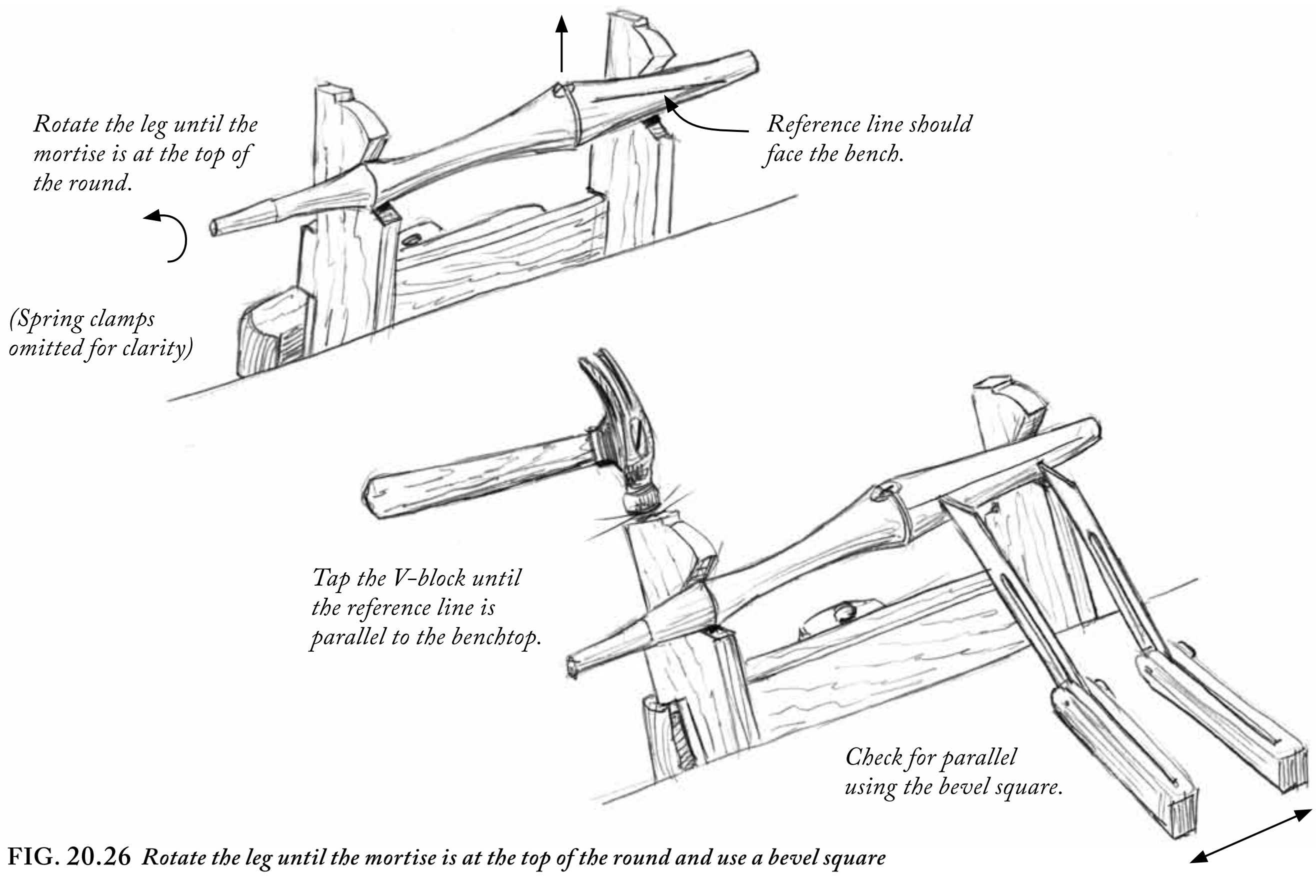



**FIG. 20.26** ***Rotate the leg until the mortise is at the top of the round and use a bevel square to confirm that the reference line is parallel to the benchtop.***

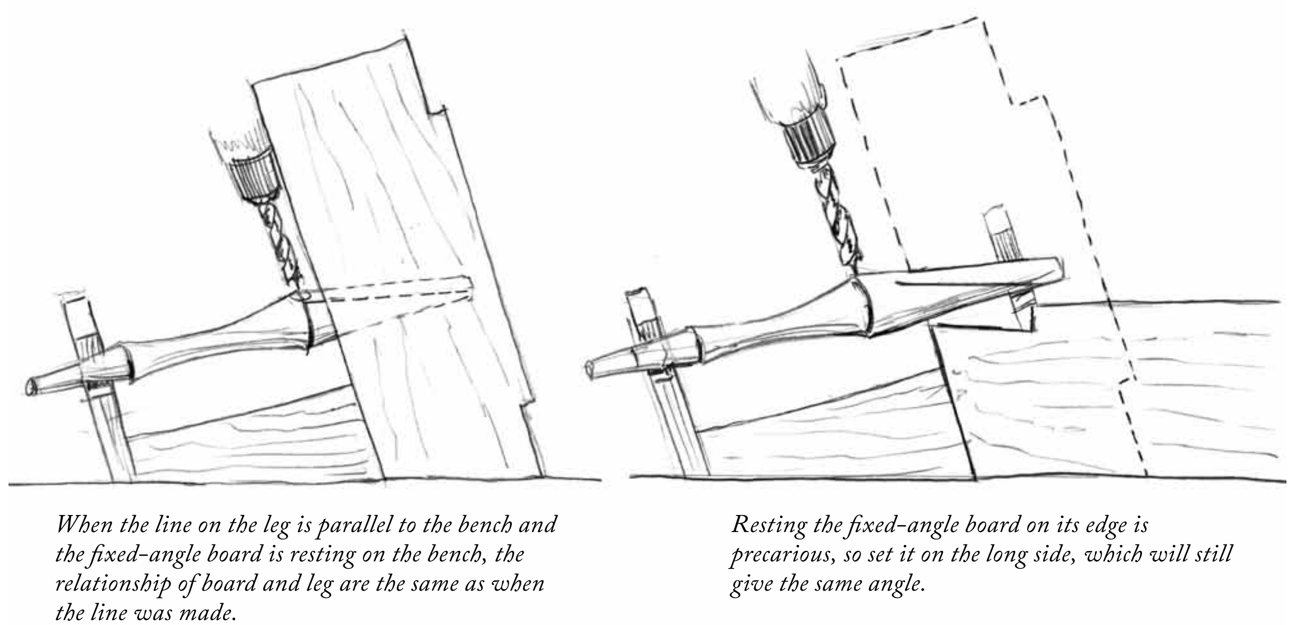



**FIG. 20.27** ***Here you can see how the board determines the proper drilling angle.***

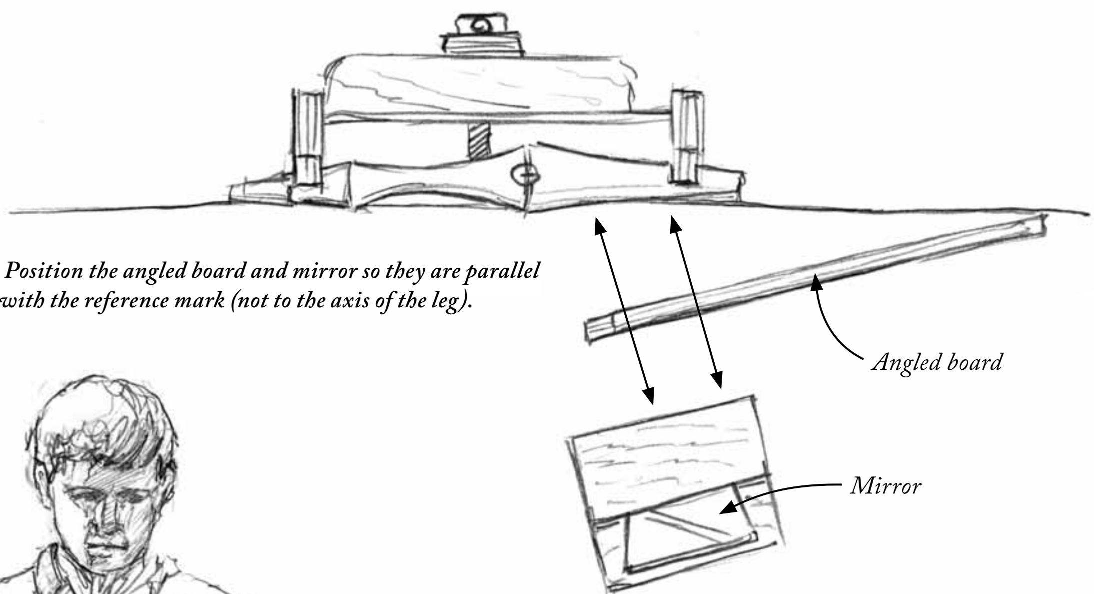



**FIG. 20.28** ***Position the angled board and mirror so they are parallel to the surface with the reference mark (not to the axis of the leg).***

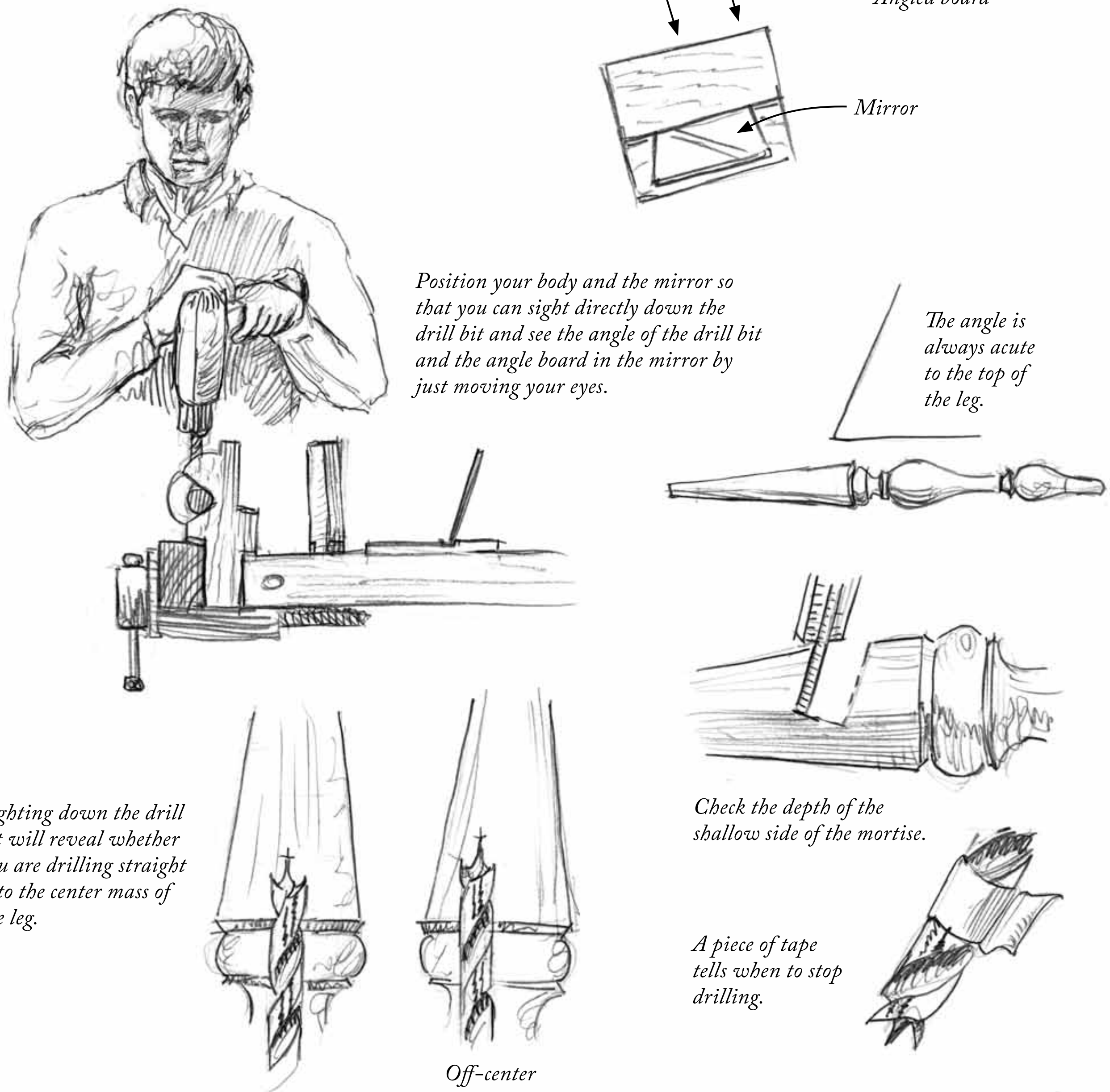



**FIG. 20.29** ***How to position your body to drill accurately.***

**DRILLING**

I am careful to place the leg in the holder with the mortise location at the top center. It can help to hold a pencil vertically on the mortise location and rotate the leg until the pencil is on the top of the round. Set a mirror next to the angle board on the benchtop.

One detail to be aware of in this process is that the angled board and mirror will not be set up parallel to the axis of the leg, but parallel to the surface of the tapered leg. This will ensure that the angle is the same as when the board was placed against the surface of the leg to make the mark.

I monitor whether I am drilling vertically (in the center of the leg) by sighting down the bit. If there is equal mass visible on either side of the bit as I drill, then I know I am drilling into the center.

Remember that all of the stretchers have acute angles toward the top of the leg, which means that you will always be leaning toward the top of the leg.

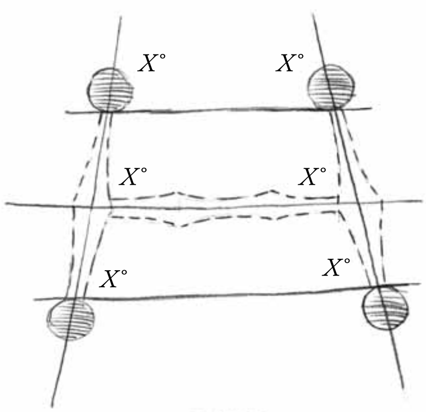
Drill until the short side (bottom) of the mortise is $1\frac{1}{16}$" deep. A piece of tape wrapped around the bit at $1\frac{1}{4}$" from the bit's nickers can help you judge the rate of feed and depth. I check the depth with my folding rule.

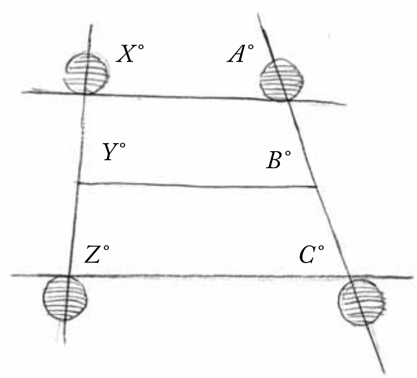
There is a short and long side to the mortise, and the tenon's line will be buried on the long side. Once you get the full depth on the first hole, place the bit back in the hole and move the tape to the edge of the mortise to serve as a more exact depth guide for the remaining holes. Stop the rotation of the drill when removing the drill bit from the mortise to avoid catching the spurs on the edge of the mortise. If you have trouble placing the bit back in the mortise, use the mirror to match the alignment to the bevel square and it will slip in.

## STEP 6. MEASURE & DRILL FOR THE CENTER STRETCHER

There are lots of ways to measure the angles for drilling the mortises in the side stretchers for the center stretcher.

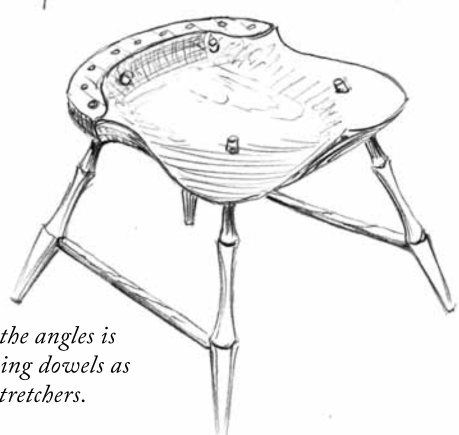
*If the legs are exact in their angles, the trapezoid formed by the stretchers will be made up of similar angles.*



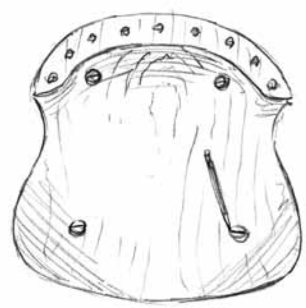




*But usually, the legs are a bit different than the plan, which translates to having different angles at this point.*

*The angles that must be derived are Y and B. They are found by averaging the other angles.*



*Finding the angles is easiest using dowels as dummy stretchers.*



*While the dowels are in place, it's a good time to mark the ends of the legs for sawing wedge kerfs.*

**FIG. 20.30** ***Using dummy stretchers to measure angles for the center stretcher.***

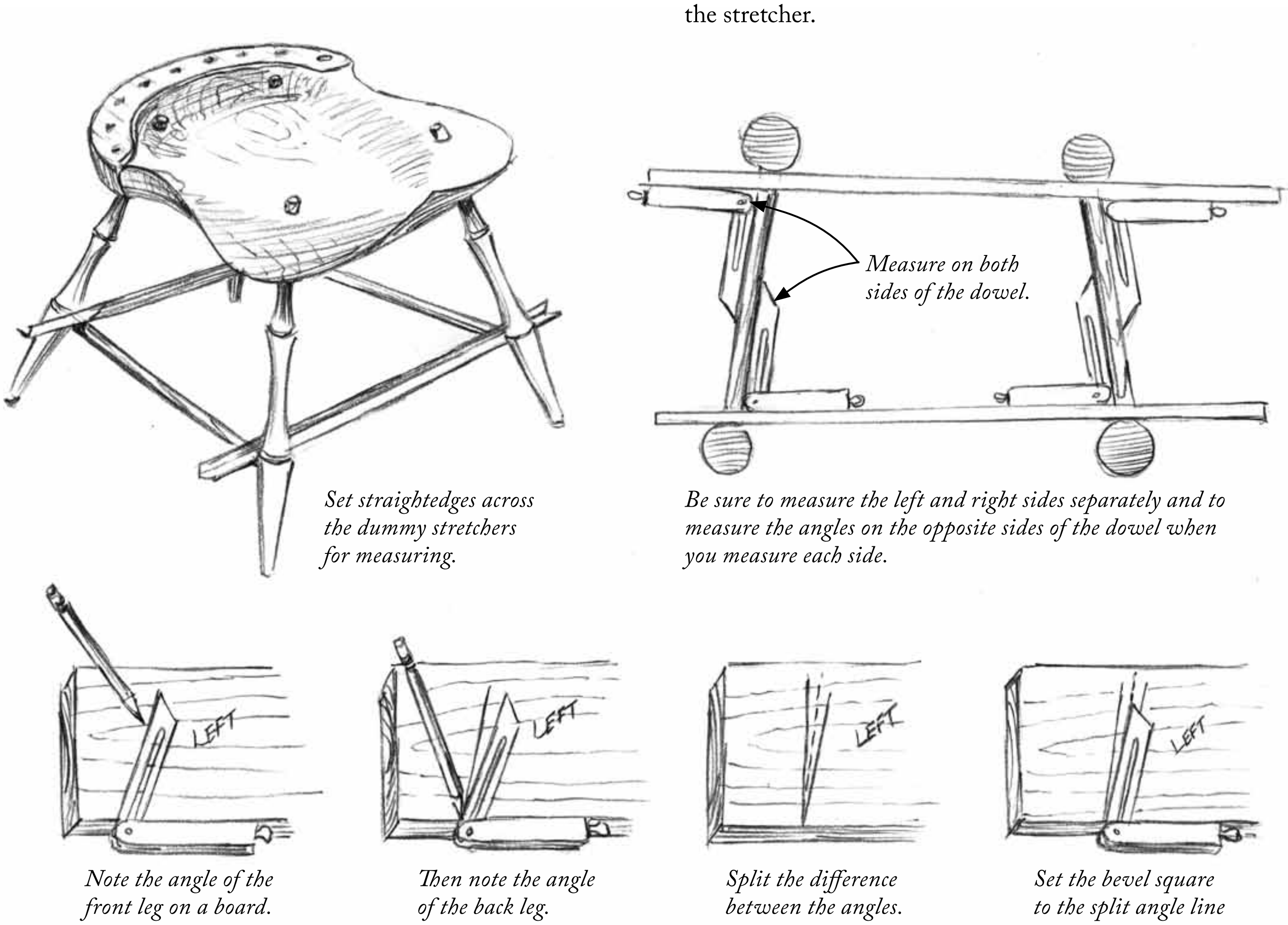
Basically, the center stretcher sits halfway between the front and rear legs. In a perfect world, the legs at stretcher-height form a trapezoid that has two similar obtuse and two similar acute angles. Adding each acute angle to an obtuse angle would result in 180° and give the correct angle to drill the mortises for the center stretcher.

But in the real world, the legs are rarely reamed perfectly, which means that the trapezoid is misshapen and the angles for the center stretcher must be found. After working with many different methods, I've chosen again to abandon measuring numbers.

I start by cutting 5⁄8"-diameter dowels about 1⁄2" shorter than my side stretchers' finished length. Then I set them in the mortises from front to back and replace the legs in the seat. This also gives me a chance to check my leg drilling. If the mortises are angled correctly, the slightly undersized dowels will spin freely. This is a good time to mark the tops of the legs for cutting the kerf for wedges because the dowels position the legs so they are in their final rotation. Before gluing the legs in, I saw the kerfs about two-thirds of the way to the end of the taper.

With the dowels in place, I also check the alignment of the marks on the seat and leg to ensure they match. If not, I erase the mark on the leg and remark it to match the seat.

Next, I take a section of aluminum angle and place it on the dowels and against the back legs as shown. I set a bevel square to match the angle on each side and note it on a board (I usually use the same board that I used in the previous steps). Make sure to note left and right. Then I move the aluminum angle to the front legs and set a bevel square to match the angle on the opposite side of the stretcher.




*Set straightedges across the dummy stretchers for measuring.*

*Be sure to measure the left and right sides separately and to measure the angles on the opposite sides of the dowel when you measure each side.*

*Note the angle of the front leg on a board.*

*Then note the angle of the back leg.*

*Split the difference between the angles.*

*Set the bevel square to the split angle line for drilling.*

**FIG. 20.31** ***Using dummy stretchers to measure angles for the center stretcher.***

I mark the front measurement next to the rear and see if they are the same. It should be no surprise that they are different. When it comes time to drill the side stretcher, I set my bevel square by splitting the difference between the two angles gleaned from the front and rear of each side, which saves me a lot of measuring and math. Before drilling, I mark the mortise location for the center stretcher. I do this when I have the dowels and aluminum straightedges in place.

It's worth restating from the joinery section that the rotation of the side stretcher will be determined by the end grain in the mortise in the leg. It's best to avoid having the plane of the tenons' greatest seasonal change pressing against the unmoving end grain of the mortise. Once I've marked which end of the stretcher is going to join the front leg, I rotate it correctly as shown and then, holding my pencil parallel to the seat, I mark halfway up the side of the stretcher. Having a distinct mark that notes the back of the stretcher is helpful because the angle of drilling will always lean acutely toward the back.

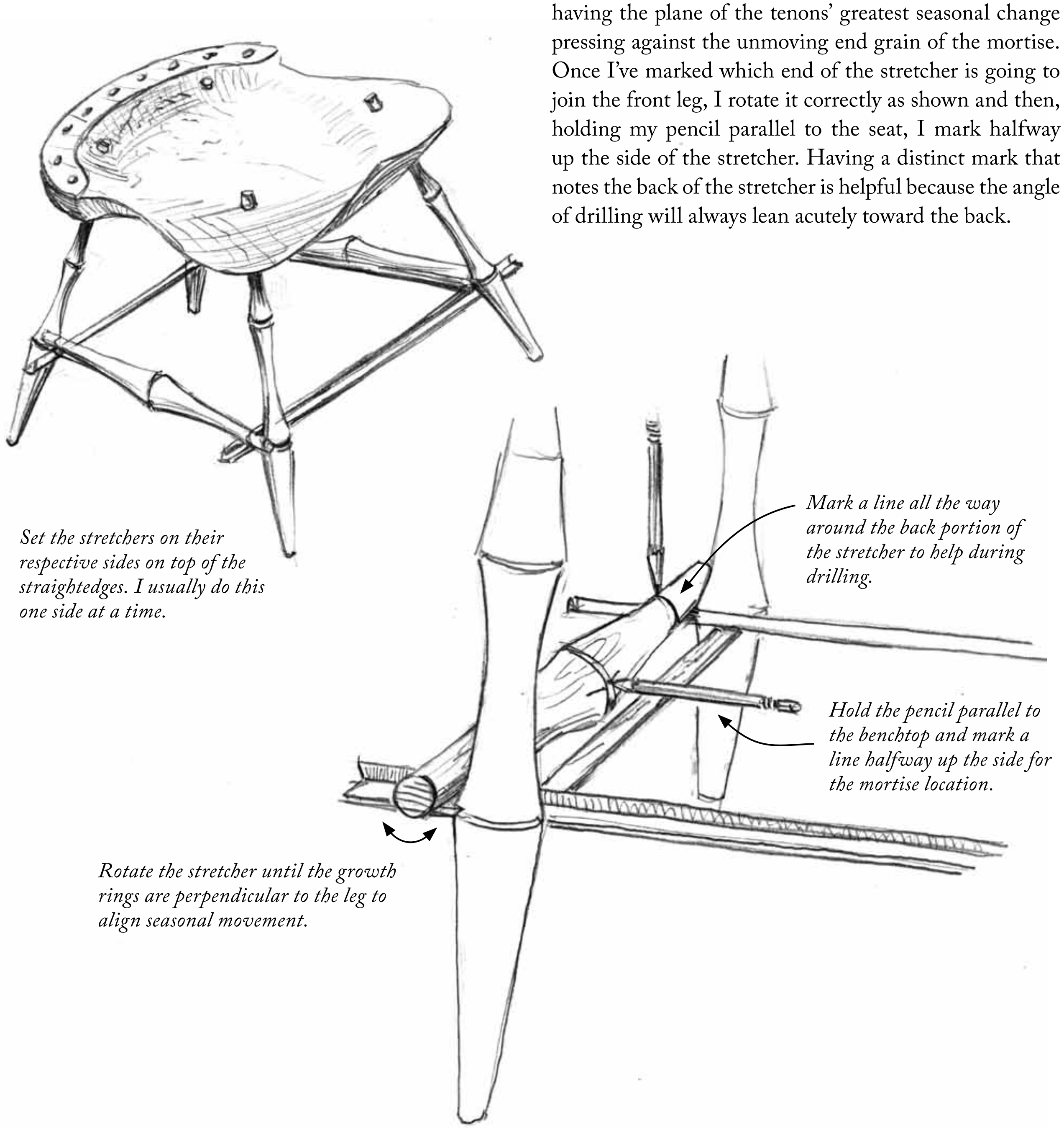



**FIG. 20.32** ***Marking the back of the stretchers, the rotation and the mortise location.***

## STEP 7. DRILL THE SIDE STRETCHERS

To drill the side stretchers, place one in the holding jig with the stops against the bench so that the stretcher's axis is parallel to the benchtop and set up the bevel square to the correct angle then drill using the mirror. Once again, the depth of the holes is just beyond 1" on the short side of the mortise.

## CONCLUSION

It's easy to look at a finished undercarriage and become overwhelmed by the many angles to be achieved. But really, it's just drilling a bunch of holes. I'm sure you will find that a little experience goes a long way toward making the process less stressful.

Eliminating the numeric angles has made building undercarriages less intimidating for me. But it is as an instructor that I've come to really appreciate this method, having taught it for years and to many large classes. I've found the success rate is far beyond any other process that I've tried, and students are usually pleasantly surprised that following these steps works out so well.

*Set the side stretcher in the V-blocks.*

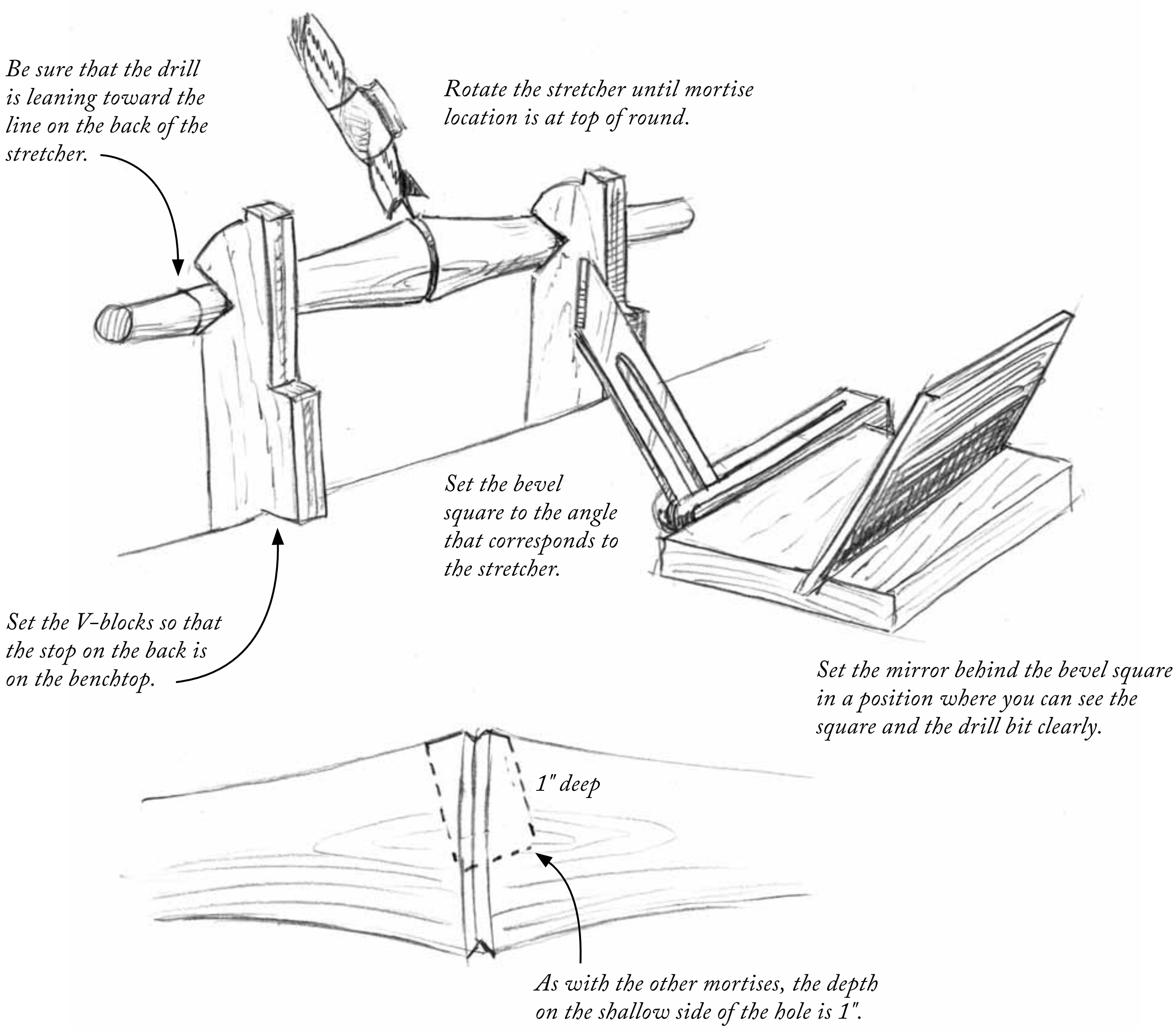
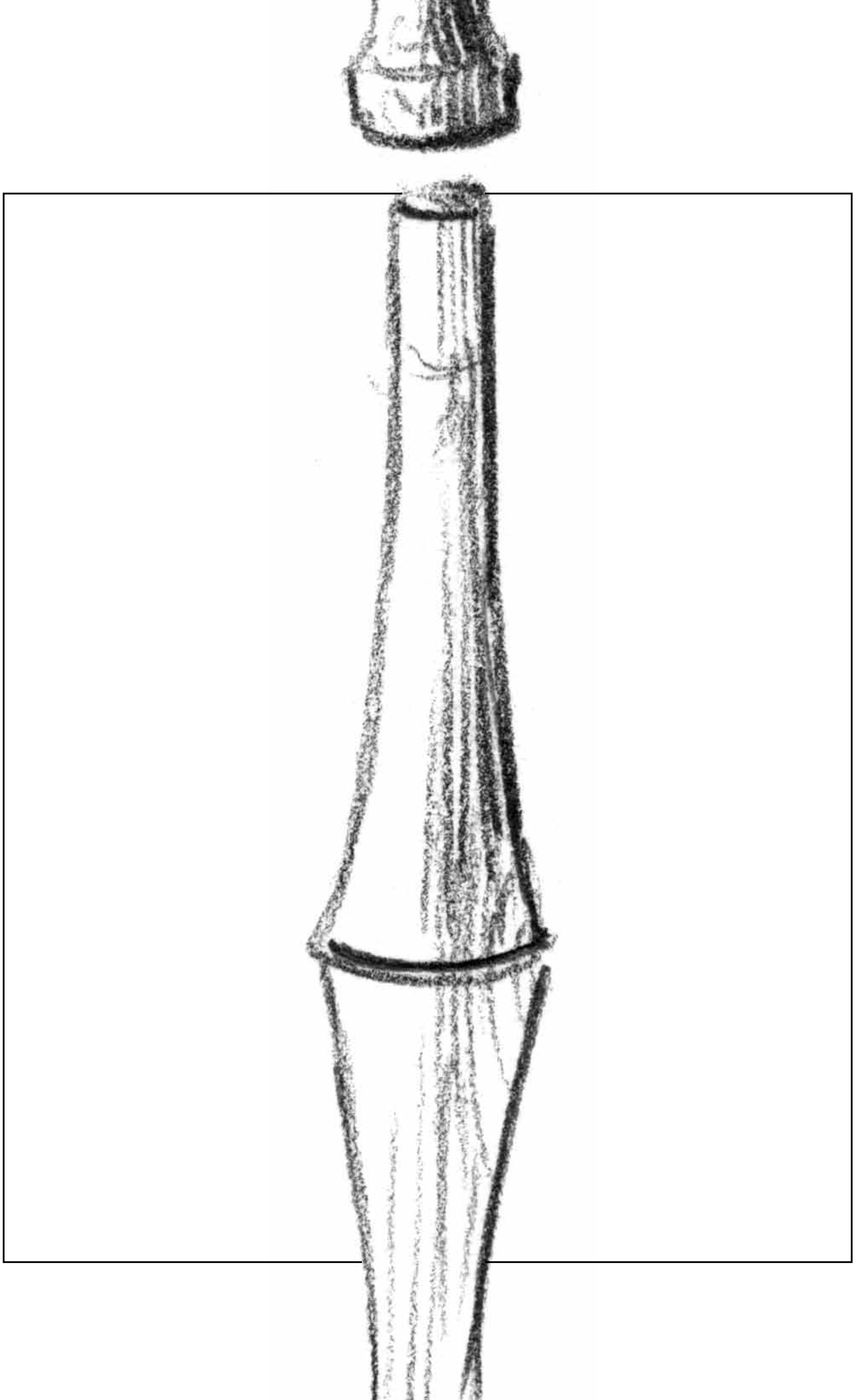



**FIG. 20.33** *Drill the mortise.*



# 21

# Undercarriage Assembly

Before speeding headlong into the glue-up, it's worth revisiting the moisture content and the condition of the tenons and mortises. It's important that the tenons be correctly sized only after being fully dried in the kiln and that they are stored in the kiln prior to assembly to ensure they are the proper dimension. I also bolster my chances for success by drilling my mortises right before assembly. Any time that they are allowed to sit will possibly affect their size.

I size my tenons as exactly as possible to fit the mortise that my bit is drilling. Every drill bit makes a slightly different-size hole, depending on its condition, the way it is chucked in the drill and the material it's drilling. (More on this in the Drilling chapter). I always make a test hole in material that is the same species and moisture content as the legs.

These are not the kind of joints that you dry-fit by driving them all the way into the mortises. They will immediately pull moisture from the mortise and likely lock tight. Think of them like wooden nails. You should be able to slide each tenon only about one-third or so of the way in. When you pull it out, it might make a popping sound. Resist the temptation to do too much test-fitting because that will compress the tenon fibers.

As I mentioned in the chapters on turning, I prefer to turn my stretchers from air-dried stock to a rough and oversized shape. Then I wrap the larger sections where the mortises for the center stretcher go in newspaper and put the stretcher in the kiln for a few days until the ends stop shrinking. I rechuck the stretcher blanks in the lathe and turn them to final shape and turn the tenons to size right before assembly. If needed, I can store them in the kiln until assembly, with the center portion wrapped in newspaper to prevent excess moisture loss.

If you plan to use a dedicated tenon cutter to form your tenons, you can turn the entire stretcher from air-dried blanks, leaving the ends oversized, then dry them before using the cutter.

Details on sizing joints are in the Turning: From Rough to Finish chapter.

Before assembly, I scuff-sand my tapered tenons with #220-grit paper to rough them up and remove the oxidation and burnishing from the reaming process. I also take inventory of the parts and their labels to ensure I can easily locate their positions in the chair.

## Assemble the Undercarriage

When driving joints together, I use old magazines or catalogs as a buffer between my bench and the mortised part to avoid denting the piece. It's important to note that I drive the joint home with the tenoned part in one hand and the mortised part on the bench.

When I strike the end grain of a tenon while seating the tenon on the opposite side of a stretcher, I use a metal hammer; once the assembly advances and I am striking the surface of another turned part, I use a dead-blow mallet. A tiny chamfer helps the joints' initial fitting. You can do this by rubbing the corner of the tenon against a block of hardwood end grain.

## Assemble the H-assembly

The first step is to assemble the H-stretcher assembly. Apply glue to the mortise and the tenon and orient the center stretcher as shown in Fig. 21.2. Then drive the

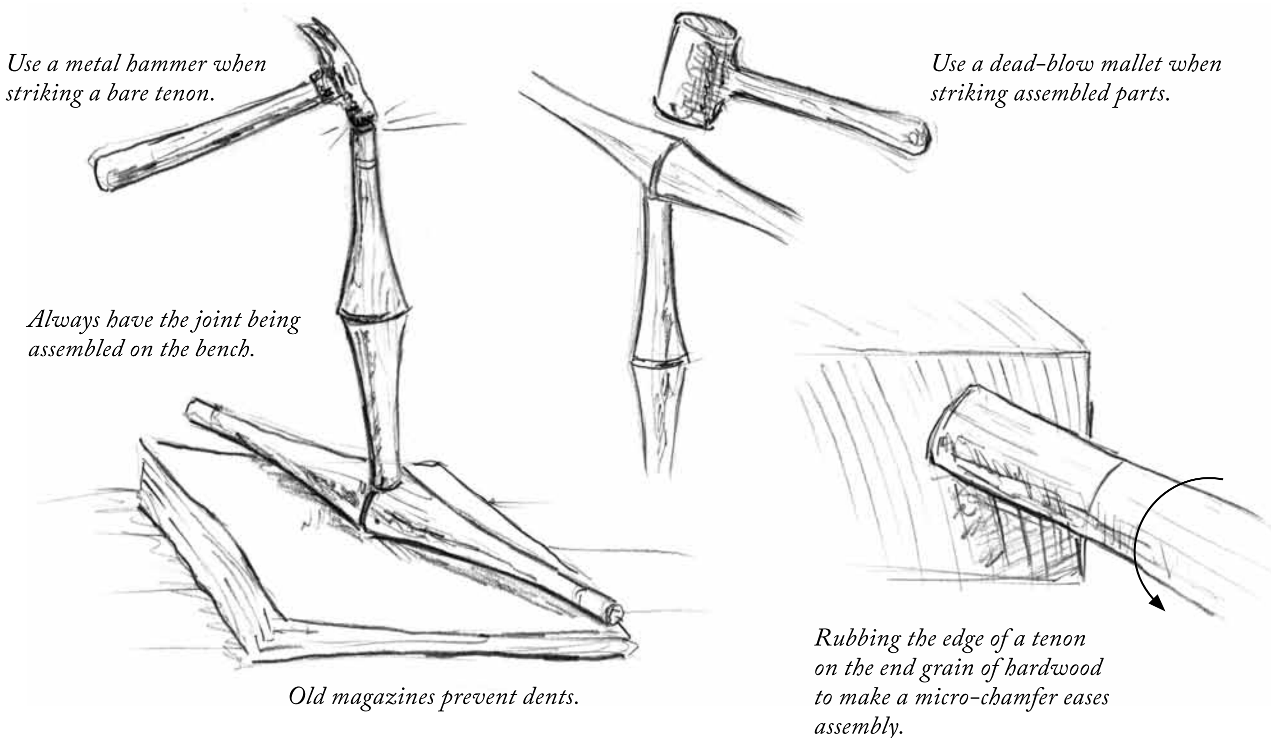



**FIG. 21.1** ***How to assemble mortise-and-tenon joints for the undercarriage.***

tenon in until the line that marks the end of the 1" tenon is touching at the short end of the mortise.

Next, I apply glue and orient the other side stretcher so that the front is in the same direction as the first one, then set the tenon a quarter of the way into the joint. This allows me to rotate the side stretcher until it's parallel to the other one. You can check the results on the benchtop as shown.

If the joint locks and you are unable to adjust it with simple pressure, place the side stretcher on the bench and apply a subtle twist to the center stretcher while resting the stretcher against your hip to oppose the twisting force.

During the moments that the tenon advances into the mortise, it also twists. By sighting down from the top, I can see the result and continue to twist the center stretcher if needed.

## Clean Off the Glue

I clean the hide glue around joints as I assemble them. Cleaning glue should be a process of removing it, not just diluting it and spreading it around until it blends in. Glue residue can affect paint adhesion as well as the patination in unpainted pieces such as cherry. So it is a good idea to remove it thoroughly. I begin by using a cheap chip brush that has been cut short to form stiff bristles. I dip the brush in hot water from the glue-heating reservoir and remove most of the water from the brush before swiping away the excess glue.

I clean the brush several times during this process and blot the excess water away on a towel before touching it to the joint. Once all traces of visible glue are removed, I scrub the joint lightly and pat away the moisture from the area. Hide glue naturally glows green under UV light, which is helpful when determining whether your cleaning process is effective.

## Mount the H-assembly in the Legs

Place the seat upside down on blocks to prevent the tops of the leg tenons from striking the benchtop as they stick out past the carved seat. The actual assembly takes place in two stages. First the legs are glued to the side stretchers, then the leg-and-stretcher assembly is glued into the seat. I've tried lots of different methods for aligning the

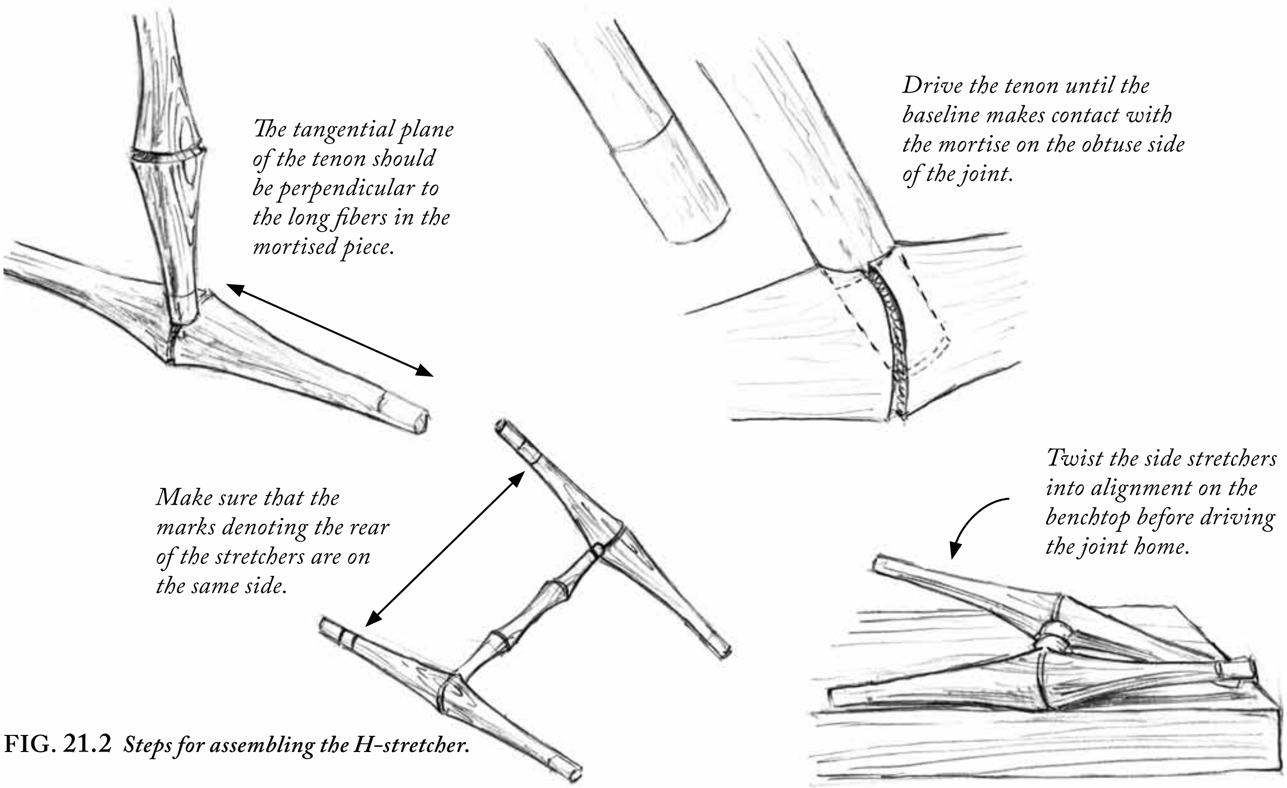



**FIG. 21.2** ***Steps for assembling the H-stretcher.***

parts during assembly. This is an important step because the joints lock as they are seated. Once the tenons are set all the way, there is usually little hope of adjusting the rotation of the leg.

To find the correct rotation of the legs when putting them on the stretcher assembly, I use the distance between the mortises in the seat as a reference. I rotate the legs on the stretchers until the distance of the baseline of the tapered tenons matches the distance between the mortises. It's important to note that the ends of the tapers will not align with the mortises at this point. I also check the symmetry of the angles of the legs in relation to the center stretcher before driving the joints home.

Be sure that the legs are clearly labeled with their respective seat mortises as well as the tenons of the stretcher assembly.

Start with one of the rear legs and put glue in the mortise and on the tenon of the corresponding side stretcher. Insert the stretcher piece about one-third of the way into the joint. Don't drive the joint all the way home or the tenon might lock and swell. Set the leg in its mortise in the seat.

**FIG. 21.3** ***How to twist the center stretcher as you seat the tenon.***

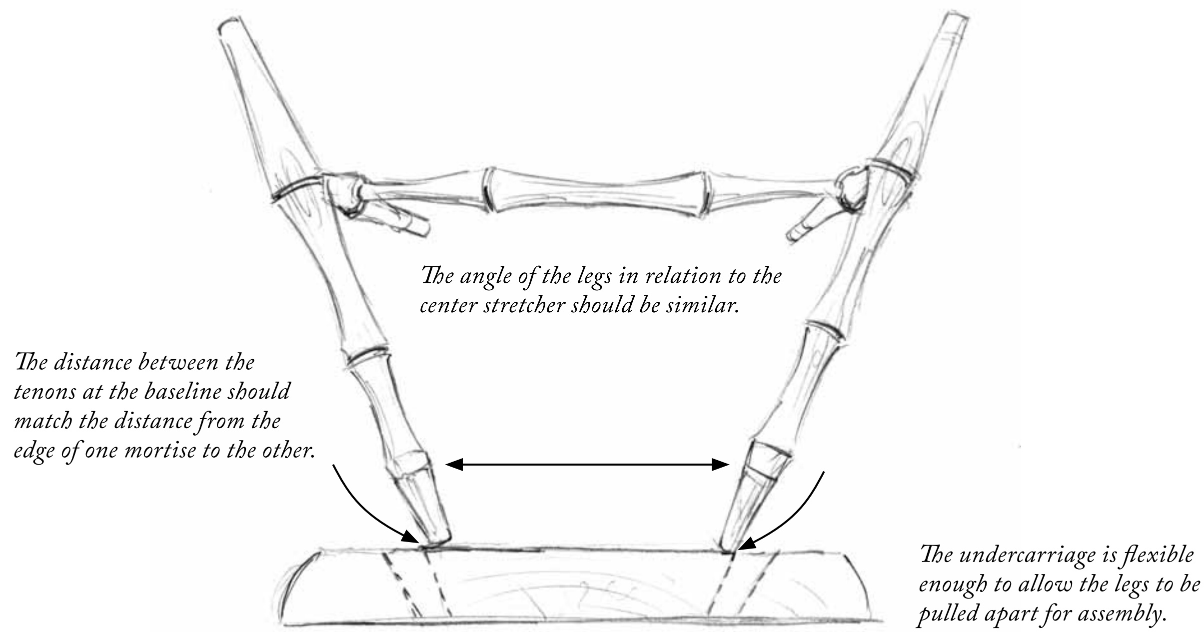



**FIG. 21.4** ***Because of the angle of the legs, the top of the tenons will not align with the mortises when assembled.***

Next, turn the leg tenon into its correct rotation in the seat, using the orientation marks at the edge of the mortise. Twist the H-assembly up or down until the center stretcher is parallel to the bottom of the seat. Then take the leg assembly out of the seat and place it on the bench. Use a magazine underneath to prevent marring the part and drive the tenon home by striking the opposite tenon with a hammer. Take note that the 1" line on the stretcher tenon will make contact with the leg toward the bottom of the leg when the joint is driven home.

Then apply glue to the mortise of the other rear leg and the corresponding tenon and assemble them one-third of the way. Rotate the leg on the tenon until the baseline of the tapered tenons align at the width of the mortises. Note that the ends of the tenons will not align perfectly with the holes because they go in at an angle and also because they are not seated all the way. When satisfied that the angle of the leg in relation to the center stretcher and other leg is correct, drive the tenon home.

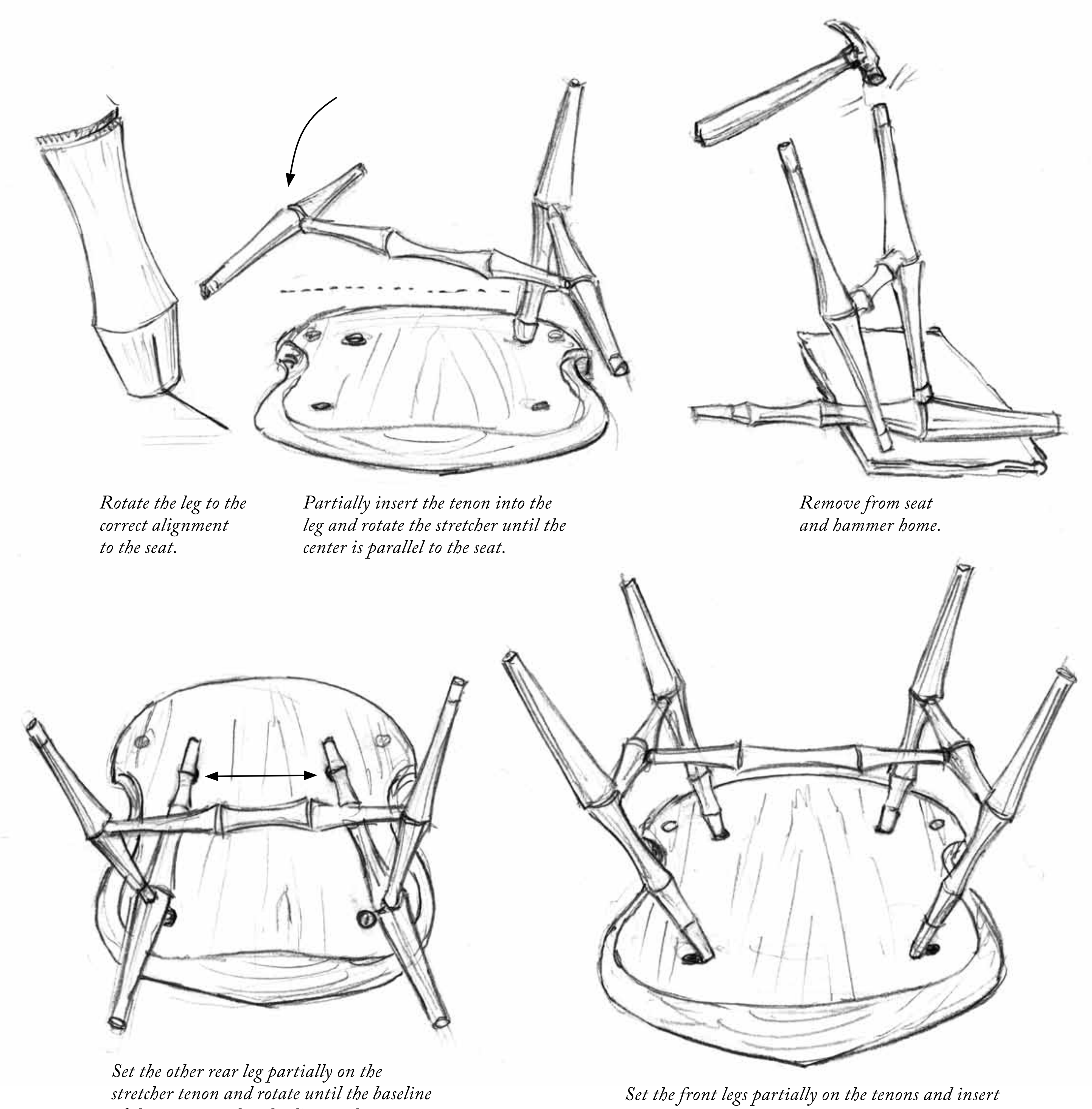
To assemble the remaining legs, once again apply the glue and place both of them on their tenons one-third of the way. Then put the assembled legs partially in their mortises and rotate the other legs until they align with their mortises. Check the distance of the mortises and the tenons as before and the relationship to the center stretcher. When they are correct, place the joints on the bench and drive them home with a dead-blow mallet.

## Fit the Undercarriage to the Seat

To fit the undercarriage to the seat, first dry-fit the legs. Mark the legs for the wedges (if you didn't do so when the dummy dowels were in place). The kerf should be two-thirds of the way down the taper and be perpendicular to the direction of the long fibers in the seat to prevent splitting it.

Because of the angled mortises, you should have to pull the legs apart a bit to align them with the mortises. Once they are all aligned, the whole assembly should drop in place.

Put glue in all of the mortises and on all of the tenons (there is no need to glue the ends of the tenons that pass through). Next place the seat upside down on the blocks again, seat the legs in place and hammer them home. It's important to remember that the tenons are tapered and can split the seat if driven too hard. I prefer to make my way around the seat, tapping each leg in until I hear a change in tone and then move on to the next leg. I do



*Rotate the leg to the correct alignment to the seat.*

*Partially insert the tenon into the leg and rotate the stretcher until the center is parallel to the seat.*

*Remove from seat and hammer home.*

*Set the other rear leg partially on the stretcher tenon and rotate until the baseline of the taper matches the distance between the mortises. Hammer home the tenon.*

*Set the front legs partially on the tenons and insert the rear legs partially in their mortises. Then rotate the front legs until they touch near the inside of the mortises. This accounts for the angle of the mortise. Remove from the seat and drive the tenons home with the dead-blow mallet.*

**FIG. 21.5** ***The steps to joining the legs to the stretchers.***

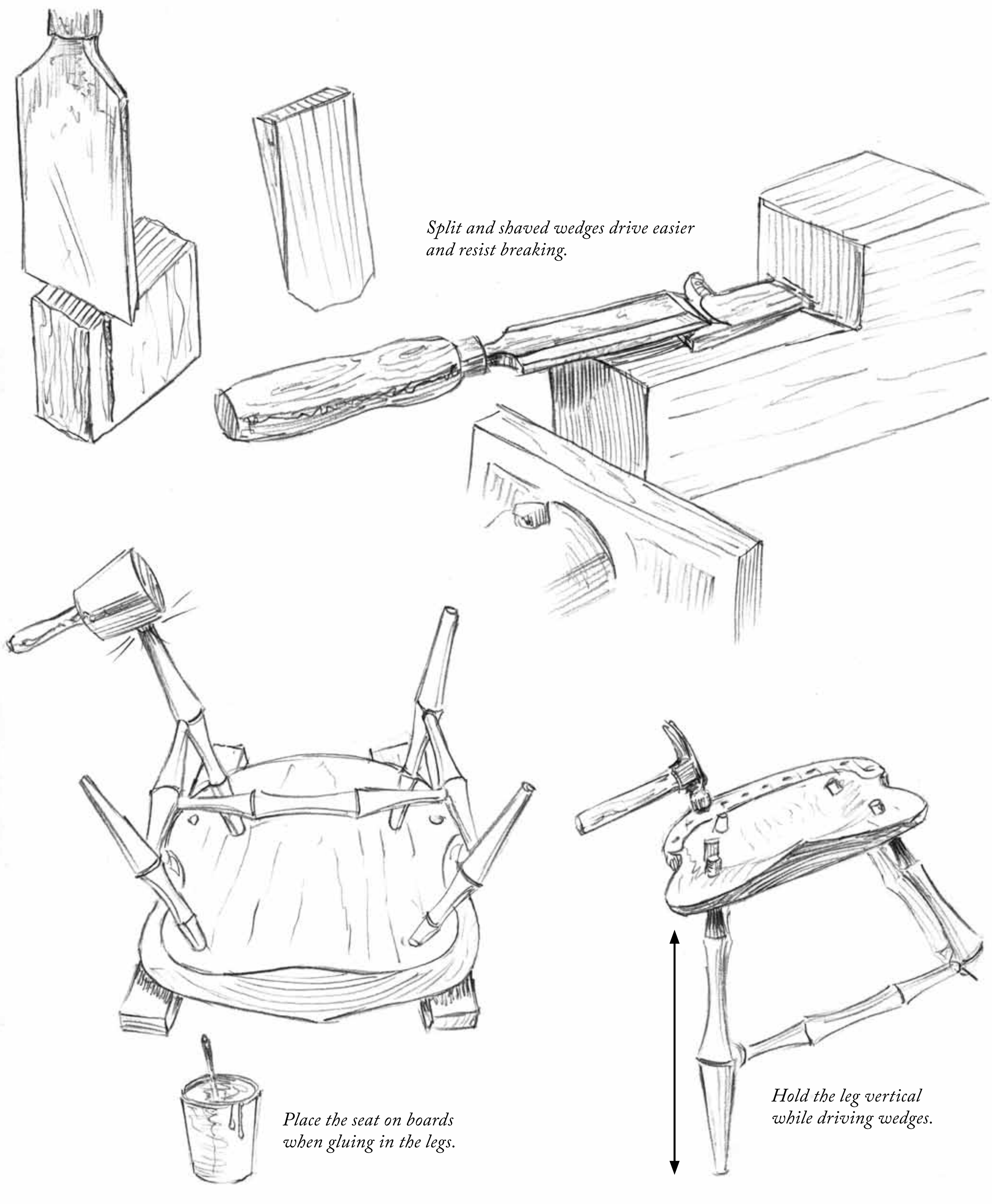



**FIG. 21.6** ***Steps for assembling the legs to the seat.***

this a few times because the seating of each joint seems to allow the other to seat a little more. Finally, when I whack each joint and hear a dull thud, I flip the seat over to drive the wedges.

I always drive the wedges immediately to avoid disturbing the glue as it sets. Hold the leg vertical over the leg of the bench to ensure that the force driving the wedge is absorbed without driving the leg back out of its mortise.

I prefer to split and shave my wedges from hard maple or oak. Split wedges break less often and drive more smoothly than sawn wedges. I glue only one side of the wedge to allow a "plane of failure" where stress can be relieved during seasonal movement. I make my wedges just a hair wider than the mortise at the top and cut off the corners to ease their entry. Once again, you will hear a dull thud when the wedges are driven fully home.

Let the chair sit overnight so the glue can fully cure before trimming the legs and the tenons.

## Assembly Problems

Most of the time, there are small imperfections, but nothing that the forgiving nature of the chair can't readily absorb. However, some problems will have to be addressed either before or during assembly. Usually, a little persuasion with a mallet or hammer can stress the legs into position, but some circumstances may require further effort.

### TENON DRIVES TOO DEEP

It isn't unusual to drive a tenon too deep, especially when you are new to making joints with such tight tolerances. It's usually only an 1⁄8" or less because of the depth of the mortise. If for some reason it's deeper, which still won't be too much of an issue, you can either drive the tenon on the other side of the stretcher less, or attempt to pull the stretcher out by twisting and pulling. A little heat from a heat gun or lamp might help, but be careful; even hard maple tenons can shear when twisted.

### TENON WON'T DRIVE IN

If the joint is too tight or you're using yellow glue, the tenon might seize halfway home. Sometimes a good hard whollop will free the joint and it will drive the rest of the way with no problem. In extreme circumstances I've sacrificed the mortised part by splitting it apart at the tenon. The tenons should be able to slide one-third of the way into the mortise without twisting and squeaking.

If the tenon is within 1⁄8" or so from being fully seated and won't go any deeper, then the mortise might not be deep enough. It won't be an issue, but you should check the other mortises to make sure that they are a full 1" on the shallow side.

### SPLIT SEAT

Seat splits during assembly are rare when fitting well-shaped tenons in wood that has been properly dried. I've only seen lots of splitting when the moisture content of the wood used in the seat is questionable. When the outer portions of a seat are drier than the center, the shrinking on the surface creates tension between the two faces of the board. When the top is carved, leaving only a small band of the surface wood at the spindle deck, the battle of tensions is off-balance, and driving a tenon in the bottom is the last straw. Small splits that stay within the edges of the seat can be filled with thin shims and epoxy. Splits that reach the edge can be kerfed with a saw and filled with veneer and epoxy. Obviously this is not the most desirable result. Allowing the seat stock to acclimate to the shop for a couple of months should resolve the issue if variation in moisture is the cause.

### SPLIT LEG

The joints in chairs must be tight, it's not unheard of to see a small split on the lower portion of the leg. The lower portion of the legs is thinner due to the tapering, and because the mortise is drilled at an angle. Driving the tenon at odd angles can also contribute to a split.

While this isn't the most desirable result, the split doesn't cause any problems, besides adding a little anxiety to the process. If this happens, take it as proof that the joints are tight. And inspect the rest of them to make sure that they aren't oversized. If you've left the tenons exposed to the air outside of the kiln for too long, they may have absorbed moisture and swelled. Placing them in the kiln, or in a hotter kiln, can help. Care should be taken not to place green wood in the kiln alongside the dry wood before assembly, because the moist atmosphere will transfer the moisture and cause the tenons to swell.

### BAD ROTATION OF A PART ON A TENON

If a part is fully seated yet it is rotated so that the tangential plane is not perpendicular to the long fibers, you might be able to correct it by applying rotary motion (and perhaps some heat) to the joint. A tight joint might make this impossible, but this isn't such a bad result that I'd cut the part off. On the other hand, if the part is rotated so that the geometry of the undercarriage becomes overly stressed and heat and torque cannot correct the rotation, I cut or split the part off and make another.

**WRONG LEG LOCATION**

I always draw a line completely around the side stretchers to correspond with the back of the chair. I can see the mark regardless of the position of the stretchers. This helps ensure that the stretchers are correctly oriented to each other and that the legs are in the proper position.

Another easy thing to spot is the reference line marked on the outside of the leg during the drilling process. If you ever see this mark on the inside of a leg during assembly, then you immediately know that it is in the wrong position. If the leg is put on the wrong tenon, hopefully it is only put on the wrong side; otherwise the difference between the front and back angles may require you to split off the leg if it won't come loose.

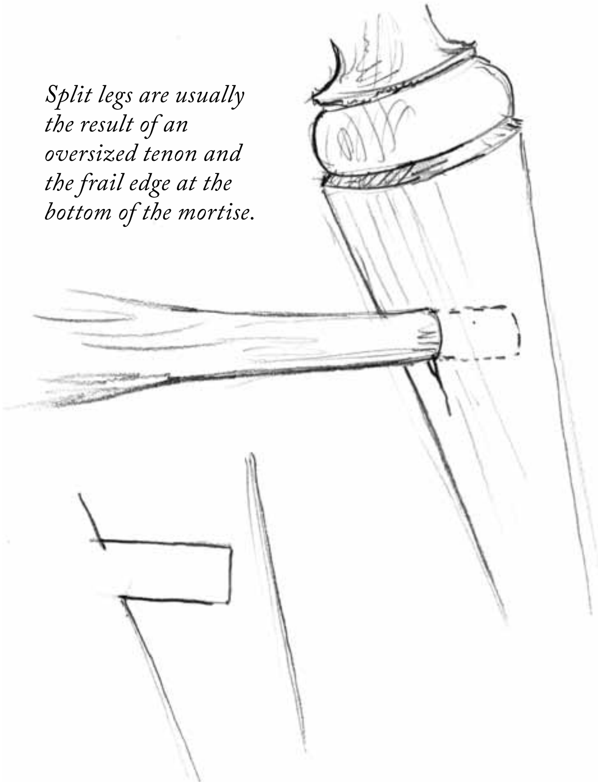



**FIG. 21.7** *Occasionally a leg will split.*

**WEDGE PROBLEMS**

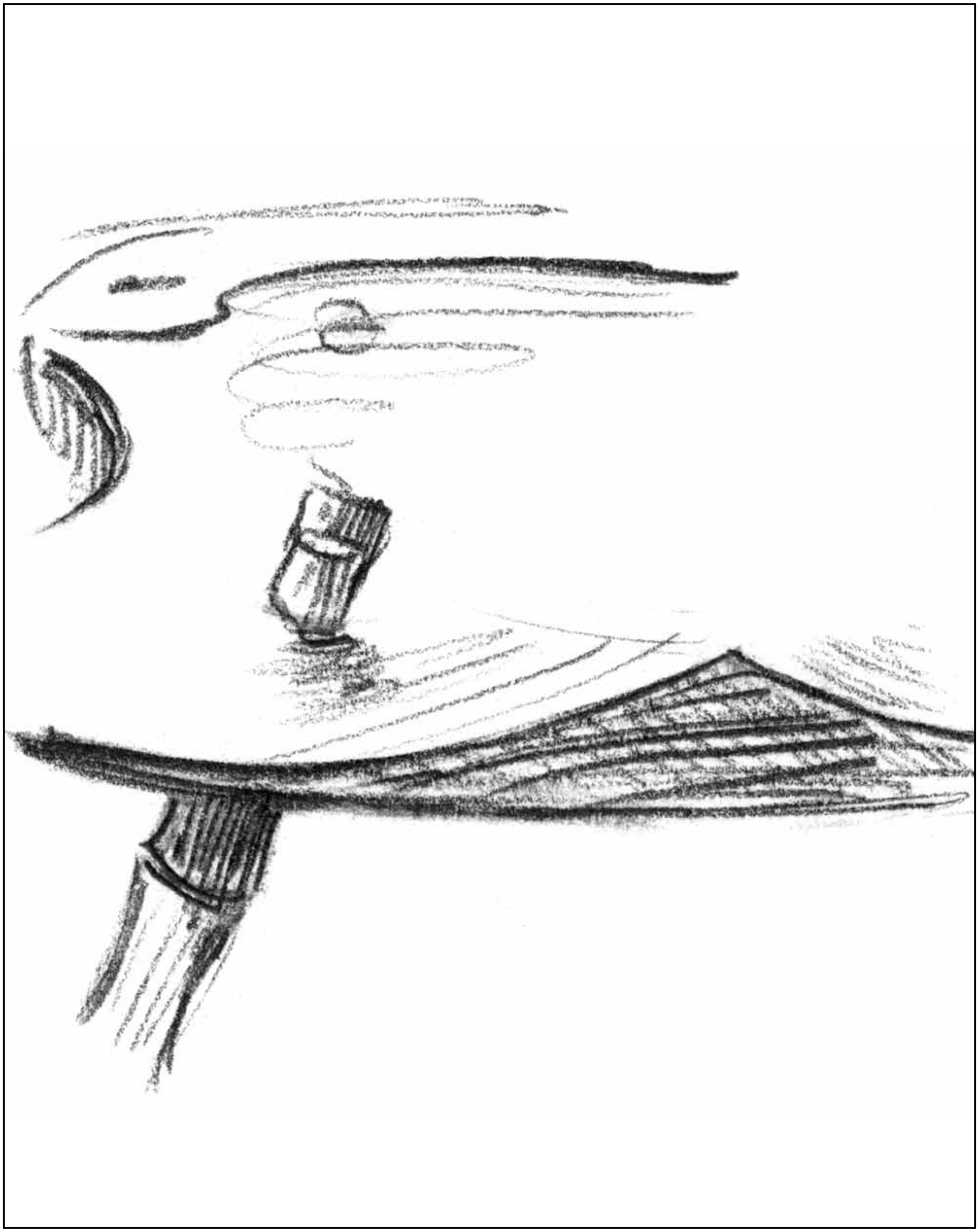
Driving wedges can be tough. Getting them started when the kerf has closed can lead to all sorts of clumsiness. A small tap with a chisel in the kerf usually creates enough of a start. If not, a triangular file does a good job of widening the starting point. Often the wedge drives in crooked. If this is a constant problem, check the wedges to make sure that one edge isn't thinner than the other. I use a metal hammer to focus the force of the blow.

If a wedge breaks while driving it, you can often drive the rest of the broken wedge into the gap and continue. If not, I usually just chase the part that is already in the gap with a new wedge, rather than trying to fish it out.

It's wise to not have too much of the tenon exposed beyond the mortise when wedging. When the tenon is too long, it can deflect enough to cause it to break below the edge of the mortise, leaving an ugly wound.

It seems obvious, but it's true, that the best results during assembly will come from avoiding errors earlier in the process. Luckily, the H-stretcher assembly is forgiving, and the undercarriage can usually be persuaded into behaving, even with less-than-perfect joint alignment.

When building my first chairs, I swept the shop twice and took a long coffee break while mustering the nerve to assemble the undercarriage. Most of this need arose from my inexperience and lack of a consistent process. Since then, I've refined my process and assembly is anticlimactic. That being said, it's still OK to sweep the shop one more time and wait for the coffee to finish while you mull it over.



# 22

# Complete the Undercarriage

After the undercarriage is assembled and the glue has dried, I level the legs and trim the tenons protruding through the seat. Then I take care of all the other details or flaws that the assembled top of the chair will obstruct. I have learned to address any aesthetic issues that I don't wish to see in the final chair at the time that I find them. Too often, problems that "I'll fix later" end up in the finished piece.

Much of this work is "make pretty," which gives me a chance to recharge and get ready for the final push of assembling the top.

## Trim the Legs

After the glue is dry, I trim the bottom of the legs, which makes the chair stable and easy to hold for the remainder of the work. To trim the legs, I use blocks and shims to

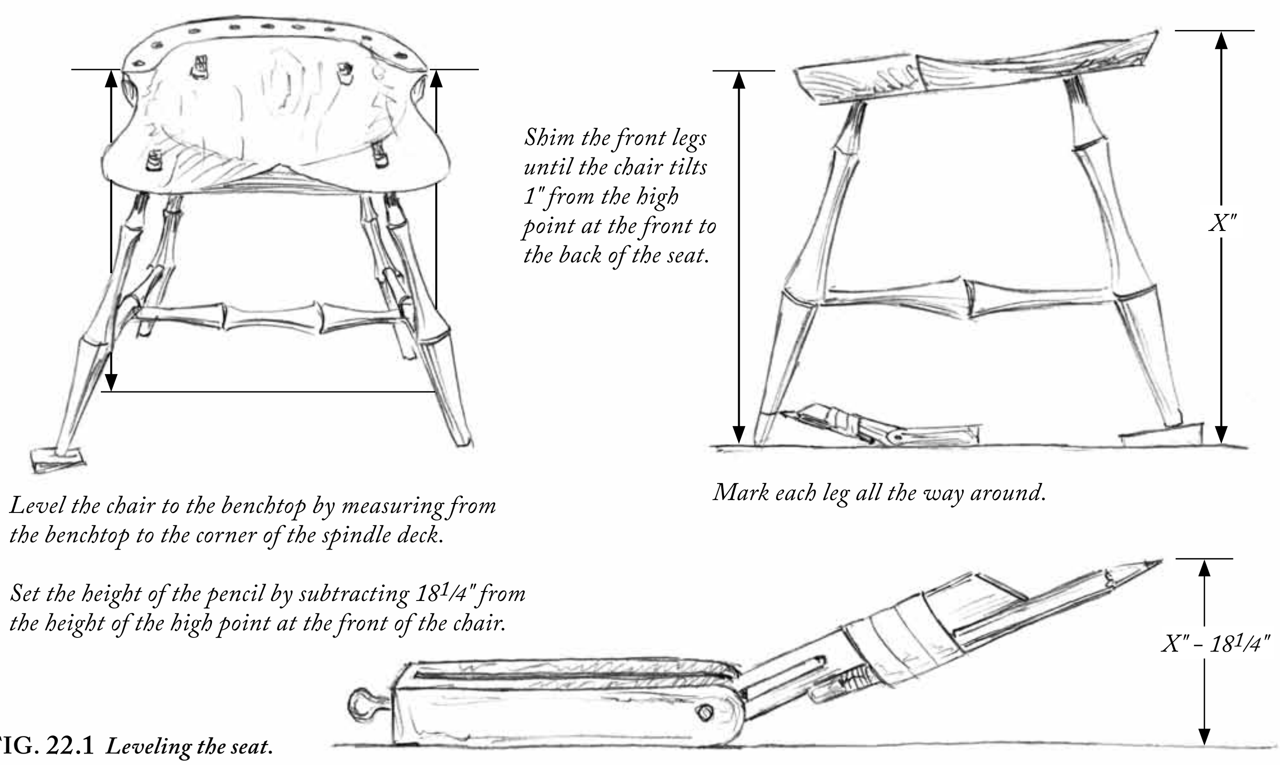



**FIG. 22.1** *Leveling the seat.*

level the seat side-to-side and position it at the desired pitch. If your bench has a tool tray, you might need to place a piece of plywood on the bench. For the chairs featured here, I measure the height from the front of the pommel and then from the back of the seat, and raise the front until there is a 3⁄4" to 1" drop at the back.

Once the chair is shimmed to the desired pitch, I subtract the desired height at the front of the chair (18" to 18½") from the actual height at the front of the chair and set my sliding bevel/pencil to mark the difference off the benchtop. Then I mark each leg at that height.

My favorite saw for trimming the legs is a Japanese dozuki (crosscut) saw. When sawing each leg, it's helpful to keep the sawblade parallel to the benchtop. Start sawing on the line and cut around the circumference about halfway before letting the saw cut across the leg. This creates a path of least resistance for the saw's blade and, together with keeping the saw parallel to the benchtop, yields a straight cut.

I don't saw the legs all the way through one at a time; that would make the chair unstable for the other cuts.

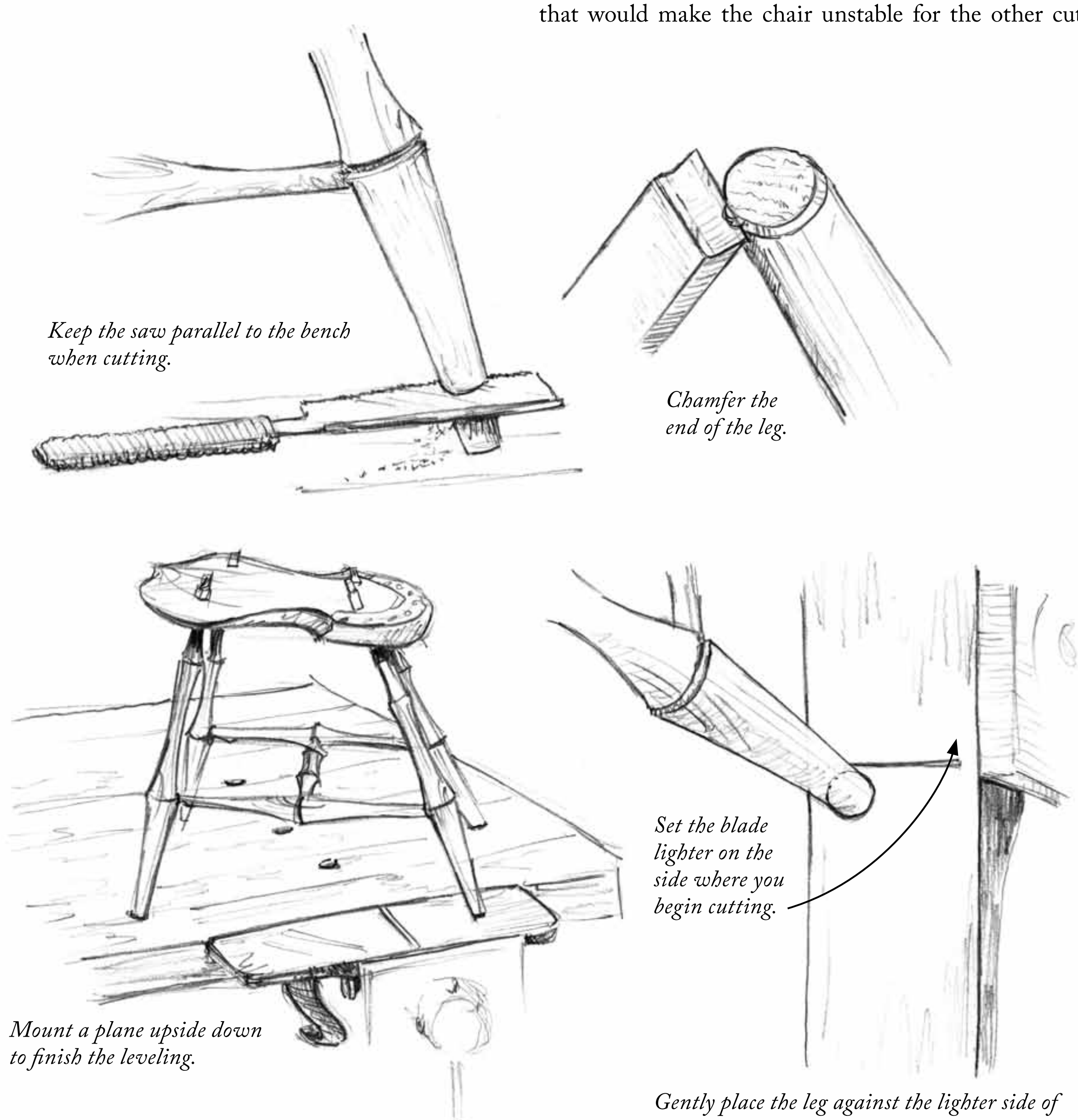



**FIG. 22.2** ***Trimming the legs.***

Instead, I cut most of the way on all of the legs and finish the cuts once all of the legs have been kerfed.

You can use a Western saw for this by placing the chair on its side and sawing one leg at a time. Be sure to use a pad to prevent marring the seat where it contacts the benchtop.

The next step is to chamfer the ends of the feet, which will reduce the chance of fibers chipping off the edges in the final step. You can do this with a chisel, being careful to keep your hand out of the path of the tool.

For the final step, I place a handplane upside down in the vise, level with the benchtop. Then I set the blade skewed in the mouth so it takes the lightest cut on the side farthest from the bench. Finally, I place each chair leg, in turn, on the plane and slide it diagonally across the blade to shave the bottom of the leg smooth. Start each cut by gently placing the leg against the blade then sliding it along and across in one motion. Avoid smacking the leg against the blade when starting the cut. Once all of the leg bottoms are smooth, I check the chair to see if it rocks on a flat surface and shave more off the long legs to make it stable. Then I make sure the chamfers are even.

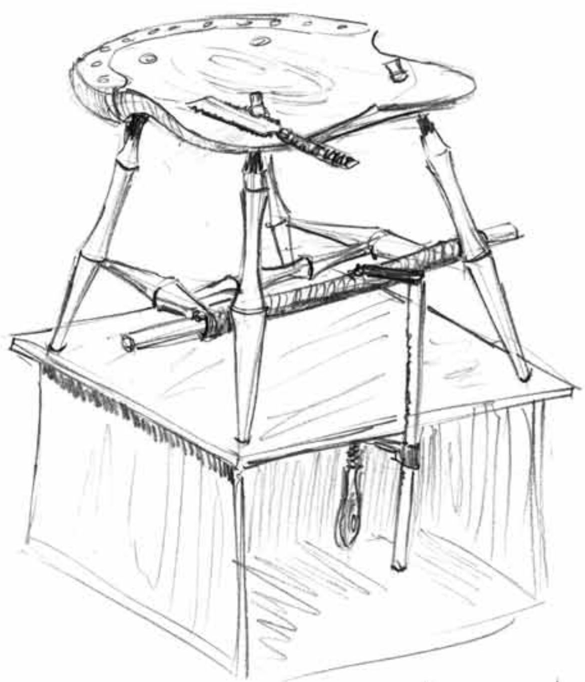
## Trim the Leg Tenons

Just as I finished all of the underside surfaces of the chair before legging up, I finish all of the surfaces on the top of the seat before assembling the upper portion of the chair.

The first step in finishing the seat top is to trim the protruding leg tenons. Having a method for holding the chair firmly at a comfortable height will make this process more enjoyable. I use a low bench next to my workbench. It's a simple plywood box that elevates the seat to the height of my elbow. I clamp the seat to it using a wooden rod with pipe insulation around it.

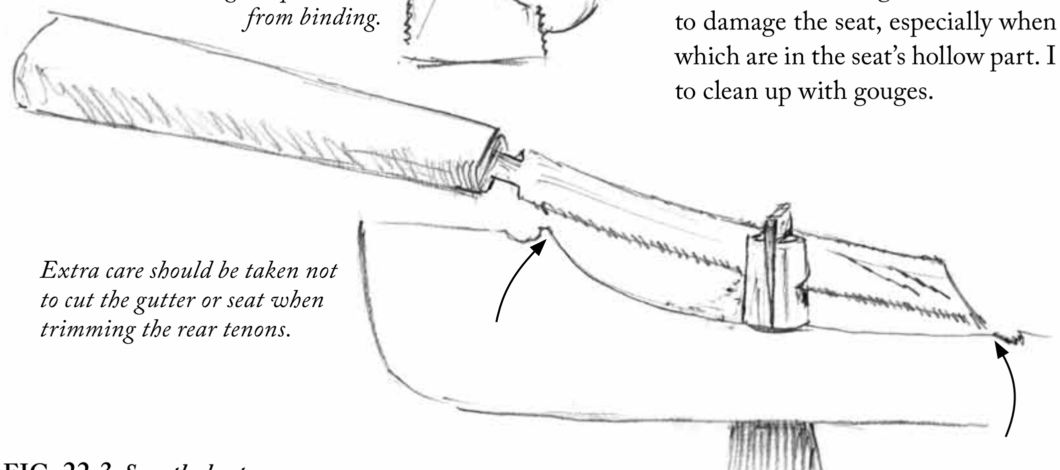
Take care not to apply too much force and damage the undercarriage.

With the seat secure, I trim the tenons first with a flush-cut saw, being careful not to cut the seat. It's easy to damage the seat, especially when sawing the rear legs, which are in the seat's hollow part. I leave about 1/8" or so to clean up with gouges.



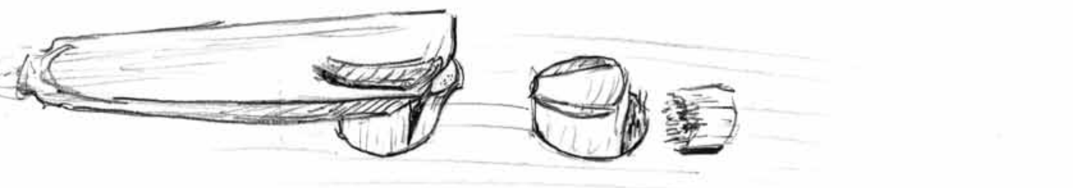
*A low bench secures the seat at a pleasant working height.*

*Cutting across the wedge keeps the saw from binding.*

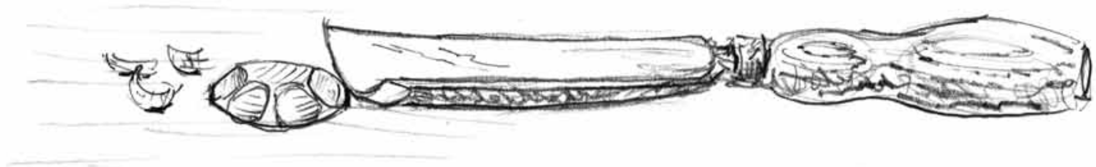


*Extra care should be taken not to cut the gutter or seat when trimming the rear tenons.*

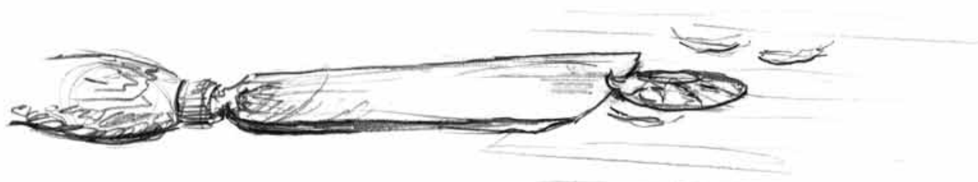
**FIG. 22.3** *Saw the leg tenons.*



*Cutting all the way across the tenon tears out an unsupported chip.*



*Cutting in from all directions while holding the handle low lets the gouge come up and out of the cut in the middle.*



*Pare with a wide, flat gouge with a slicing motion until flush.*

**FIG. 22.4** ***Paring tenons flush.***

The first gouge that I use has a No. 8 or so sweep, which is curved enough to take small bites from around the edge of the tenon. I carefully tap the gouge with a mallet because taking a large chip, or cutting all the way across the tenon, can tear out the fibers below the surface of the seat; that looks terrible and is tough to conceal. A better strategy is to hold the handle of the tool low so that it comes out of the cut near the middle of the tenon. I repeat this from all sides. This forms a mound in the middle that can be lowered as you make your way around. Once the tenon is nearly level with the seat, I switch to a wide, flat gouge and pare across the tenon until it is level with the seat, or even a hair below it.

## Finish the Seat Top

I am keen to take advantage of any second chances to get things right, so I begin work on the seat top by planing the spindle deck until it's clean. This reduces the depth of my gutter carving and allows me to recarve it a bit and fair its curves. Once I've finished this, I shave a chamfer around the back of the seat. One of my favorite details is the way the gutter carving emerges at the edge of the seat, cutting through this chamfer. A little extra care to refine this adds a lot to the appearance of the chair.

Once the back of the seat top is complete, I use my travisher to shave cleanly up to the gutter at the rear of the seat where my planing might have created a flat. I leave a small flat, about $1/32$" wide, that can later be rounded slightly with sandpaper. This flat is delicate because it is all short grain and must be approached carefully, especially with the scraper.

## The Scraper

Scraping pine is a joy. With a sharp scraper and good technique, you can pull broad shavings while leaving a clean surface behind. Of course, to get these results takes a sharp, nick-free tool.

When I built cabinets and tables, the scraper was occasionally useful for smoothing flat surfaces, but now that I make chairs, a scraper is a serious workhorse in my

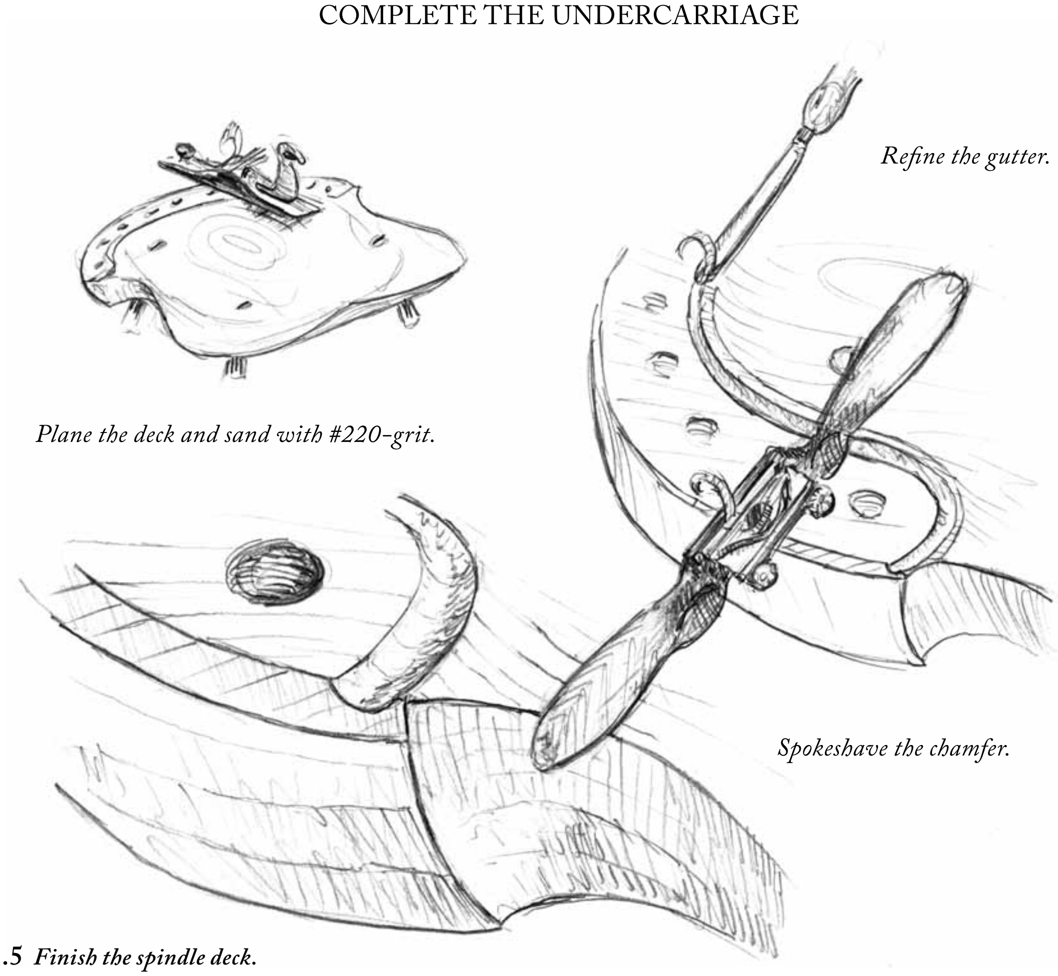



**FIG. 22.5** ***Finish the spindle deck.***

shop. For refining complex surfaces it's fast and effective, plus it nearly eliminates the need for sanding.

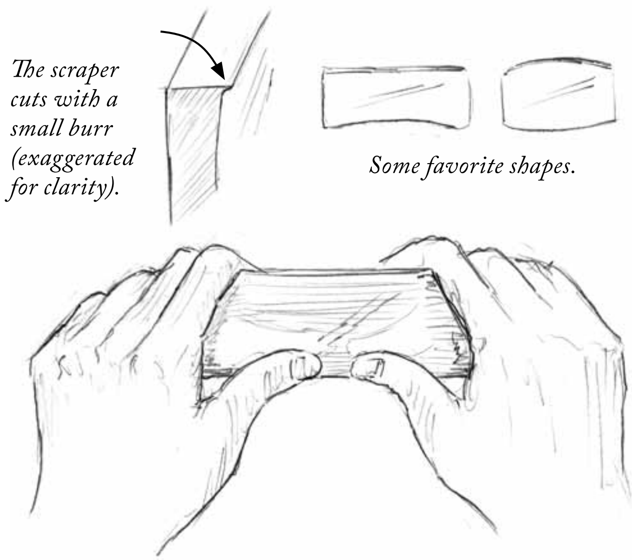
The difficulty in learning to sharpen a scraper leads many folks to reach for the #80-grit sandpaper, but with a little knowledge and practice, you can take feathery shavings from woods as soft as white pine and as hard as hickory. Knowing what to expect from the scraper is half the battle.

The scraper can be easily shaped to fit various profiles and resharpened quickly. The greatest misconception I encounter is that the burr must be large to cut. I prefer a tiny, nearly nonexistent burr. A properly honed scraper will even cut without a burr. For details on sharpening the scraper, refer to the Tools for Seat Carving chapter.

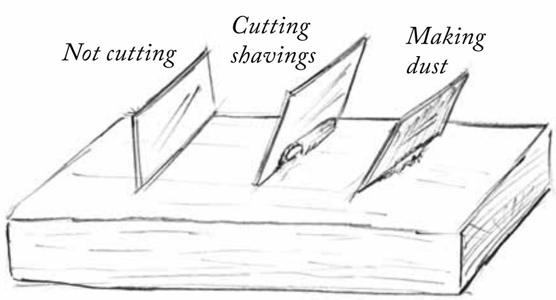
Scrapers come in a variety of thicknesses; I prefer a thickness of .025" because it is thin enough to flex, yet stiff enough to push uniformly. I also like the feedback it offers. Thicker scrapers are good for hogging off material because they flex less and heat up slowly.

I custom-grind and file a profile on my scrapers to help form the shapes on the chair seat. To grind these shapes, set the tool rest on your grinder so it will cut at 90° and grind to your line, being careful to go slowly enough to not heat the blade too much. If it turns blue, the temper in that area is lost until you grind well beyond that point. I wouldn't sweat it too much, however; just continue to use the tool and expect that area of the tool to dull quickly.

The one drawback to scraping is that it compresses the fibers as it cuts, causing the grain to raise when wet. This can lead to more work when finishing with water-based milk paint. On the seat, the grain raising can yield a pleasing result, allowing the texture of the wood to be more visible through the paint. If you wish to limit this effect, you can seal the seat with a thin coat of shellac before painting.




*Supporting the scraper with both thumbs close to the work surface increases control and sensitivity.*




*The forward pitch of the tool affects the cutting action. Avoid tilting the scraper more forward than necessary.*

**FIG. 22.6** ***Using a scraper.***

The actual cutting action of a scraper is tough to see, so I rely on feel and results. The sharp burr should be so small as to be nearly invisible and not too obvious to the touch.

To get the feel for the proper cutting angle, push the tool across or along the wood while holding the blade perfectly vertical. It won't cut in this position. Then make another pass and tilt the blade slightly forward. When tilted just enough, it will grab. That is the angle at which the tool should always be held. The tendency is to tilt the blade too far forward because it takes less effort to push, but it then takes only dusty little cuts while quickly dulling the blade.

Tilting the blade too far forward also directs the pressure downward into the wood, causing more grain compression than when the force is directed forward, which also supports the cutting edge. The key to keeping the blade in position is to position your thumbs at the bottom. It takes practice and discipline, but the reward is shavings and a crisp surface.

Just like the shaving tools, the scraper benefits immensely from skewing and slicing. When handled properly, the scraper can cut a surface from multiple directions, which is helpful when leveling a surface. It's similar to planing a board flat by taking strokes from multiple directions. Each direction offers different information and, after a while, all the high spots are leveled.

At first, it can be confusing to determine which direction to scrape the top of a seat because of its dips, curves and humps. While always scraping from high areas to low areas will generally be a safe assumption, the best way to get a clean, flowing surface is to approach each area from multiple directions. To do this, keep the scraper facing the direction as though it's cutting from the high areas to the low areas, but slice it diagonally across the fibers as you cut.

This will also help you traverse the transition areas without tearing out the end grain on the opposite slope, just as with the inshave and travisher.

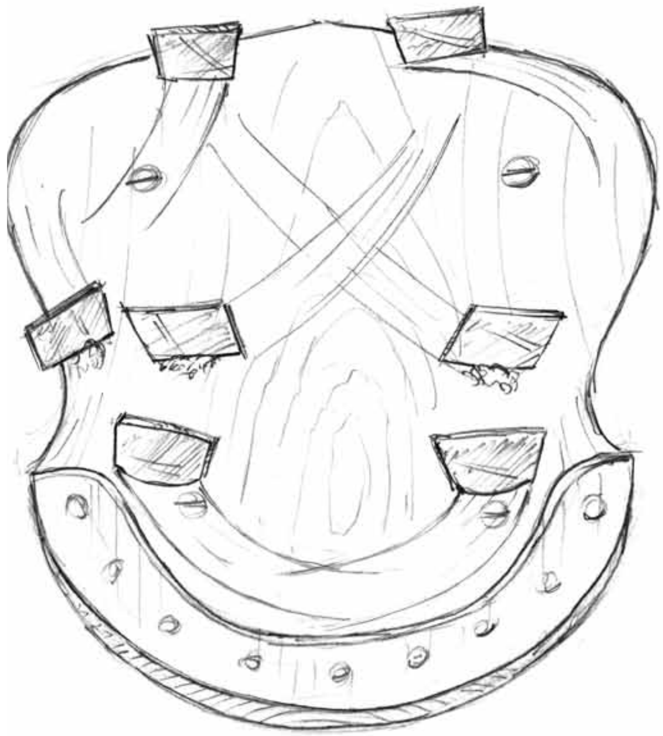
Cutting multiple directions whenever possible delivers the best results.

The rear of the seat is challenging because of all the exposed end grain. With the grain running from the front of the seat to the rear, it's safe to scrape from the gutter toward the bowl, as well as from the center of the back toward the sides – as long as the scraper is facing downhill toward the bowl as you travel.

## Scrape the Leg Tenon

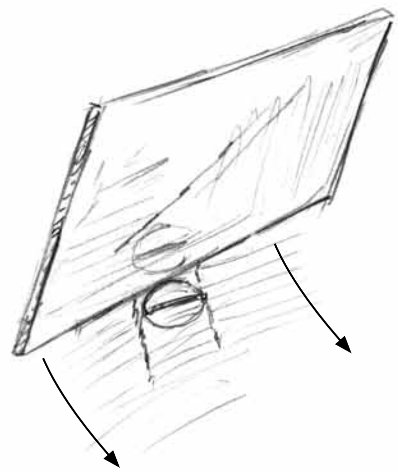
The leg tenons can present some difficulty during scraping. The difference in density between the end grain of the hardwood legs and the soft pine of the seat can cause the scraper to dig into the pine when it hits the tenons. Also, the angle that the scraper cuts best is different for pine and hardwood's end grain, so plowing along the pine and running headlong into the tenon creates an ugly hump that is sometimes only visible when the chair is painted and oiled.

My solution is to carefully pare or scrape the tenon alone until it sits a hair beneath the pine seat, then to cut



*Scraping from different directions and crossing strokes helps level the surface. The blade can move sideways as long as it is facing "downhill."*

*Density variation between the seat and end grain of the leg tenons can cause humps to form around the tenons.*



*Scraping the tenon end and skewing while cutting across the hump can eliminate the problem.*

**FIG. 22.7** ***Scraping from multiple directions.***

from multiple directions to level the pine until it is flush with the tenon.

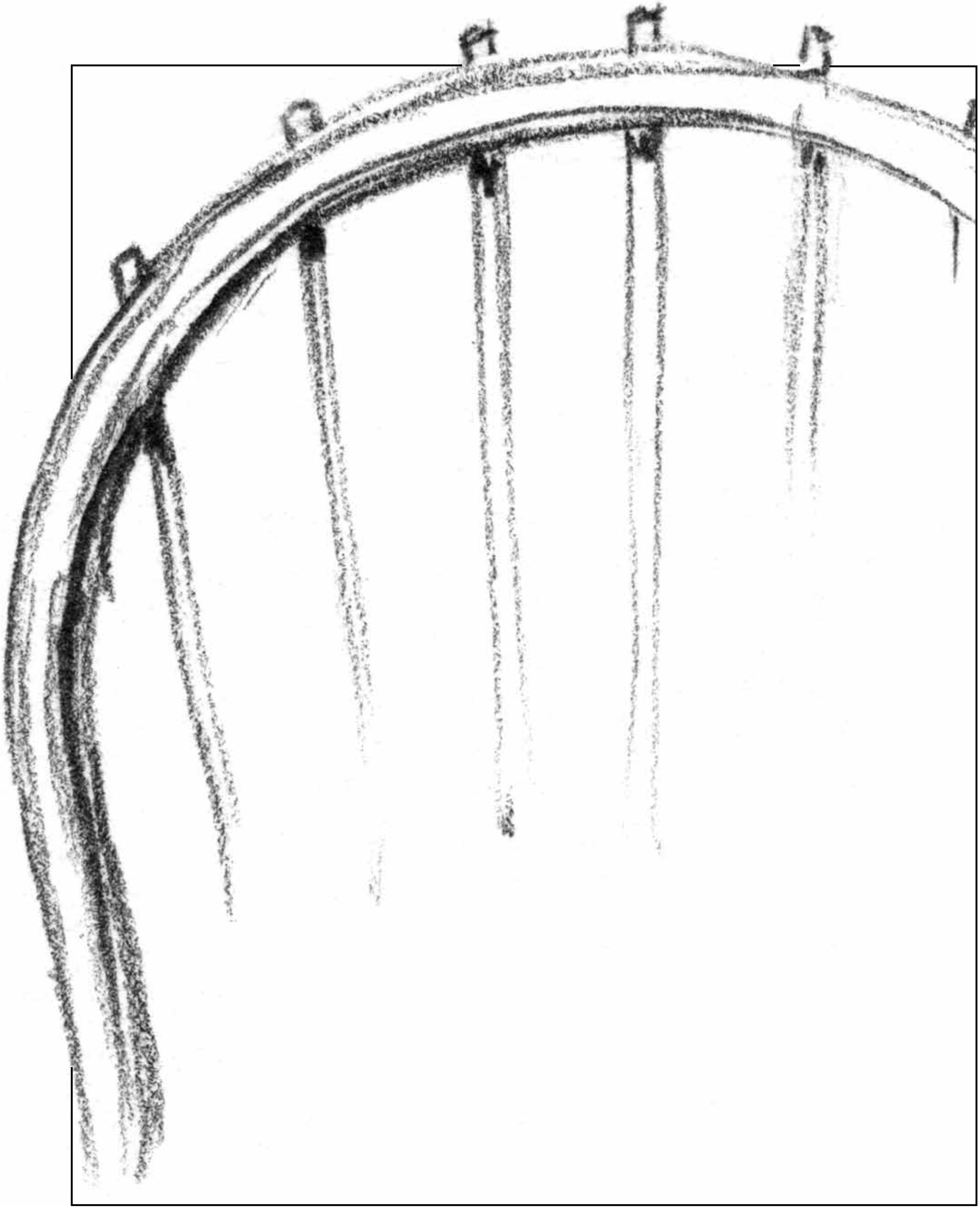
Starting the stroke so that it is partially on the exposed tenon while cutting the pine around the joint can also help create an even surface. Take care not to create a flat spot or hollow while correcting the problem.

I use a raking light to carefully check each tenon. I move the light all around the seat so that I can catch any shadows being cast. With practice and experimentation, you will learn how to deal with the various surfaces and dramatically reduce the need for sanding.

When I am through with my initial scraping, I use #180-grit sandpaper to further level the surface. Then, breaking the rule about not following sandpaper with an edge tool, I return to scraping to remove all of the scratches left by the paper. Then, after a light sanding with #220-grit paper, I am ready to assemble the top.

The seat is the broadest surface of the chair and draws a lot of visual attention. The condition of the surface becomes much more obvious after the finish is applied. I find that a few extra minutes of examination with a light raking across the surface is time well spent.

Having the undercarriage complete is a pleasant landmark to reach in the process. Even though the whole job is not complete, I always enjoy taking a step back to recognize the chair emerging from what was recently just a bunch of parts.



# 23

# Uppercarriage Assembly: Balloon-back

These steps will complete the construction of the portion of the balloon-back chair that is above the seat. The mortises in the seat were completed before carving the seat to take advantage of the flat reference surface.

## STEP 1. CLEAN THE BOW

Once the bow is completely dry and its bend is set, remove it from the kiln. If the bow is already off the form and tied, be sure to dry the tenon ends before forming the tenons.

I clean up the surfaces of the bow with a handplane, spokeshaves and scrapers. First, I complete the rounding of the back of the bow. I do a lot of this work at the shavehorse. The concave portion of the bend might be difficult to shave cleanly due to compression of the fibers during bending. If this is the case, scrape those areas. I try to scrape as little as possible because all of the scraped areas will require sanding later after wetting to remove raised grain.

The convex portions should shave easily with a spokeshave. If any fibers lifted in the bending process, shave them away or glue them down using tape to hold them. After gluing, shave the area clean. Be careful not to create flat spots on the curves, or thin spots while trying to remove surface defects.

The face of the bow should be relatively flat. While it is not important that it be a truly flat plane, it should look flat. Sometimes the bow will twist a bit during bending, which results in waviness. To remedy this, clamp the bow to the benchtop and shave a little from the crests of the

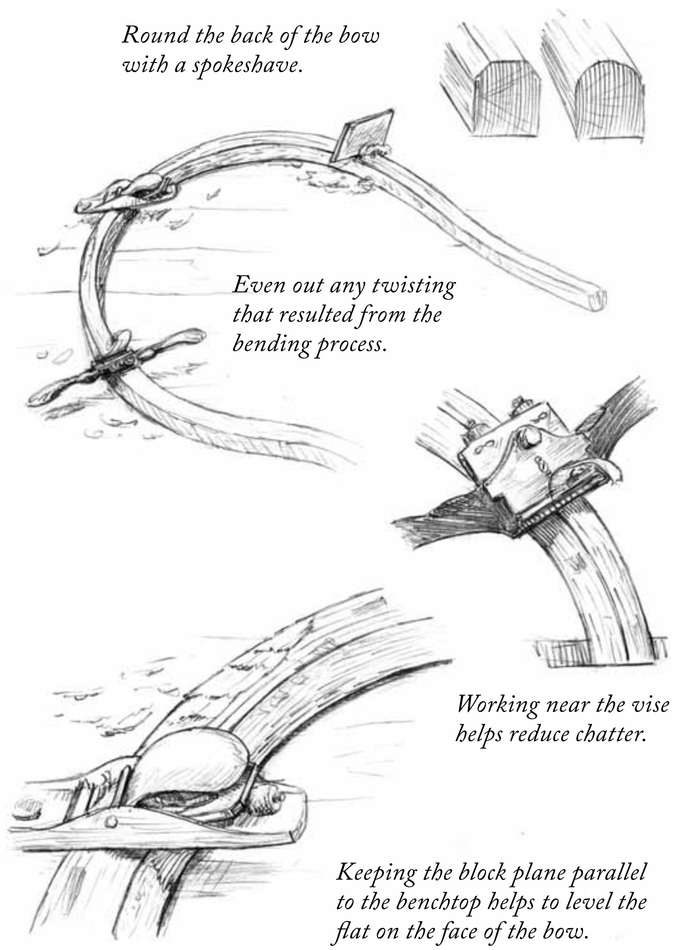



**FIG. 23.1** ***Clean the bow.***

waves with a handplane. Take light cuts across the fibers with the plane skewed until the bow seems flat. Be careful not to remove too much wood, especially where the spindles pass through the bow. The beads on the face of the bow will help conceal any problems.

## STEP 2. CUT TENONS ON THE ENDS OF THE BOW

The tenons on the ends of the bow are straight and 5⁄8" in diameter. They should be sized while the bow is fresh from the kiln, and returned to the kiln before assembly to ensure that they will remain the correct dimension.

To get a crisp transition from the bow to the seat, I cut angled shoulders on the bow where it enters the seat, which is easier than it sounds. I begin by marking the bow while it's on the form to get the shoulder line at the front.

I then continue that mark all the way around the bow at the same level. Later I'll cut the angled shoulders, but first I'll size the tenon from this line down. I use my drawknife to shave away from the front, back and sides of the tenon to just over 5⁄8". The bow is split and shaved, so following the fibers will yield parallel sides when shaving the tenon.

Then, just as if I were making spindles, I shave material from the corners until I have an even octagon just larger than 5⁄8". I round it out and size it to fit a 5⁄8" mortise in a test block. The portion of the tenon just below the shoulder will be shaped after the shoulder is established.

I have also used a 5⁄8" tenon cutter in a brace to good effect for this tenon. A power drill can also be used, but extra care should be taken not to go too far too fast.

To use a tenon cutter, I first round the tenon to a true 5⁄8" for the first 1⁄2", using a hole in a block to test. This area will seat beyond the blade and guide the cutter, so it should be in line with the rest of the tenon.

Then I clamp the work flat on my benchtop and visually align the cutter with the tenon and start cutting. Take care to stop cutting short of the shoulder mark.

Once both of the tenons are formed, place them in their respective mortises in the chair, making sure they are the same depth by measuring to the shoulder line at the front.

Raise or lower the bow's tenons until they are 1" above the spindle deck. Then cut a piece of wood as shown and use it as a base for a flush-cut saw to cut the shoulder, or to mark the shoulder all the way around the tenon. Remove the bow and carefully saw the shoulder line; go only as

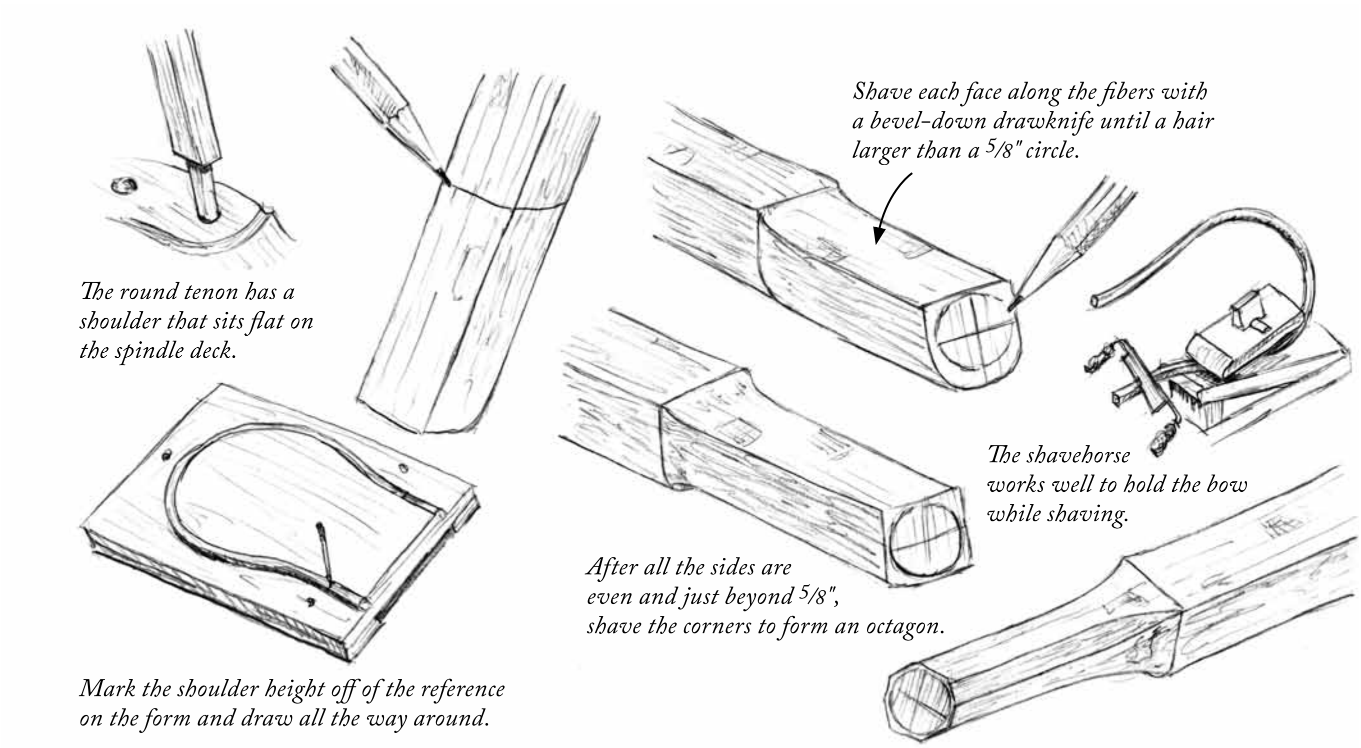



**FIG. 23.2** *Tenoning the bow.*

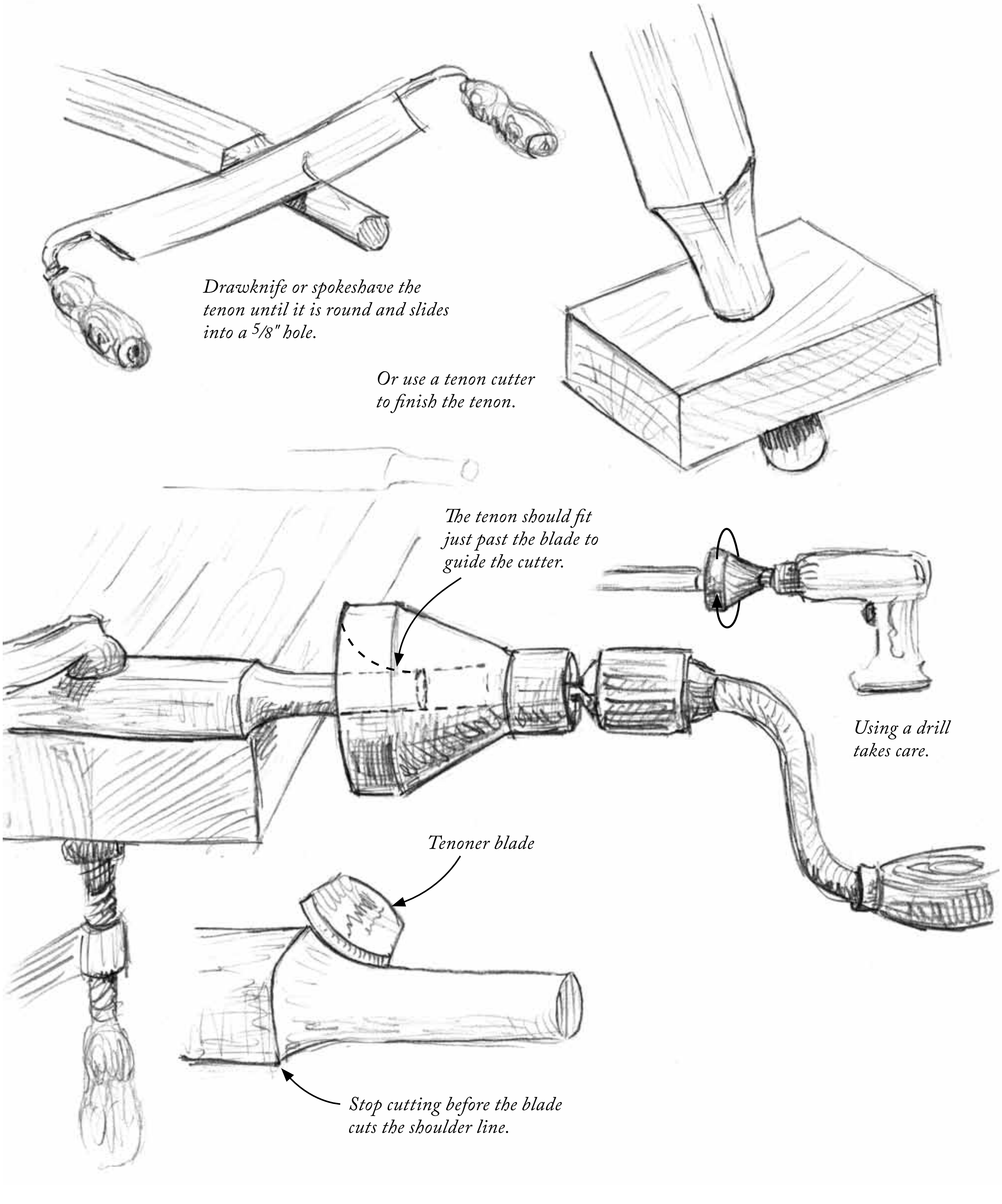



**FIG. 23.3** ***Finishing the tenon.***

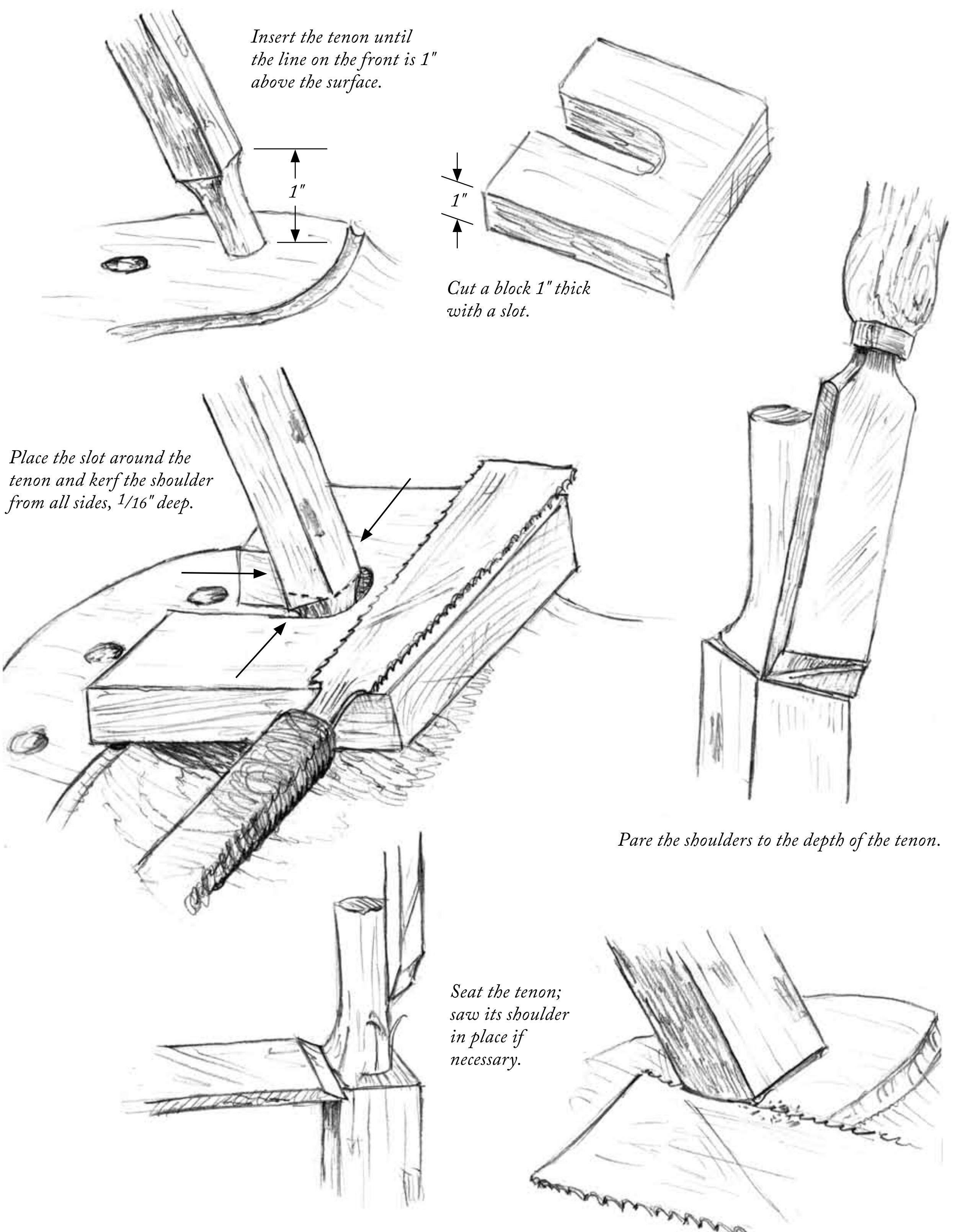



**FIG. 23.4** *Cut the angled shoulders on the tenons.*

deep as necessary to meet the 5⁄8" tenon. Then, using the tenon as a guide for your chisel, pare away the rest of the tenon leading to the saw kerfs at the shoulder line. Once you have both tenons cut, fit the bow-back in the chair. If the shoulder line fits perfectly, congratulations!

If not, take a flush-cut saw and ride it on the spindle deck while kerfing the shoulder. Flush-cut saws have "set" on their teeth on one side only; be sure that the orientation of the saw is correct so you don't cut into the seat. You need not cut all the way to the tenon; just establish a clean kerf that's parallel to the deck, then remove the bow and pare away the rest of the shoulder to the tenon.

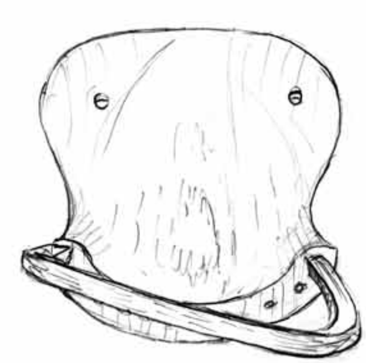
## STEP 3. CHECK THE BOW FOR TWIST

Once the shoulders are pared and fit cleanly against the spindle deck, check for a twist in the bow. Stand behind the bow and sight down to the seat. When looking down the centerline of the seat, the bow should intersect the spindle holes evenly. If it doesn't, try twisting one (or both) tenons in its mortise until the bow sits correctly. Once it's positioned correctly, make an alignment mark on the spindle deck to help orient the bow during assembly. If you are going to cut a bead all the way to the shoulder, be sure to locate the alignment mark where it won't get scraped away in the process.

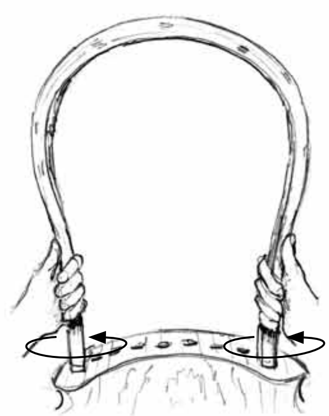
If the bow seems dramatically twisted you can correct it by heating an area of the bow and twisting it to the correct shape as shown in the Bending Wood chapter. The heat will loosen the lignin enough for the fibers to adjust; when cooled, it will hold the shape. Gently heat an area around the bow with a heat gun, being careful to keep the gun away from the wood and moving it to prevent scorching. When the area is hot to the touch, twist the bow (a bit beyond the desired amount) and hold it in position until the area cools. You will also have a chance later, when the spindles are in position but not yet wedged, to slightly twist the bow into alignment.

## STEP 4. SCRAPE THE BEAD

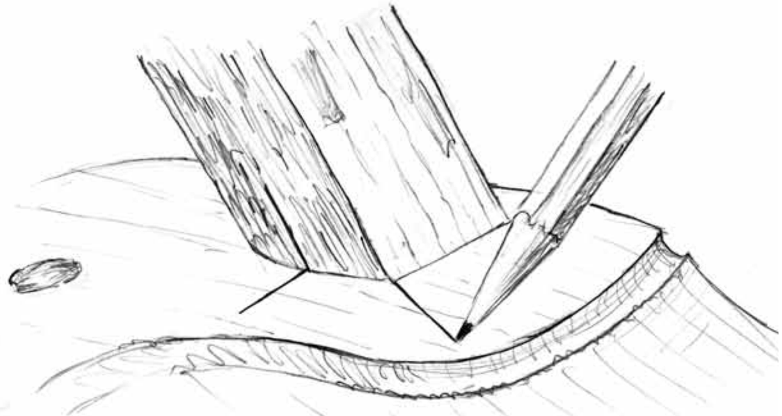
The beading on the front of the bow is an aesthetic choice, but I like the way it breaks up the space on the bow's face. I use a handmade scratch stock like the one pictured. You can purchase blank blades from the makers of commercial scratch stocks or just use steel from an old saw blade. I grind and file the profile, clean it up with a diamond hone then roll the tiny burr that does the cutting. There are a variety of options for the shape of the cutter.



*Look from the top of the bow to find a twist.*



*Rotate the tenons until the twist is eliminated.*



*Make a reference mark from the corner of the shoulder to note the rotation.*

**FIG. 23.5** ***Fix a twisted bow.***

When scraping the bead, I keep the cutter nearly vertical and take light cuts, focusing on keeping the fence on the cutter at a tangent to the curve. I push or pull the cutter depending on what's comfortable. Long, steady strokes work better than short, choppy ones. It's important not to start or end a cut abruptly because this makes getting a fluid-looking bead more difficult. Once I have the bead nearly to the complete depth, I remove the cutter from the jig to refine and finish the job freehand.

I wet the beaded area and let it dry thoroughly before sanding with #220-grit paper. I do this twice to tame the raised grain.

## STEP 5. LAY OUT THE SPINDLES

I use a jig both to check the spacing and angle of the center spindle to the bow, and to hold the bow in place for drilling.

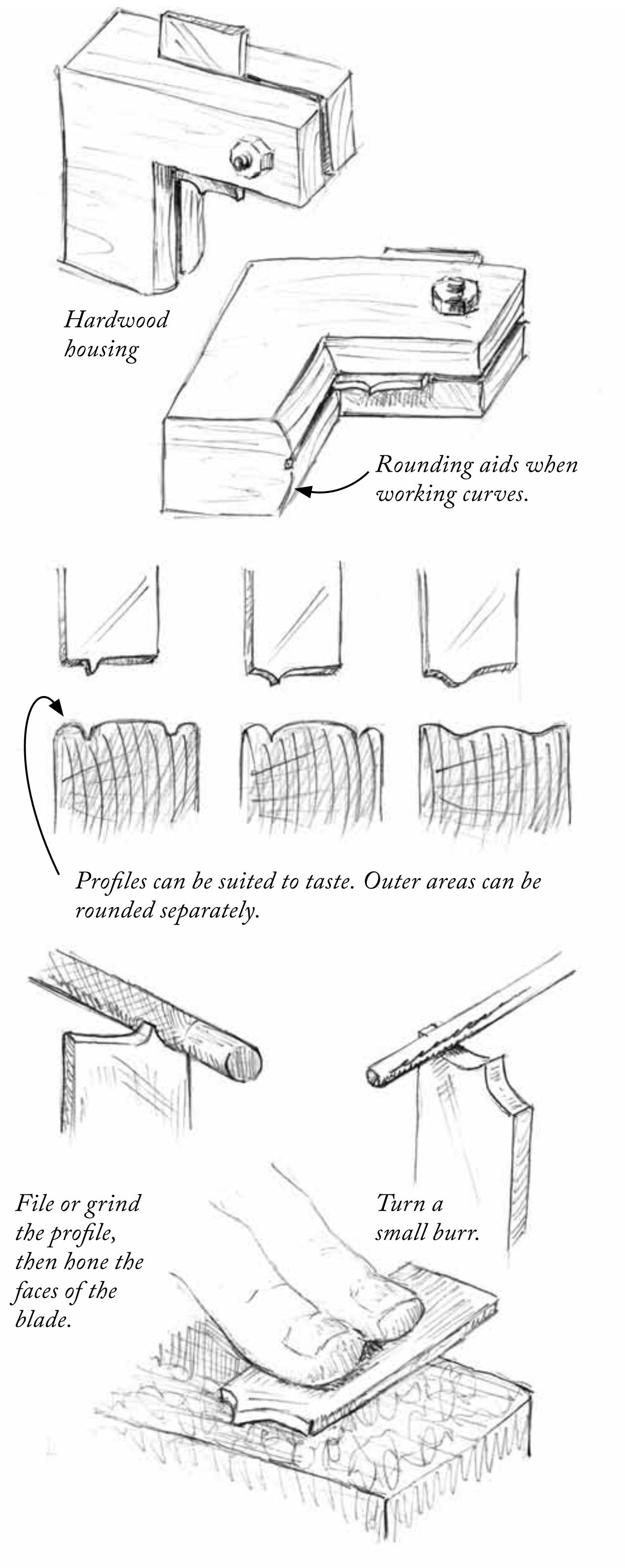



**FIG. 23.6** *A shop-made scratch stock.*

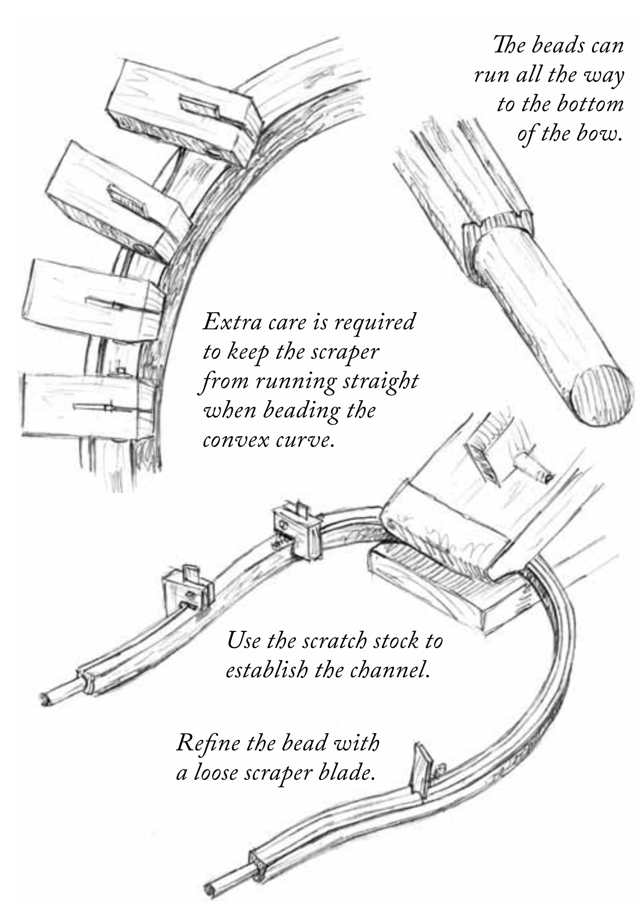



**FIG. 23.7** *Scraping the beads.*

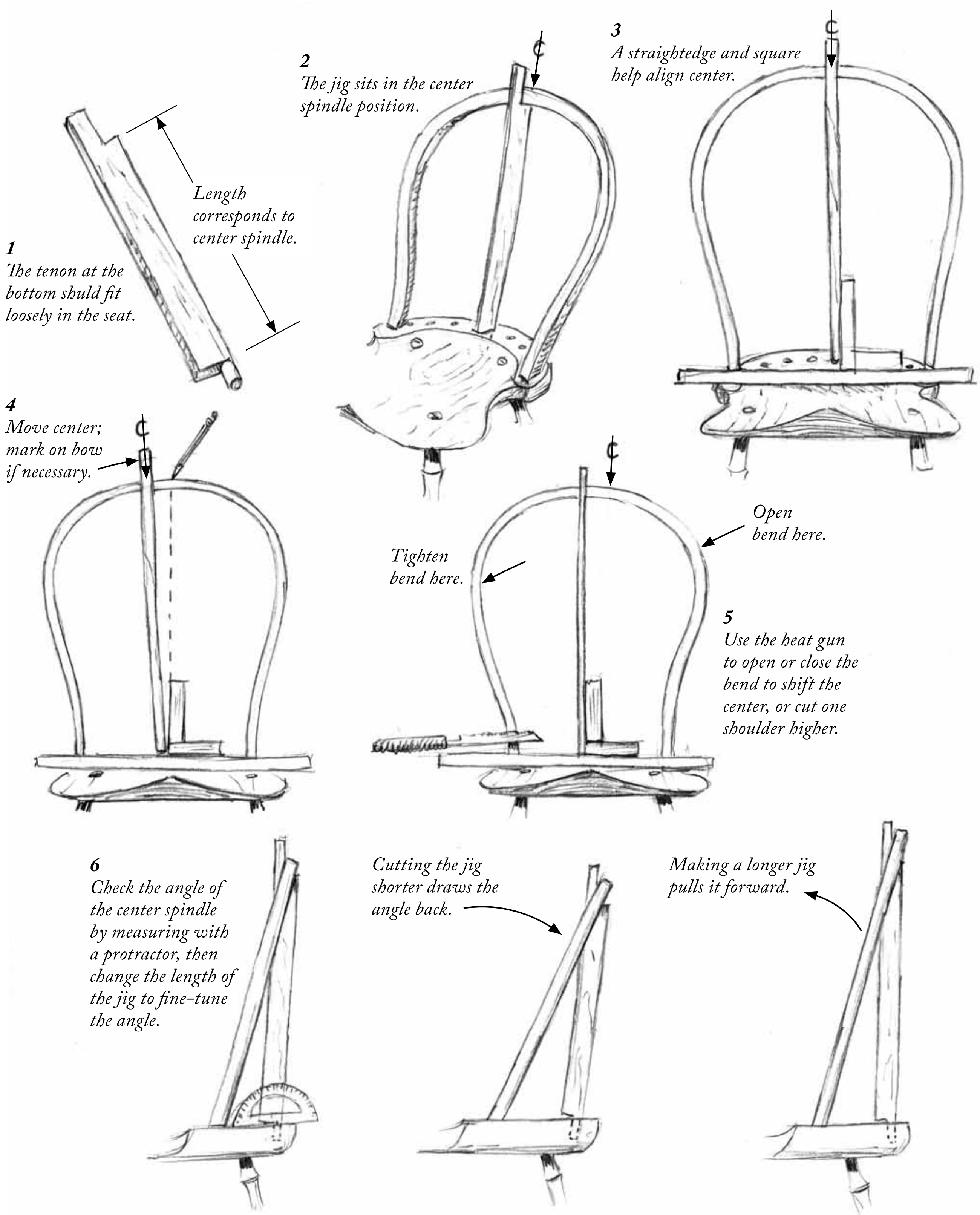
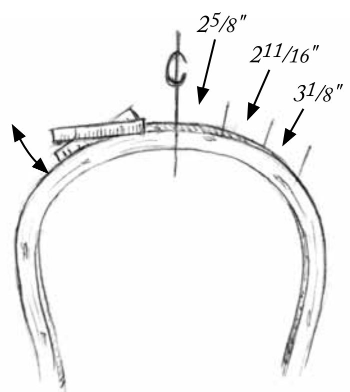



**FIG. 23.8** *A bow-spacing jig.*

The seat tends to warp a bit after carving, so to get an accurate reading of the squareness of the jig to the seat, I set a straightedge on the spindle deck in front of the bow then place the square on top of it.

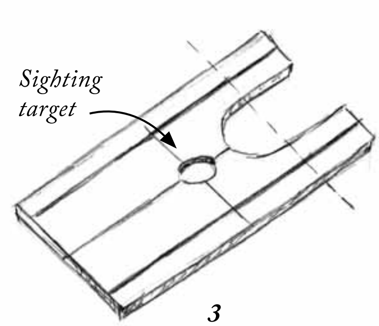
I lay out the location for the center spindle and check it against the center mark that I made for the bending process. I make sure that it is both square to the seat and halves the bow evenly when viewed from the front. If it isn't, move the location center on the bow, as long as the bow is evenly split. If moving the center mark makes the bow look lopsided, I shift the whole bow by cutting back the shoulder on one of the tenons or heating the bow and applying pressure to open or close one side of the bend. The goal is to make the bow appear even and the center spindle square to the seat. This may end up being a compromise to make a misshapen bend work. I find that leaving the bend on the form during the entire drying process helps ensure consistent curves.

If the mortises were drilled accurately and the bow is bent correctly, the rake angle of the center spindle should be about 8°. If the angle is incorrect by more than a degree or so in either direction, you can change the jig to bring the bow into position. Increasing the length of the jig will draw it forward; shortening it will pull the bow backward.

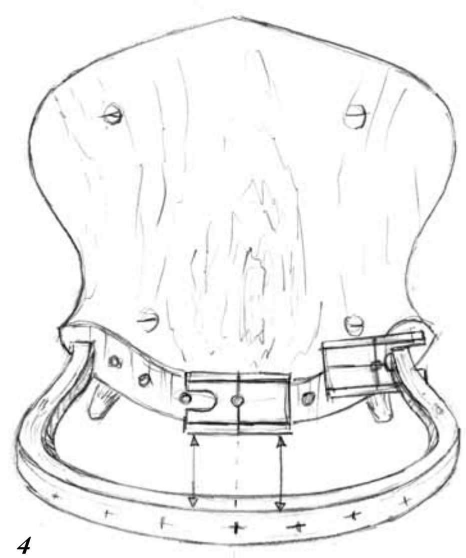



***1***
*Roll the ruler to measure spindle locations.*

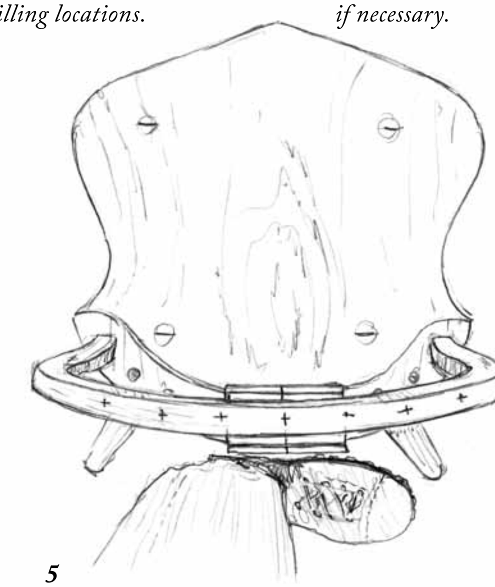

***2***
*Measure 9/32" back from the front of the bow to locate drilling locations.*




***3***
*Notch for fitting around bow, cut more if necessary.*



***4***
*The target goes over the mortise in the seat and is positioned parallel to the bow.*



***5***
*Here you can see how the target helps locate the mortise, even when the view of it is blocked.*

**FIG. 23.9** ***Laying out the bow mortises.***

Both of these solutions introduce a slight tension to the bow, but it's usually not noticeable.

The shoulder height on the center spindle will need to be adjusted to match the height of the jig.

## STEP 6. DRILL THE BOW

The next step is to lay out the locations for the spindle mortises and drill them. The drilling is done freehand by sighting from the bow to the seat. This process is daunting to newcomers, but it is a valuable skill. I have taught it so many times that I am convinced anyone can achieve it. Don't be surprised if you are a bit confused and nervous in the beginning; you will surely find that your tension will decrease with experience.

Now that you've been warned, you might be thinking, "What's so tough about this?"

You must learn to visually align all the guiding references while also learning to handle the tool with real-world consequences.

Isn't there a way to do this with a jig? I've seen and used jigs to create close guides for my drill bit, but in the end, I've found they slow me down and don't really make the job much easier. It's a lot like learning to drive; as we all know, after a while, you easily follow a dashed line down the highway at 70 mph while chatting away, drinking hot coffee and thinking about anything but driving.

The most difficult part of this process is that the drill and the bow block the view of the mortise. I've found that a simple "target" jig on the seat helps extend the visual clues to the location of the mortise. By aligning the bow and the target, I can then move the drill into position. A small piece of tape helps keep the target in place.

The first step is to place the target over the mortise in the seat and rotate the target until the lines are parallel to the part of the bow being drilled. Throughout the process, the target is always aligned in relation to the bow at the spot being drilled. The only significant detail on the seat is the mortise location. I always position my front foot parallel to the target, which helps me to orient my body and the drill to the target.

When you introduce the drill into the process, you will immediately find that the drill blocks the view of the bow and target. To overcome this, you will have to look from two positions to align the drill along two axes. Stand so you can comfortably move your head into two positions as shown without moving your body. It's vital to note that you cannot see both views at once and you must be able to move just your head from one view to another as you adjust the alignment of the drill. You might want to close one eye for this.

The key point to remember is that you position your gaze by first aligning the bow and the target. Then you align the drill and with the bow and target.

If the drill is too close to your head to see clearly everything clearly, stand on a block or stool.

One view looks directly down the back of the drill to fix the rake angle. In this position, you are aligning the drill, the bow and the target so they overlap evenly. The other position is looking over the side of the drill so you can set the splay. By looking over the side of the drill, you can see that the axis of the drill, the end of the drill and the mortise location in the seat all align. It's an easy mistake to knock the drill out of alignment in one axis when setting the other, but a quick check can set it right again.

It may take some time looking at one view and then shifting your head to align the other view before it makes sense. I keep the body of the drill parallel to the edge of the target and tuck it against my body to stabilize it and keep it in position when I move my head from one view to the other. This technique can be adapted to work with a bit and brace as well.

It's wise to do some practice drilling. Place the target on a seat and clamp a piece of scrap wood to the benchtop so that it hangs over the side.

It's tempting to start drilling with a slow rotation, but high speed is essential. I prefer brad-points that I grind myself (see the appendix on grinding bits) because they allow the drilling to engage the work at an angle. With shorter-spurred bits, you might need to begin drilling more vertically in relation to the surface, then move to the correct angle while advancing the drill.

I set the clutch on my drill to a low setting to prevent the bit from blowing through the exit side. The curved surfaces under the bow don't lend themselves to using backer boards. Most folks using a bit and brace let the lead screw poke through and then drill through from the bottom with the bow removed from the seat.

The drill bit will advance at a speed determined by its geometry. The key is to allow it. Advancing too fast will make a rough hole; too slow will cause the hole to glaze and resist glue. When the lead spur starts to poke through, the change in resistance usually causes the bit's

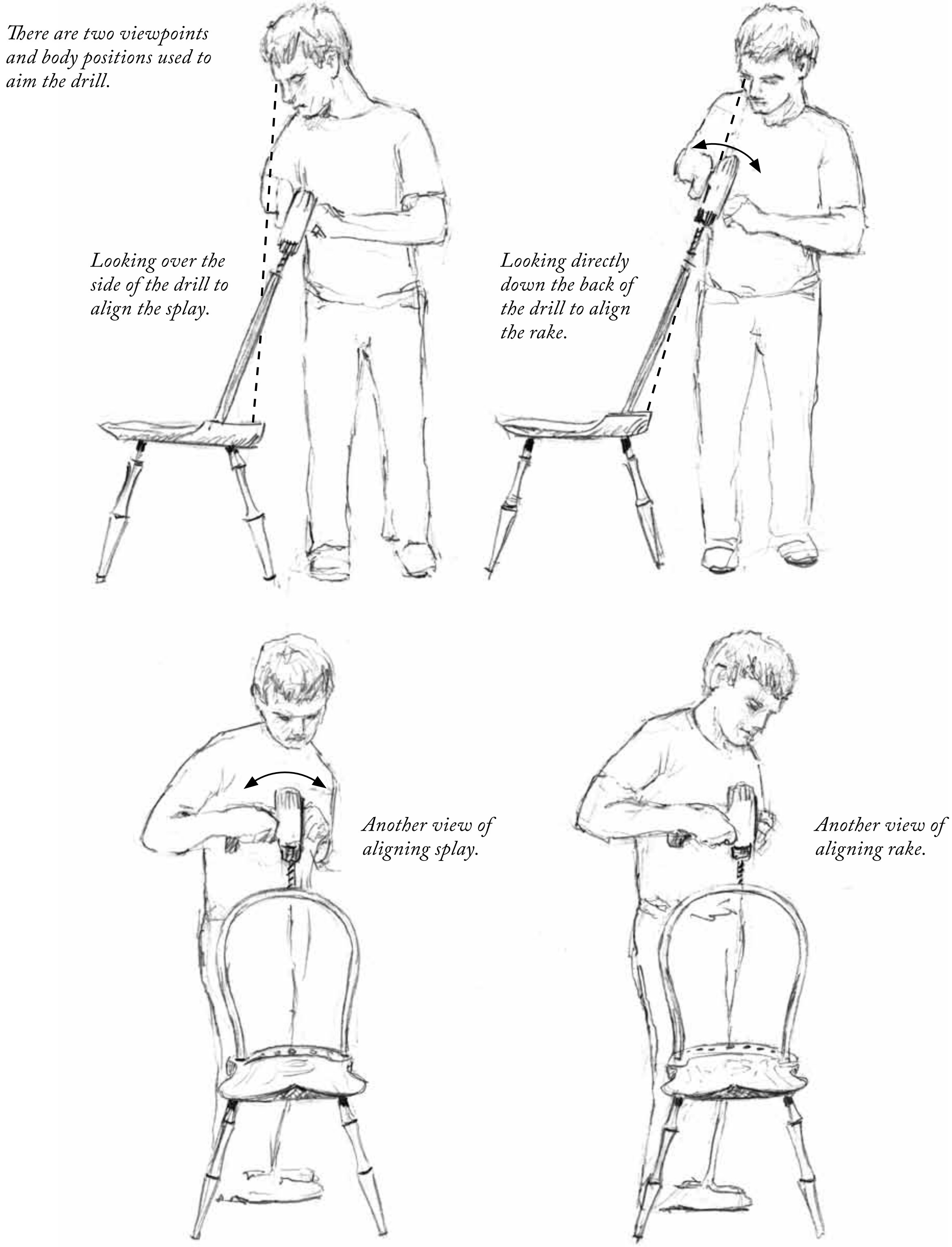



**FIG. 23.10** ***Body position while drilling.***

nickers to bind. This trips the clutch, stops the rotation and makes a grinding sound. Release the trigger.

You might be able to retract the bit from the hole enough to get it spinning again; if not, running the drill momentarily in reverse usually frees the bit. Once the bit is free, run it at full speed without making contact with the bottom of the hole and gently lower it to shear the remaining wood. Continue to align the drill using the visual guides, or the misalignment might cause the clutch to trip again. Don't be surprised if the clutch trips repeatedly. After a few practice attempts, you will develop a sensitivity to the cutting action and the light touch that will trip the clutch less often. It also will reduce how often you must endure the obnoxious grinding sound.

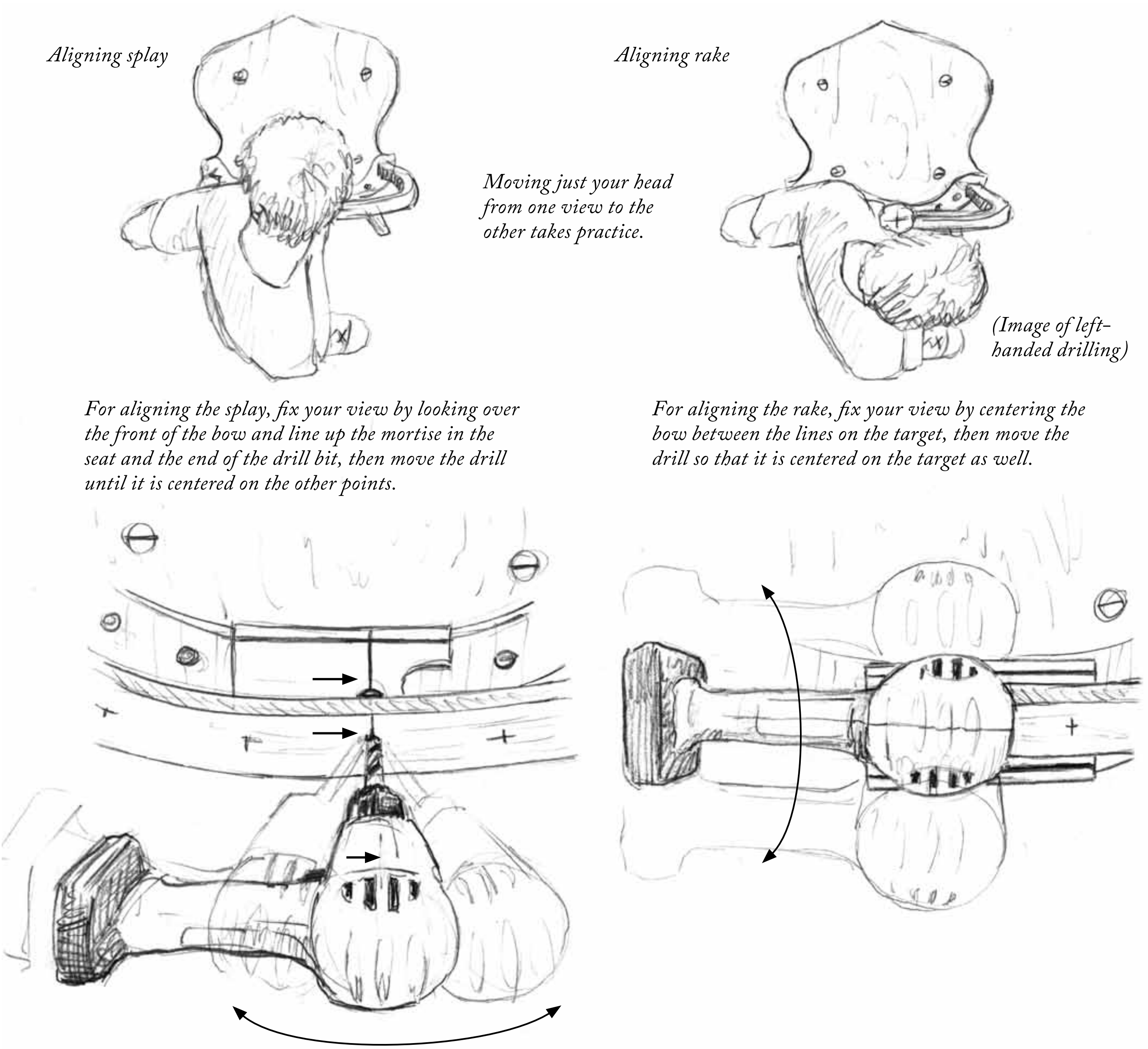



**FIG. 23.11** *Align the drill to the splay (left) and rake (right) of the chair.*

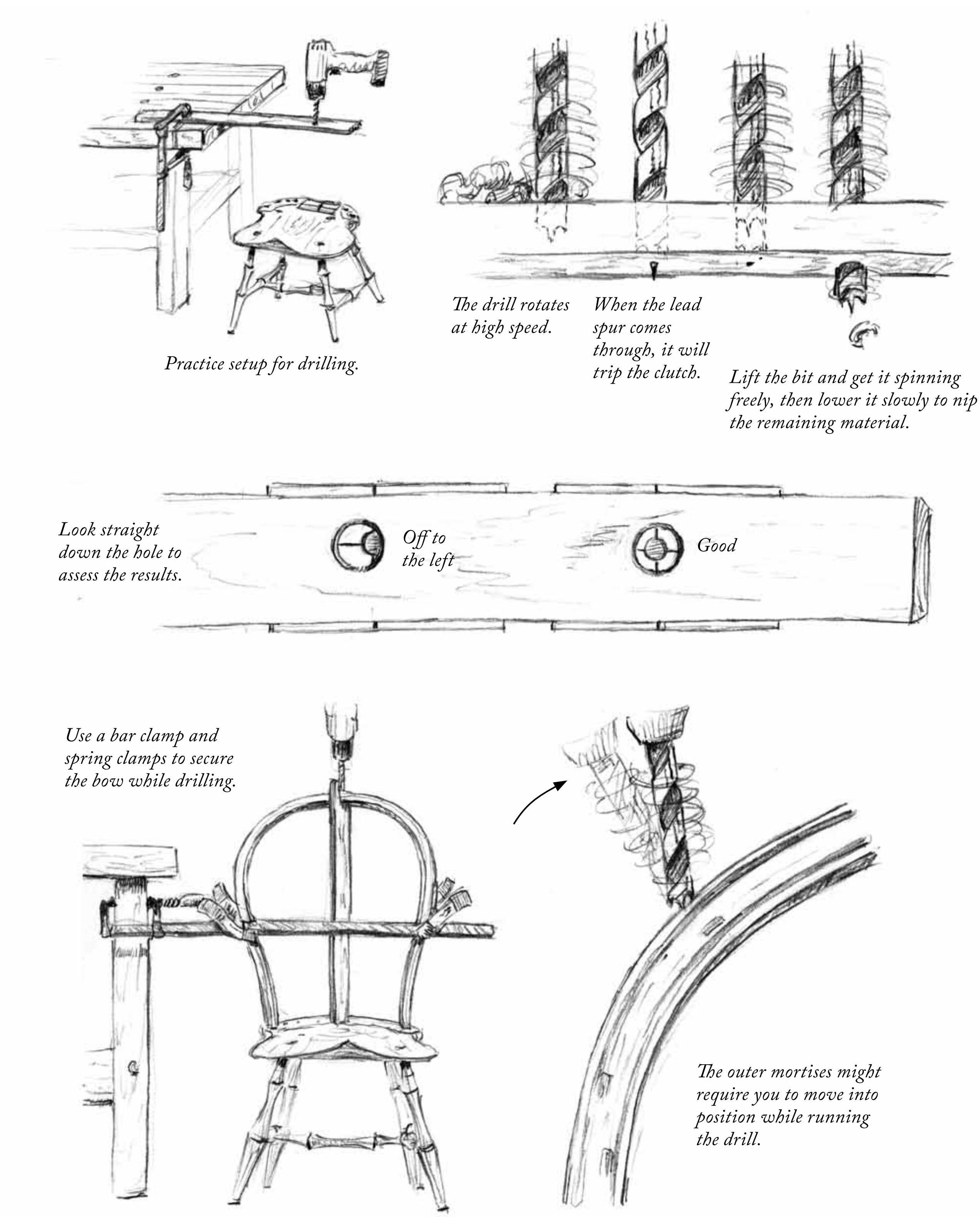



**FIG. 23.12** ***How to drill the bow.***

Once the hole is drilled, check your results. Place a piece of white paper below the hole and look down it until you can't see the sides of the hole. Then remove the paper, revealing the mortise location on the seat. If the mortise in the seat is dead center, then you nailed it. If it is off to one side of the hole, congratulations, chairs are very forgiving creatures. If it is nowhere to be seen, you should try another run at the practice drilling and see if you can fix the issue. Once you are confident, stabilize the bow as shown and drill the mortises in the actual bow.

When drilling the outer spindles, to prevent the nickers from catching you might find that you need to start the drill bit somewhat perpendicular to the surface and shift it into position while it's spinning.

## STEP 7. Assign the Spindles to a Mortise

The processes that involve sizing and shaping the spindles should only be performed after the spindles are fully dried and fresh from the kiln.

Once the bow is drilled and in position, I measure the length of my center spindle from the top of the mortise in the spindle deck to the mortise on the underside of the bow, as well as where it exits the top of the bow. I keep a ¼" dowel on hand for this. Later, I will shave the center spindle to create a shoulder at the point under the bow. This keeps the bow from lowering on the spindle in years to come. When transferring these measurements to the center spindle, be sure to add 1" to account for the depth that the spindle goes into the mortise in the seat.

It's not a bad idea to shoulder all of the spindles if you are so inclined. Driving a small pin, usually a bamboo skewer, can also help permanently set the position of the spindles in the bow.

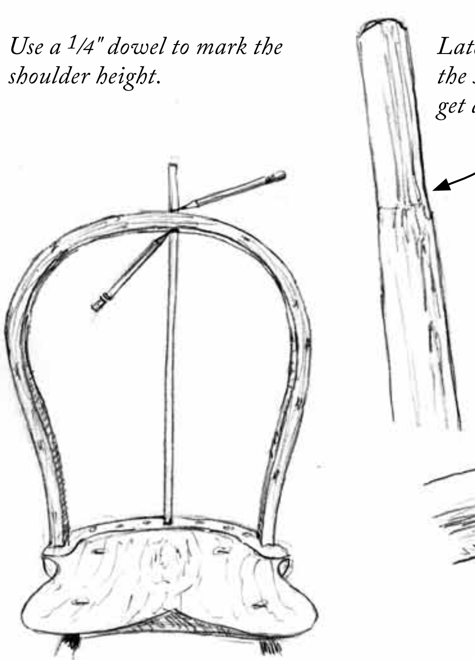
This chair has a good amount of flex in the back, which won't threaten the spindles with breaking, but does put a lot of pressure on the tenons to shift in the bow.

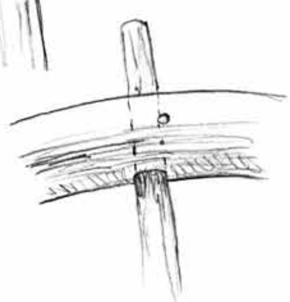
Measure the overall length of all of the spindles. I like to cut and chamfer them so they will have about ⅜" sticking out the top of the bow, which is enough to split with a chisel for wedging but not so much that the wedges can cause the sides to shear at the mortise from too much deflection. I leave the center spindle a bit longer so that I can have an easy start to assembly.

Before I dry-fit the spindles, I use a chainsaw file to oval the top of the mortises in the bow. This, along with the shoulder that I shave on the spindle(s), will form a mechanical lock so that the bow cannot raise or lower.

## STEP 8. Cut the Spindles to Length

While in the kiln, the spindles have shrunk out of their perfect octagonal cross section. I like to dry them as octagons because it makes it easier to see and correct the



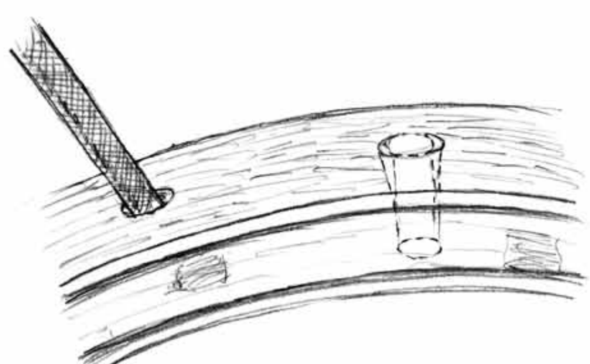




**FIG. 23.13** ***Determine the spindle length.***

distortion, and to size the ends. I arrange the spindles so that the ones with the longest swellings are toward the center. This results in a nice visual element where the swellings will echo the curve of the bow. I always take joy in the way that a lack of consistency in shaving spindles can be used so effectively to add to the aesthetics. I can further reinforce this effect by intentionally shaving more material from swellings.

Once I decide on its position in the chair and I note where each spindle intersects the bow, I cut them to length and number them 1 through 7, from left to right.

One of my favorite techniques is to use tenon cutters

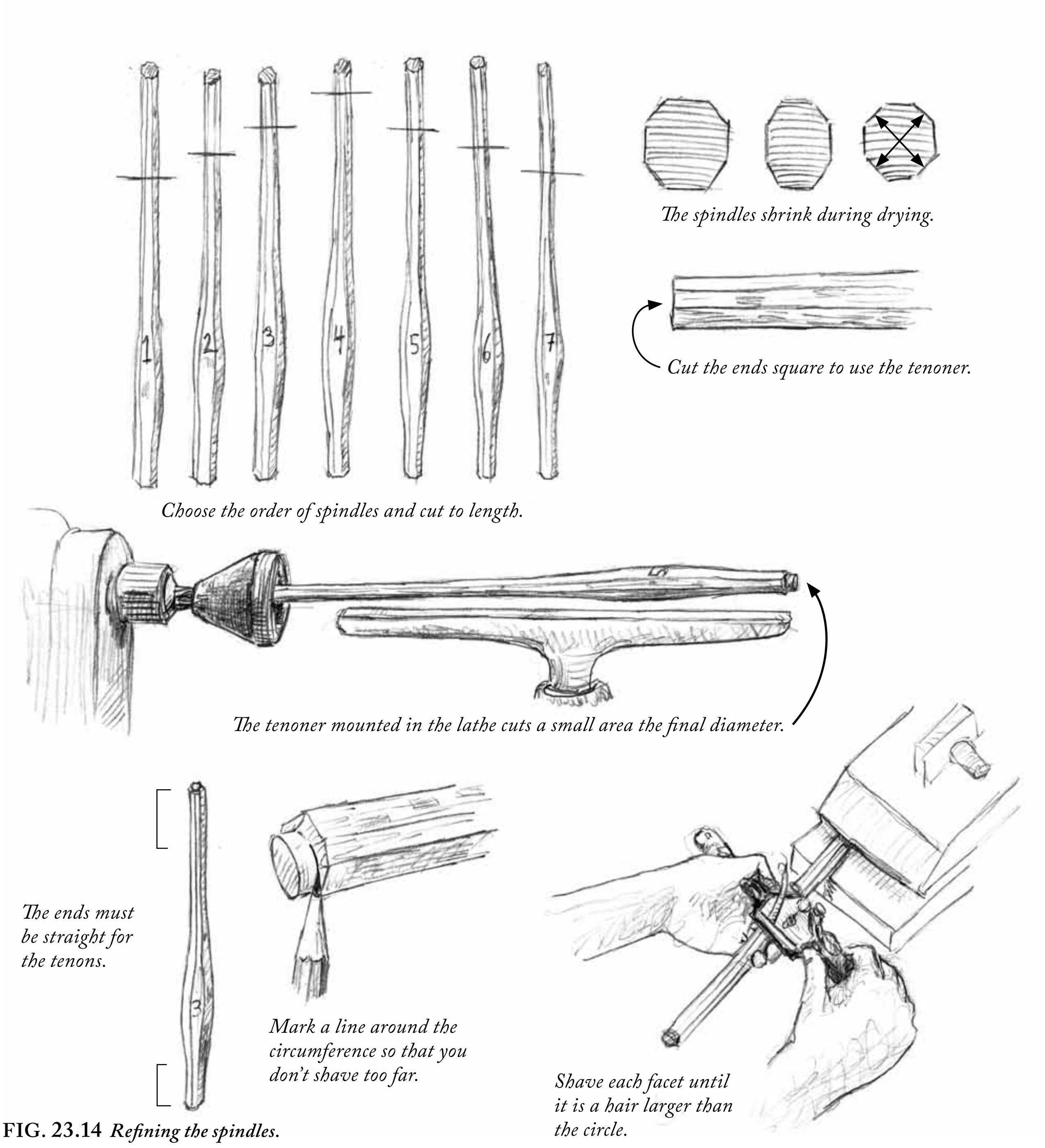



**FIG. 23.14** ***Refining the spindles.***

to cut a 1⁄8"-long round on the ends of my spindles so that I can see the final size I am heading for as I work. I've also found this to be very helpful for students. For this chair, I use a 1⁄2" cutter for the bottom and a 3⁄8" cutter for the top. I do this in my lathe with a Jacobs chuck, but you could do it with a hand-held drill as well. First, make sure that the cuts on the ends are square, or the rounds will not be centered on the end of the spindle. Don't try to cut the whole tenon with the cutters because there is no way to consistently align them with the axis of the spindle.

With the small rounds cut on the ends of the tenons, shave the octagon down, almost even to the round portion on either end. Be sure to maintain and refine the octagon as you shave the facets. Rounding the spindle at this point slows the process too much to be effective.

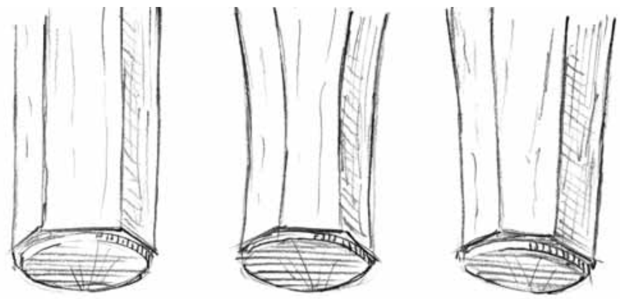
Take extra care to leave the last 1¼" of the top and bottom straight for the tenons. I leave the facets oversized about the thickness of a pencil line, which will come down later. Be sure to always cut from the thick areas of the spindle toward the thin.

If you don't use the cutters, you can use a ruler to measure across the octagon at the ends and keep trimming until they are 1⁄32" oversized.

Once I have shaved the spindles as octagons to a pleasing shape and the correct size, I round them down. I do this in an orderly way: Starting with the bottom end of the spindle, I shave successive strokes from one of the corners to form a new facet, then I tilt the spokeshave a bit to the left or right to knock the corners off the new facet. Then I rotate the spindle and do the next corner until my eight original corners are broken. Then I flip the spindle end for end and repeat the process on the top. This will leave the spindle nearly round, with some lovely little facets that can be seen from up close.

I pick up a consistent rhythm for this process, usually taking three or four strokes along the thicker areas of the spindle then following the strokes out to the end for a couple of strokes and then taking one pass on each corner of the new facet. I find that counting the strokes makes the job fast and consistent.

I use a grip on the spokeshave that I find helpful in supporting and moving the spindle, skewing the tool and getting feedback on the surface quality. I hold three fingers of my non-dominant hand under the spindle and hook my thumbs over the handle of the spokeshave. I hold the spokeshave in my dominant hand at a leading skew. This is especially helpful on long, thin spindles.



*The spindle ends should be straight.* *Not hollowed* *Not tapered*

**FIG. 23.15** ***The proper shape of the tenon ends.***

Once the spindle is round, I refine the tenons using a block of wood with slightly oversized holes in it for the tenons on the bottom and top. A little pencil lead in the holes of the test block can help reveal any high spots that hold up the fit. The key to this process is understanding the relationship between the holes in the test block and the holes in the chair parts.

The tenons on the bottom will go in one at a time into a soft pine seat that has some give and the softwood usually forms larger mortises, so I like these to be quite tight in my test block. Also, because each bottom tenon is glued in the seat independently, the fit can be quite snug.

On the other hand, the tops of the spindles must fit through the bow all at once, so the tenons must slide straight through the test holes without squeaking, but also without rattling around. Be sure to stop at the shoulder line for the center spindle when fitting to the test block. After fitting to the test holes, it should only take a few strokes to get the fit to the actual mortises. It's easy to rush past this process in a fit to see the chair assembled, but the appearance and durability of the chair will benefit greatly from a little extra care.

A couple of extra steps can yield bamboo-styled spindles. For more details on bamboo-style spindles see the Uppercarriage Assembly: Fan-back chapter.

I like to keep the spindles sitting on the chair seat next to my shavehorse and fit them to their mortises one by one.

I slip the bow into position and fit each of the spindles to the mortises, slipping them in through the top. I call this the "peacock chair" because I end up with all the

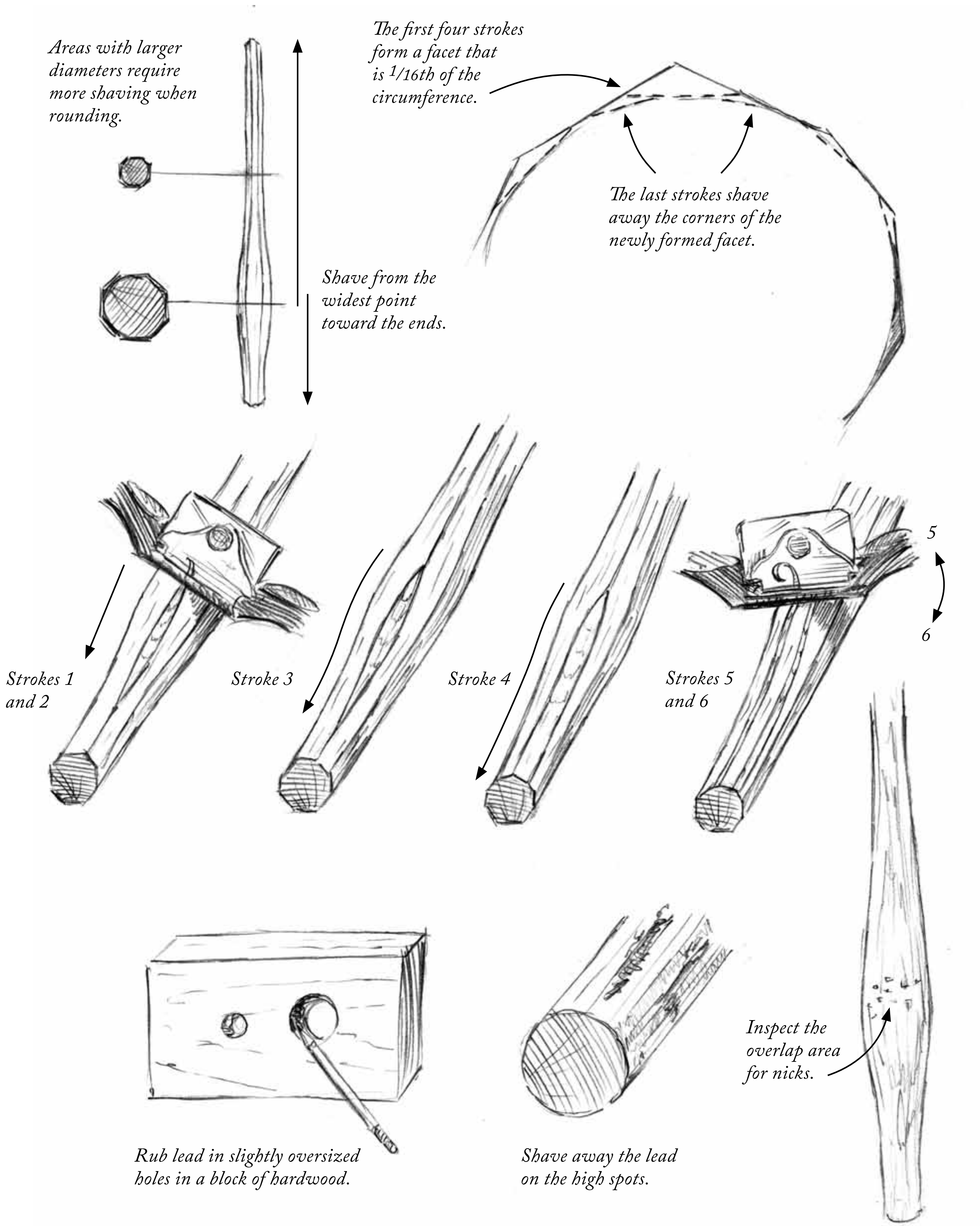



**FIG. 23.16** ***How to round the spindles.***

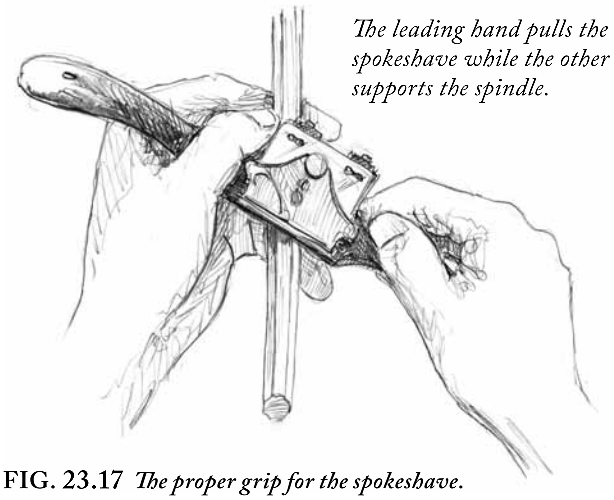



**FIG. 23.17** ***The proper grip for the spokeshave.***

spindles sticking up in the air like a fan tail. This way, I know for sure that each spindle fits its intended home, and I don't have to chase my tail figuring out which is the tight one during a test-fitting.

Next, I fit the bottom tenons in the seat. This is a good time to rotate the spindles in their seat mortises to find their best orientation. There are two priorities to guide you. If you are concerned with coordinating the seasonal movement of the joints in the seat or in the bow, you can rotate the spindles until their tangential planes are parallel to the end grain in the mortises of one or the other. Another factor that might guide you, seeing that the orientation can only be right on the bow or the seat (but not

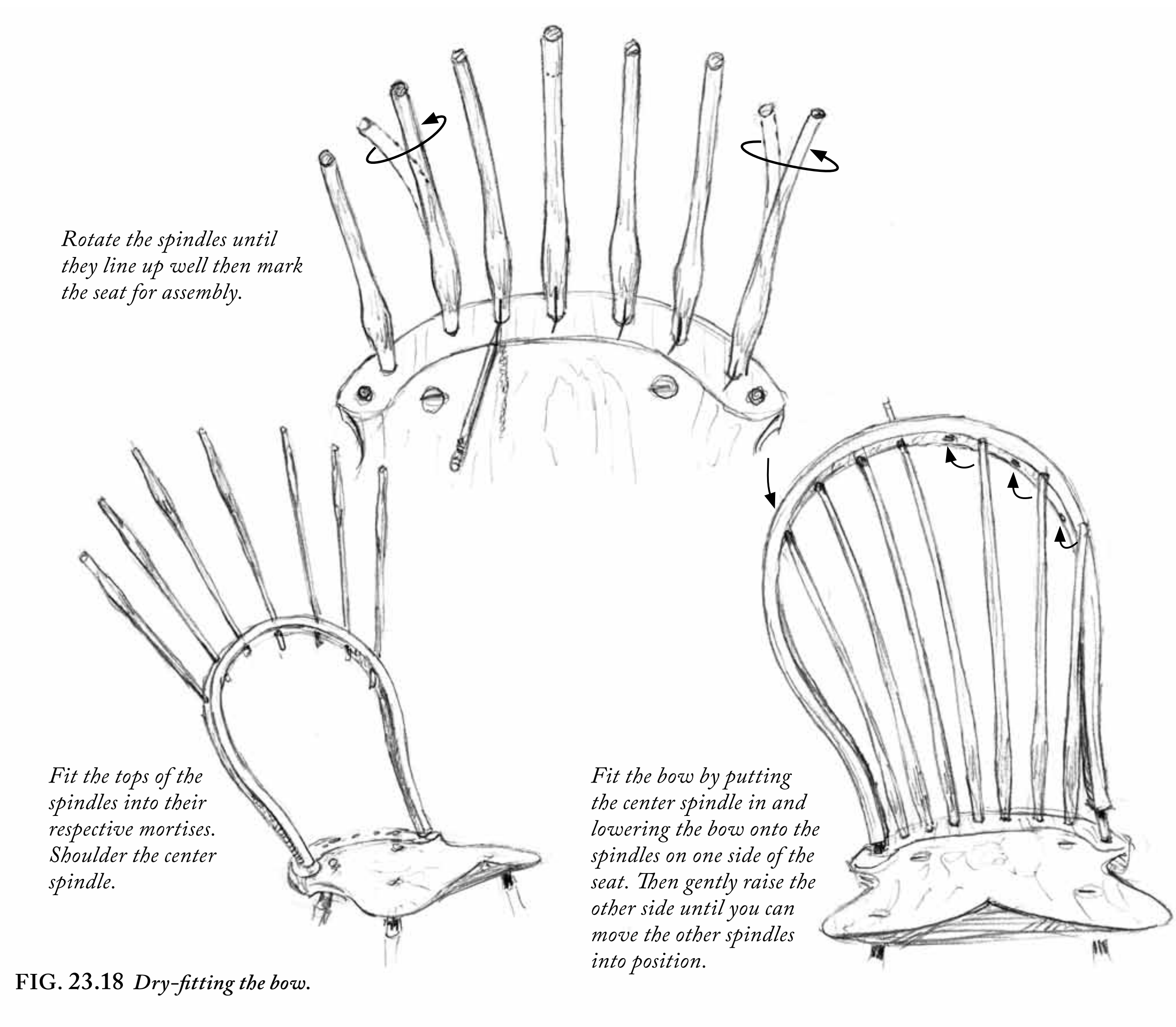



**FIG. 23.18** ***Dry-fitting the bow.***

both because their grain goes opposite directions), is to orient the spindles based on reducing the impact that any natural warp might have.

I usually correct or align to accommodate the natural warp of the spindles. It is quite simple to straighten out the spindles with a heat gun and some pressure, but more often than not, I find the restraint of the bow and a little helpful orientation can tame the warp.

Either way you decide to go, make a small mark on both the seat and the spindles to help reorient them during glue-up. I avoid inserting the tenons in the seat multiple times because this tends to compress the soft pine and loosen the fit of the joints. If the joints loosen due to compression during fitting, steam or water can be used to restore them before final assembly.

## STEP 9. DRY-FIT THE TOP

Assembling the top doesn't have to be harrowing. Of course, preparation is the key, so I complete a successful dry-fit of the top. Putting the spindles in their respective holes in the seat is simple enough, but getting all of the spindles through the bow while seating the bow into the seat can be tricky.

Usually, folks try to get all the spindles to fit at once, but I've found it is easier to start the center spindle and all of the spindles on one side. Then the other side can be tapped upward and lowered onto the other spindles one by one.

Extra care should be taken not to stress the bow too much because the open mortises weaken it until assembly is complete. Tap the bow to the correct height with a dead-blow mallet and check the angle of the center spindle. If the angle is too far forward, tap the bow farther down on the spindles until it reaches 8° or 9°. Check the bow again for twist and against the rotation alignment marks made on the seat. Often, the bow can be corrected by twisting the tenons or by knocking the bow farther down the spindles on one side. Once the bow is straight and the angles are correct, mark the bottom and top of the spindles to locate where the glue will be applied.

## STEP 10. MARK SPINDLE LOCATION ON THE BOW

Disassembly should proceed as carefully as assembly. Light upward taps with a dead-blow mallet will lift the bow off the chair. Any spindles that get stuck and pulled out of the seat should be shaved more.

I cut kerfs with a saw in the ends of the bow about two-thirds of the way to the shoulder. The kerfs are parallel to the front of the bow so that when the wedge splits them, they will put pressure against the end grain of the mortises. The other orientation will split the seat. The spindles will be split with a chisel after they are glued.

## STEP 11. GLUE SPINDLES TO THE SEAT

I begin by gluing the spindles in their respective mortises in the seat. I clean up the glue squeeze-out after a few spindles. It's important to either let the hide glue set to a gummy consistency then pick it out or use a brush to remove the glue while it is wet. Take care not to flood the glue with water, which will dilute the glue and spread it around. This layer of glue seems harmless, but it can resist the adhesion of the milk paint, or cause unpainted wood to oxidize and change color unevenly.

## STEP 12. GLUE & MOUNT THE BOW

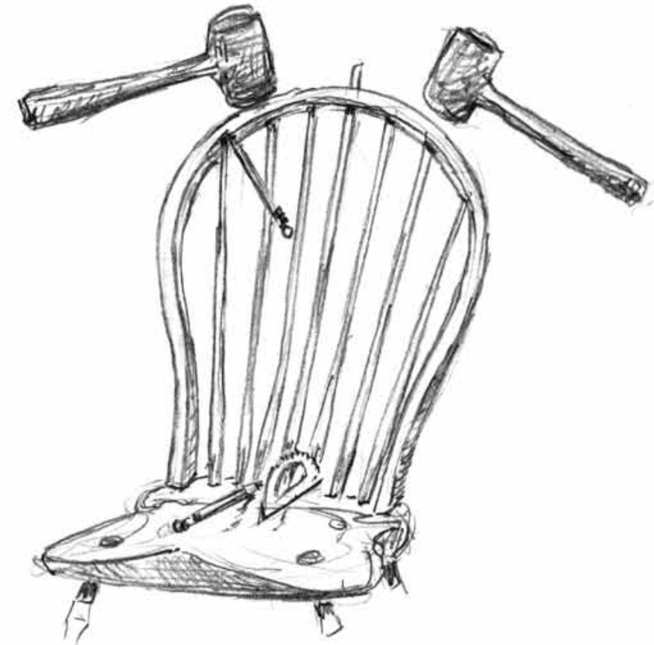
Before starting the bow-assembly process, I make enough wedges for the bow ends and the spindles. I like to split my wedges from a piece of dry, straight oak or maple. I first split out a section to the desired width of the wedge then split off 1⁄8" blanks that I then shave to the proper taper. I make my wedges about 1⁄32" wider than the mortise to bite into the side of the mortise and prevent twisting. Leave the end sharp, but ever so slightly blunt so that it will find its way into the kerf.

Once the spindles are all set in the seat, I apply a thin layer of liquid hide glue to the tenons on the bow, the tops of the spindles and the mortises on the bow. Then I follow the same sequence as the dry-fit.

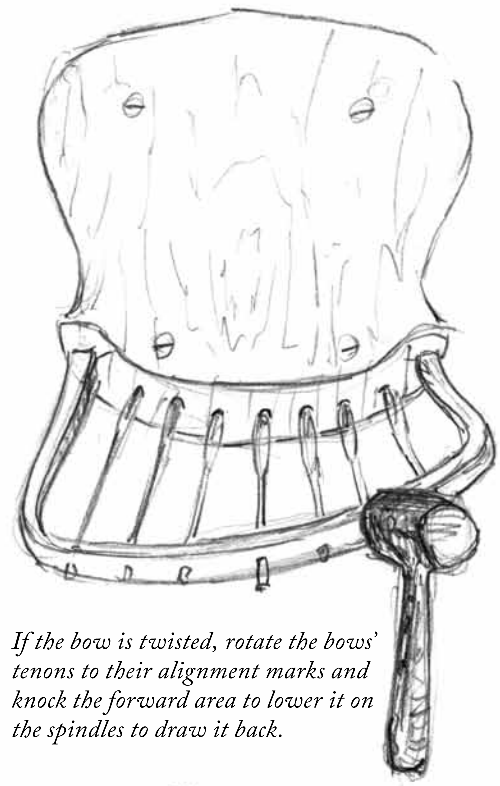
Once all the tenons are in place, I use the dead-blow mallet to seat fully the bow. Then I realign the marks at the angled shoulder and check for a twist in the bow. If it is twisted, I put my knee on the seat and try to correct it. If the bow is still twisted, I strike the side of the bow that is too far forward with the dead-blow mallet to draw it back.

## STEP 13. SPLIT & WEDGE SPINDLES

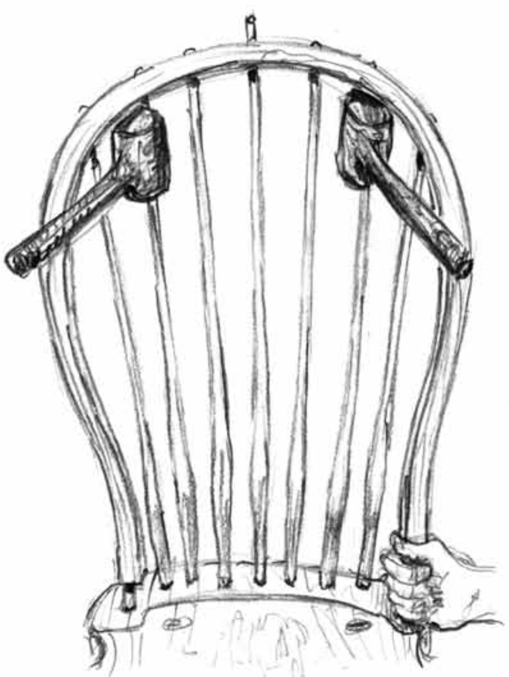
Once the bow is straight, I turn the chair over and drive the wedges into the ends of the bow's tenons. I put glue on one side of the wedge only. This allows for a "plane of failure." When the seasonal movement causes the tenon to shrink, a harmless gap will open along the wedge, rather than breaking the bond of the tenon with the mortise.



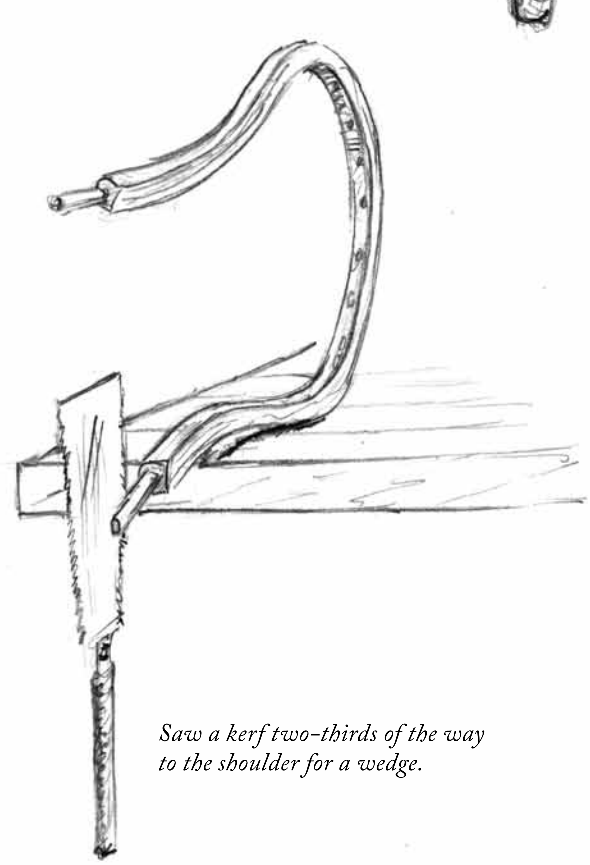
*Tap the bow on evenly. Once in position, mark the spindles to note where to put glue and check the angle of the center spindle.*



*If the bow is twisted, rotate the bows' tenons to their alignment marks and knock the forward area to lower it on the spindles to draw it back.*



*Remove the bow by knocking it upward evenly. Push your hand against the seat while gripping the bow to unseat the tenons.*



*Saw a kerf two-thirds of the way to the shoulder for a wedge.*

**FIG. 23.19** ***Dry-fitting the balloon-back.***

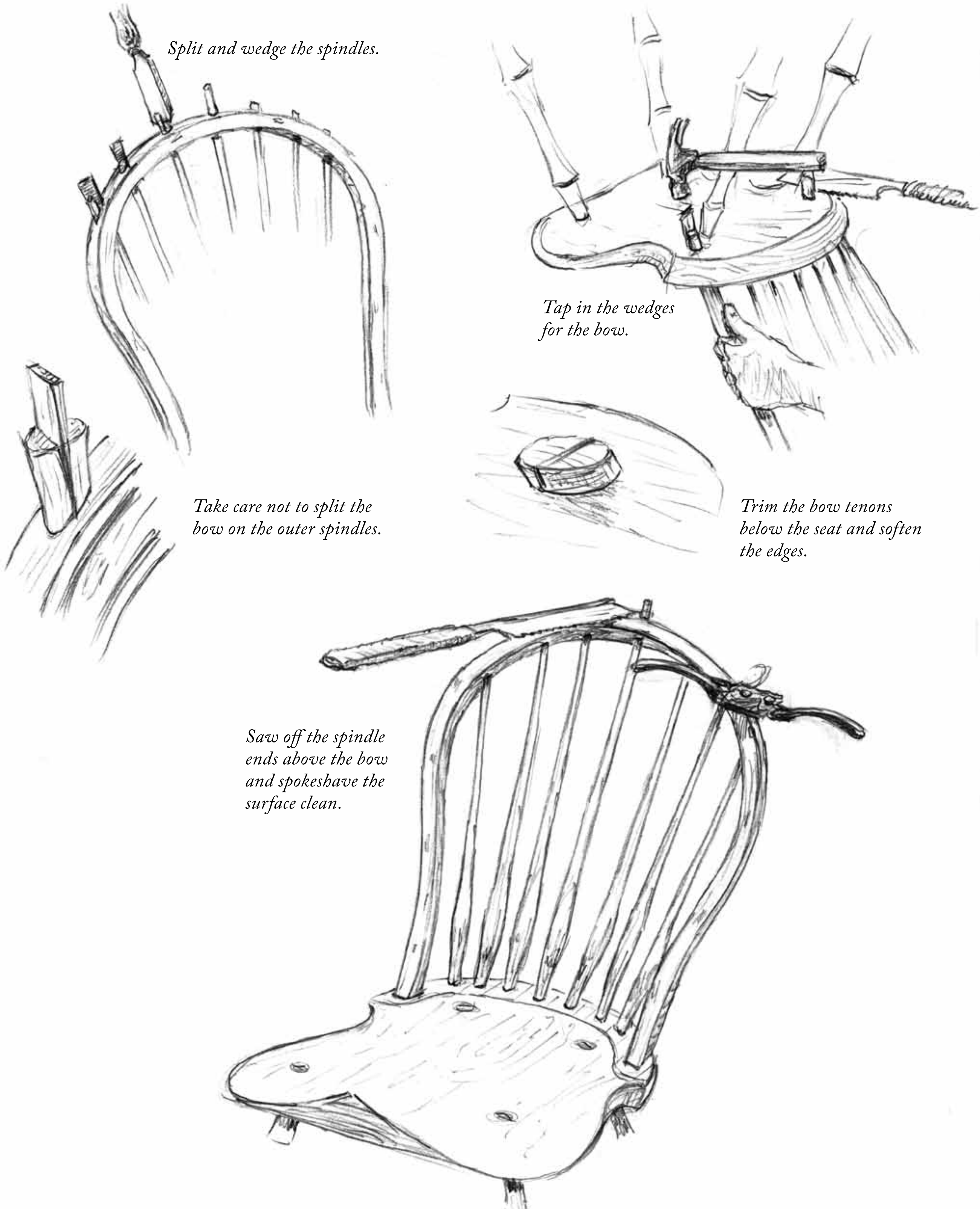


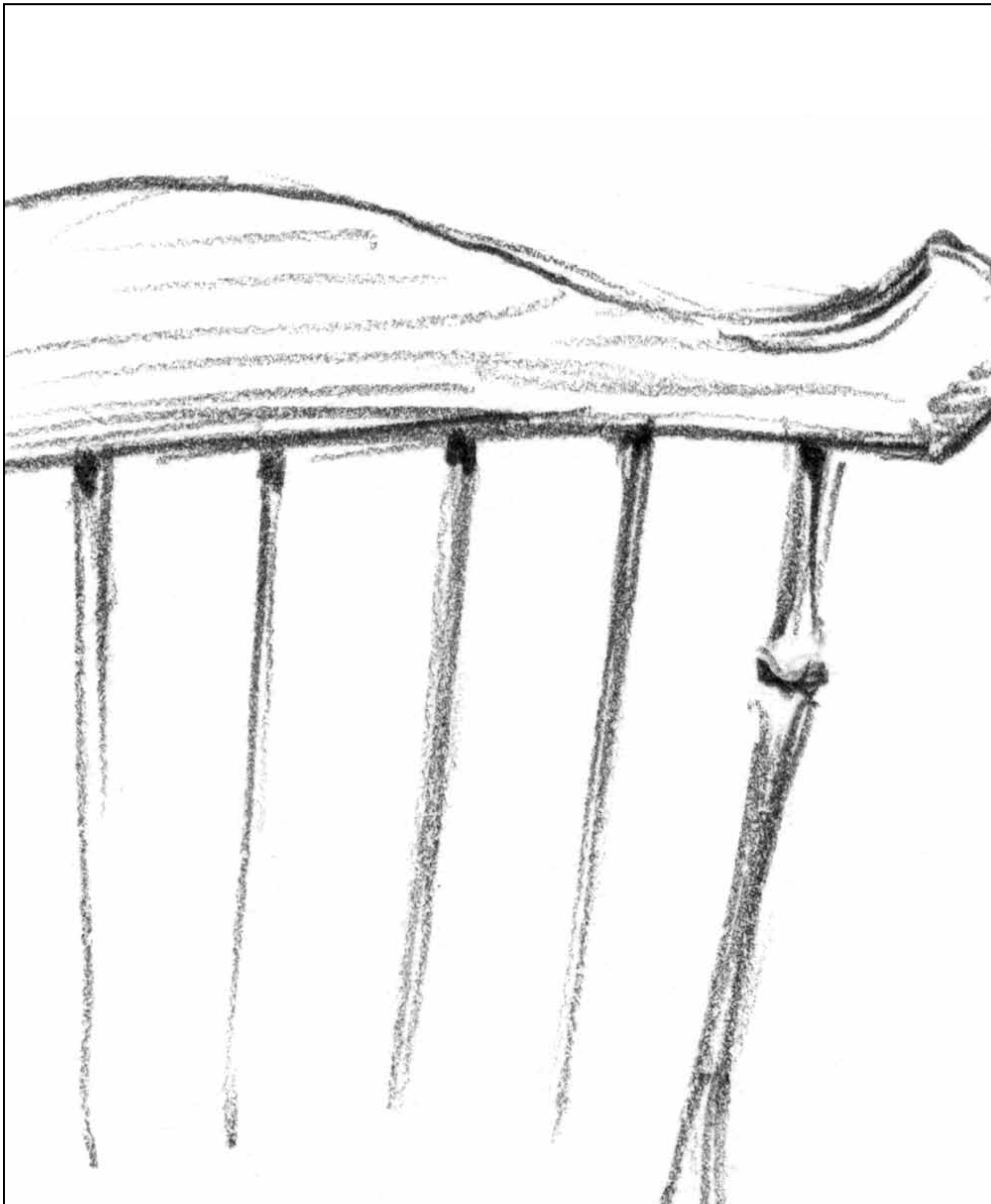

**FIG. 23.20** ***Gluing, wedging and trimming the spindles.***

To wedge the spindles, I tap the end of a chisel into the end grain to open a split. Then I start in the middle, put glue on one side of the wedge and drive each one home until I hear a dull thud. Care must be taken when wedging the outer spindles because the bow can split out on the weak side of the angled mortises.

## STEP 14. Trim the Tenons

I clean up the glue and let it dry overnight before trimming the tenons and shaving the bow smooth on top. I also trim the ends of the bow under the seat so that they poke out about 1⁄4". Then I use a knife to break the sharp edges.

This completes the assembly of the bow-back side chair. There is a great deal of information to take in to achieve this piece, but you will find that the skills and processes are applicable to just about every other Windsor form. Other chairs might seem more complex, but they mostly just add a few extra details. The heart of the craft can be found in this chair, and I'm sure that after putting one together you will have a newfound respect and appreciation for this "simple" chair.



# 24

# Uppercarriage Assembly: Fan-back

The fan-back requires a different set of skills to drill and assemble than the balloon-back. With the balloon-back, there is a lot of drilling done with the bow in place; the fan-back, however, requires that you take measurements, make some reference marks, then do the drilling away from the chair. The actual drilling is assisted by mirrors and bevel squares.

My preference for having a crest with a large radius curve requires a little extra effort to drill, but I think the added comfort is worth it. The difference between the curve at the back of the seat and the curve of the crest causes the spindles and posts to enter the crest with varying rakes, which might be difficult to conceive, but is actually simple to drill.

Before starting the marking and joinery, clean up the crest with a spokeshave, scraper and drawknife. It's likely that the part has changed shape during the bending and drying process and that you will want to refine things. It's important to leave a small flat at the top of the crest for knocking the crest onto the chair. You can thin the top edge once the top is assembled. After the final shaping in the chair, sand any scraped areas to #220 grit.

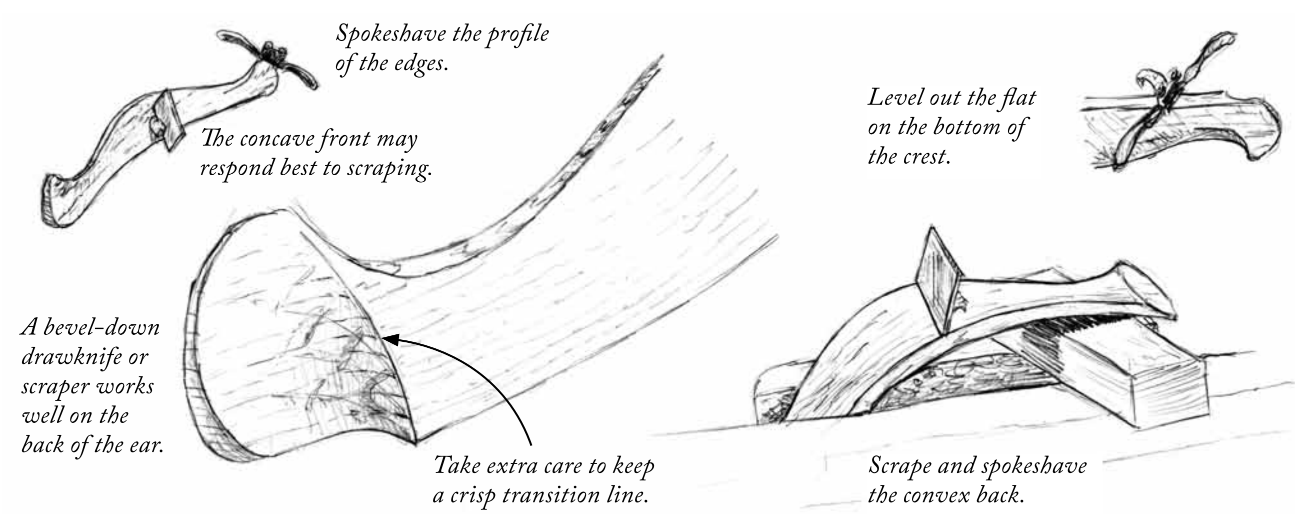



**FIG. 24.1** ***Finishing the crest.***

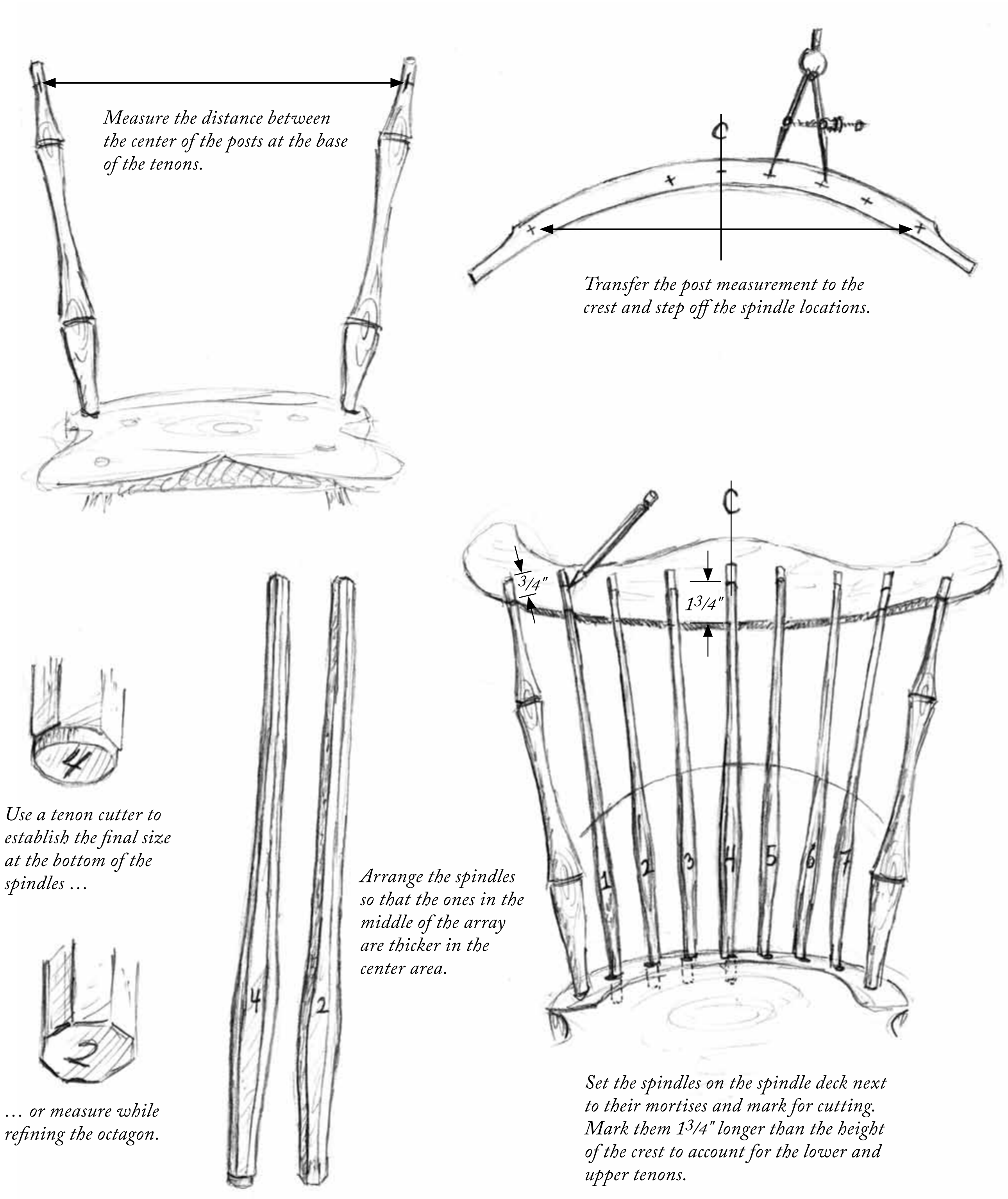



**FIG. 24.2** *Crest layout.*

### STEP 1. TRANSFER MEASUREMENTS FROM THE POST TENONS TO THE CREST

While perfectly reamed posts will always end up in the same positions and be a known distance apart at the top, I find it more practical to measure the actual results by measuring from one tenon to the other. This is another example of building to the chair, not to the drawing. While it is important and helpful that the results of the reaming are close to expectations, the drilling locations and angles will be the result of information gathered from the actual chair.

I begin by placing the posts in their respective holes and correct their alignment. Remember that the tangential plane (where you see the growth-ring circles) should be facing the front of the seat. I measure the distance from the center of one post to the center of the other at the baseline of the tenons that I marked when the post was on the lathe. The posts are flexible and can be pulled apart a little to increase the distance or to make the distance consistent from one spindle to another.

Then I mark the distance on the crest as shown, checking to make sure that the mortise locations are equidistant from the center mark. These mortises must not be located too far into the area where the thickness of the crest diminishes for the ears.

### STEP 2. STEP OFF THE SPACING OF THE SPINDLES

Using dividers, step off the spindle locations with eight equal spaces from one crest to the other. This should be about 2³⁄8" per space. Mark each mortise location halfway from front to back. Then use spring clamps to secure the crest to the front of the posts.

### STEP 3. MARK THE SPINDLE HEIGHT

I refine the shape of the spindles as octagons to get closer to the final size of the lower tenon and to even up their shapes before assigning an order and rounding them. I use the 1⁄2" tenon cutter to make a small round at the bottom of the spindle to guide me, which is covered in detail in the chapter Uppercarriage Assembly: Balloon-back. It is vital that the last 1¼" of the spindle, which will be the tenon, is straight. I don't size the top tenon yet because the spindles are not cut to final length. When they are, they'll be oversized because they are cut farther down the taper.

Select the order of the spindles by placing the ones with larger swellings in the center of the array. The swellings of the spindles form a subtle arc. You can shave more to accentuate or subdue this effect once the order is established.

Set the spindles next to their mortises on the top of the spindle deck and lean them against the front of the crest at their mortise location. Make a tick mark where they touch the bottom of the crest. Then measure 1³⁄4" above that tick and make a mark all the way around the spindle; this is where you will cut it to length. The extra 1³⁄4" accounts for the 1" mortise into the seat and the ³⁄4" mortise into the crest. Drawing the cutoff mark all the way around is insurance against cutting at the first tick mark.

### STEP 4. CROSSCUT & FINISH THE SPINDLES

Cut the spindles to length and follow the same process for sizing the tenons and rounding the spindles found in the Uppercarriage Assembly: Balloon-back chapter. The mortises in the crest are blind. These tenons won't get wedged and should fit snugly when pushed straight into their mortises.

If you are echoing the bamboo turnings, the swellings can be thinner and you can carve a notch into each spindle to echo the V-notches in the carvings. The arc of the V-notches on the spindles should align with the lower V-notch on the post turnings. I use the edge of a half-round file to carve the notches.

### STEP 5. MARK ANGLES IN THE CREST

Place the finished spindles in their respective mortises in the seat about 1⁄4" in and up against the front of the crest where its mortise is located. Mark around the spindles and posts on the front of the crest.

### STEP 6. PUT THE CREST UPSIDE DOWN & DRILL

Now all the information you need to gather is on the crest. To drill it, set it upside down on the workbench as shown. Keep it parallel to the edge using the laminations of the benchtop or a line drawn parallel to the edge. The "ears" will need to be shimmed until the height of the bottom is a constant distance off the bench as shown and the angle at the middle of the crest is similar for the front and back.

Clamping the crest to the bench takes a little coordination. Place a clamp lightly between the spindle locations on one side while holding the other side of the crest down, then place another on the opposite side. Tighten them enough to hold the crest firmly, but not enough to distort it.

To drill the crest, you need the rake and splay of each mortise. The splay is already drawn on the front of the crest. The rake for the post is roughly parallel to the front of the crest and the rake of the center spindle is roughly parallel to the back of the crest. The other spindles vary from raking forward to back.

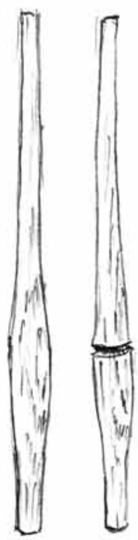
To drill, set a bevel square in front of the crest and parallel to the edge of the bench with a mirror behind it. Set another mirror and bevel square on the perpendicular to the edge of the bench next to the crest. It's wise to put some tape over the post holes before you start drilling with a note to switch bits to 7/16".

I start in the middle of the crest by drilling the center spindle (#4), which has no splay and leans back 2°. Place tape on a 3/8" bit to stop at 3/4" deep.

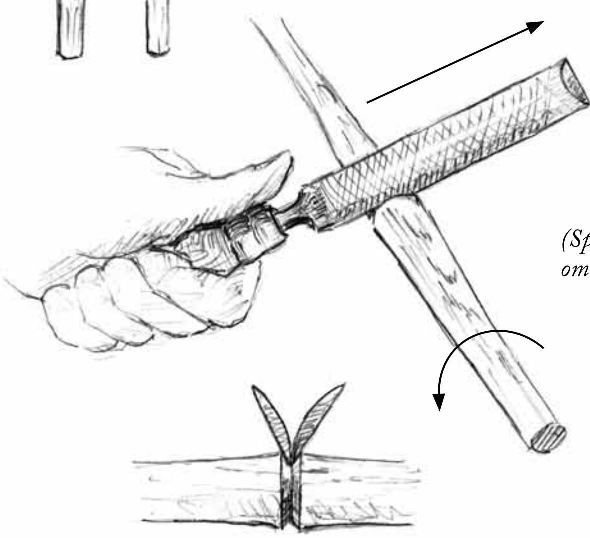
The rest of the mortises splay according to the marks on the front of the crest. The spindles alongside the center spindle (#3 and #5) lean back 1°. Use the mirror to align the bevel square with the line on the front of the crest for this (and the rest of the spindles and posts) to get the proper splay.

Spindles #2 and #6 have no rake, only splay, so set the bevel gauge to 90° for the rake, and again follow the marks on the front of the crest for the splay.

Spindles #1 and #7 lean forward 2°, and the post holes, drilled at 7/16", lean forward 4°. All the rake angles were derived when designing the chair by drilling the post mortises in the crest parallel to the front face of the crest. Then I placed the crest on the posts and used string and tape to make stand-ins for the spindles and measured the angles.

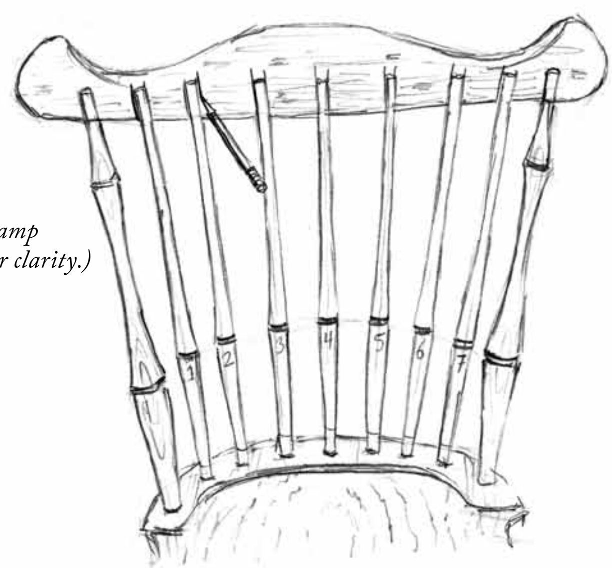


*Regular-shaped spindles can be transformed into bamboo style.*



*Use a half-round file to cut the V-notch.*

*(Spring clamp omitted for clarity.)*




*Place the spindles partially in their mortises and mark their splay by drawing a line around them on the front of the crest.*

**FIG. 24.4** ***Finish the spindles and mark their splay.***

## STEP 7. DRY-FIT THE TOP

Dry-fit all the parts of the uppercarriage. Rotate the spindles and posts to their final positions and mark the seat for their locations and depth. The depth that the tenons drive into the seat is more important on the fan-back because of the fixed distance between the blind mortises in the seat and crest. Make a small chamfer around the tops of all the tenons to ease assembly. Mark the bottom of the posts for the wedges, perpendicular to the long fibers of the seat. Dry-fit the crest using a dead-blow mallet.

## STEP 8. CUT KERFS IN THE POSTS & GLUE THE POSTS & SPINDLES

Cut kerfs in the bottom of the posts about two-thirds of the way to the base of the tapered tenons. Glue the posts in place and wedge. I set the chair upside down on the posts to make sure that I don't drive them out of their mortises while driving the wedges. Glue all the spindles in place and clean off the excess glue.

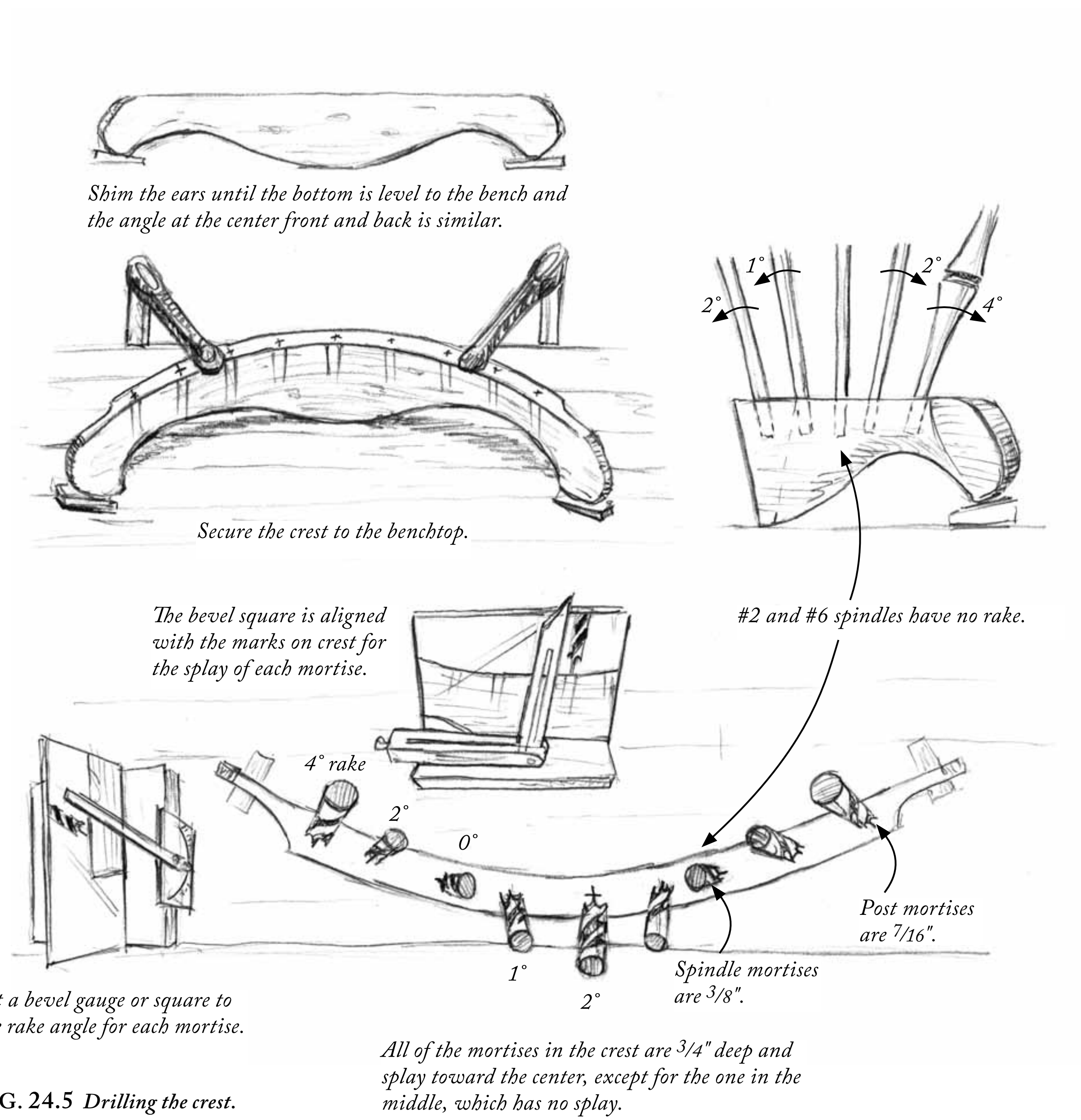



**FIG. 24.5** ***Drilling the crest.***

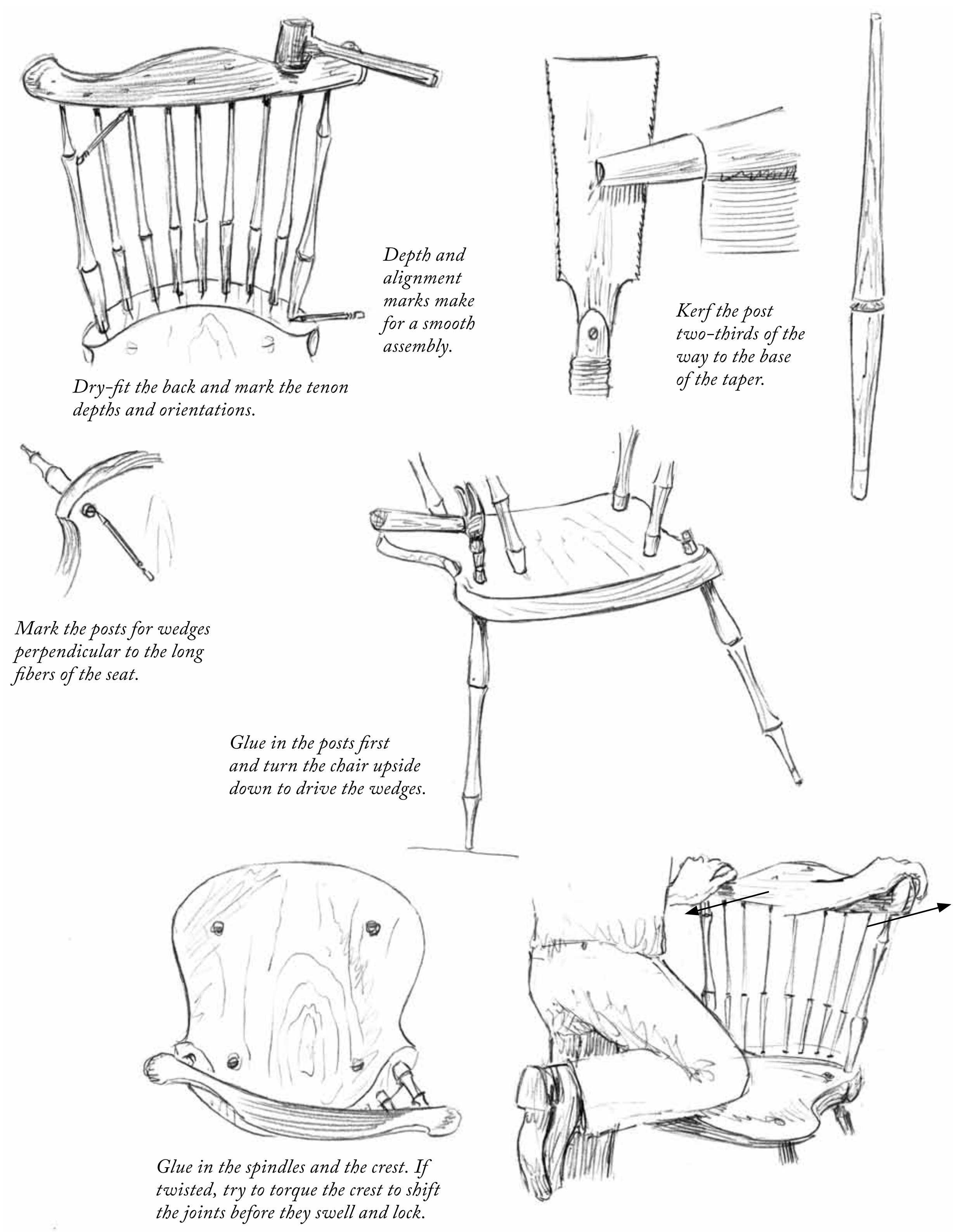



**FIG. 24.6** ***Fan-back assembly.***

## STEP 9. GLUE THE CREST

Put glue on the top of all the tenons and in the mortises of the crest then use a dead-blow mallet to seat them all. Check to make sure that the crest isn't twisted. If it is, put your knee on the seat and try to twist the back to correct the problem.

Once the top is assembled and all the excess glue is cleaned off, let the glue dry overnight. Once it's dry, use a spokeshave and scrapers to finish the top of the crest and ears to a finer taper as shown. I like to pin the posts and center spindle from the back of the crest using bamboo skewers. Simply select a drill bit that matches the diameter of the skewer, drill the hole deep enough to intersect the spindle and glue in the pins.

Once you wrap your head around spindles that rake and splay differently in all the crest mortises, you'll find that the assembly is simple. Step back and take stock of your achievement. Think back to where you started the project. You began with wood in its most basic form and applied a great deal of skill and effort to arrive at this point.

Now all that's left is to conquer finishing.

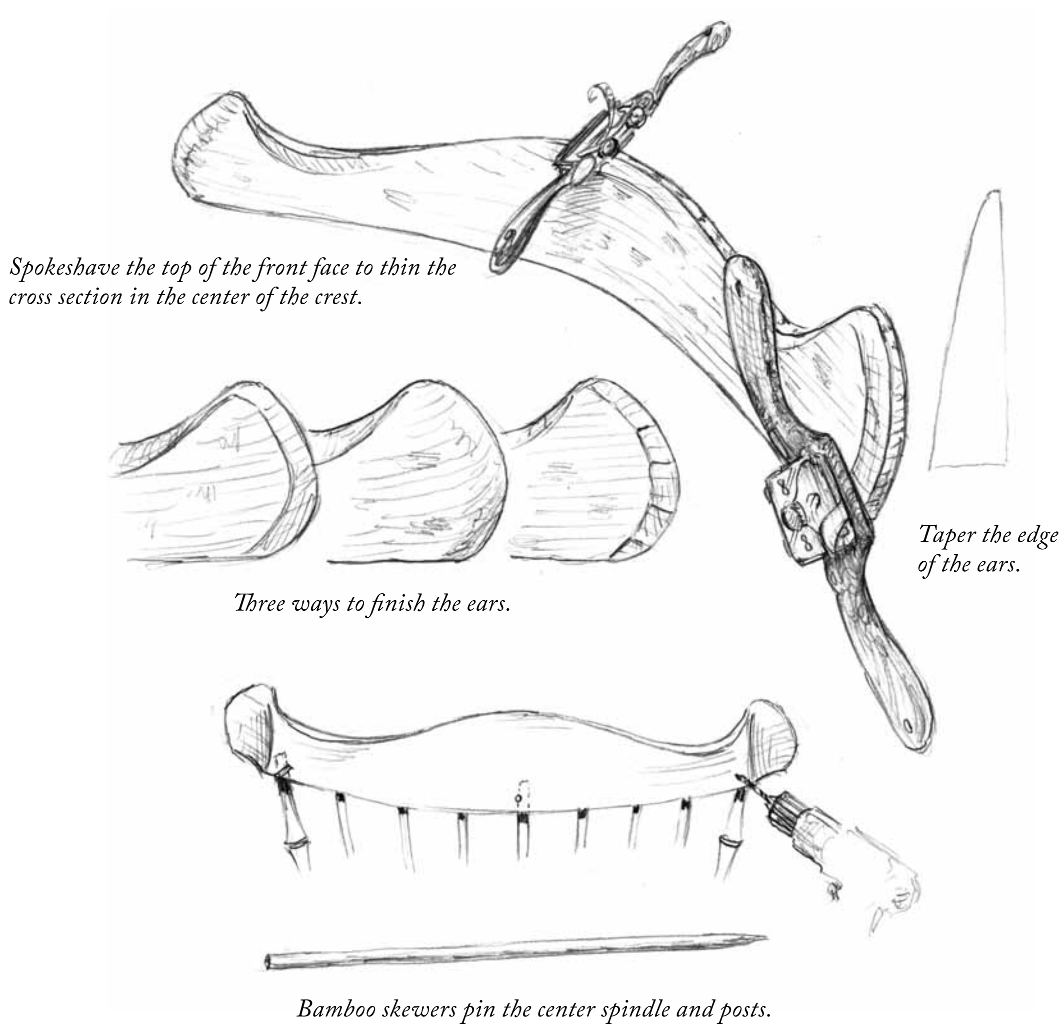
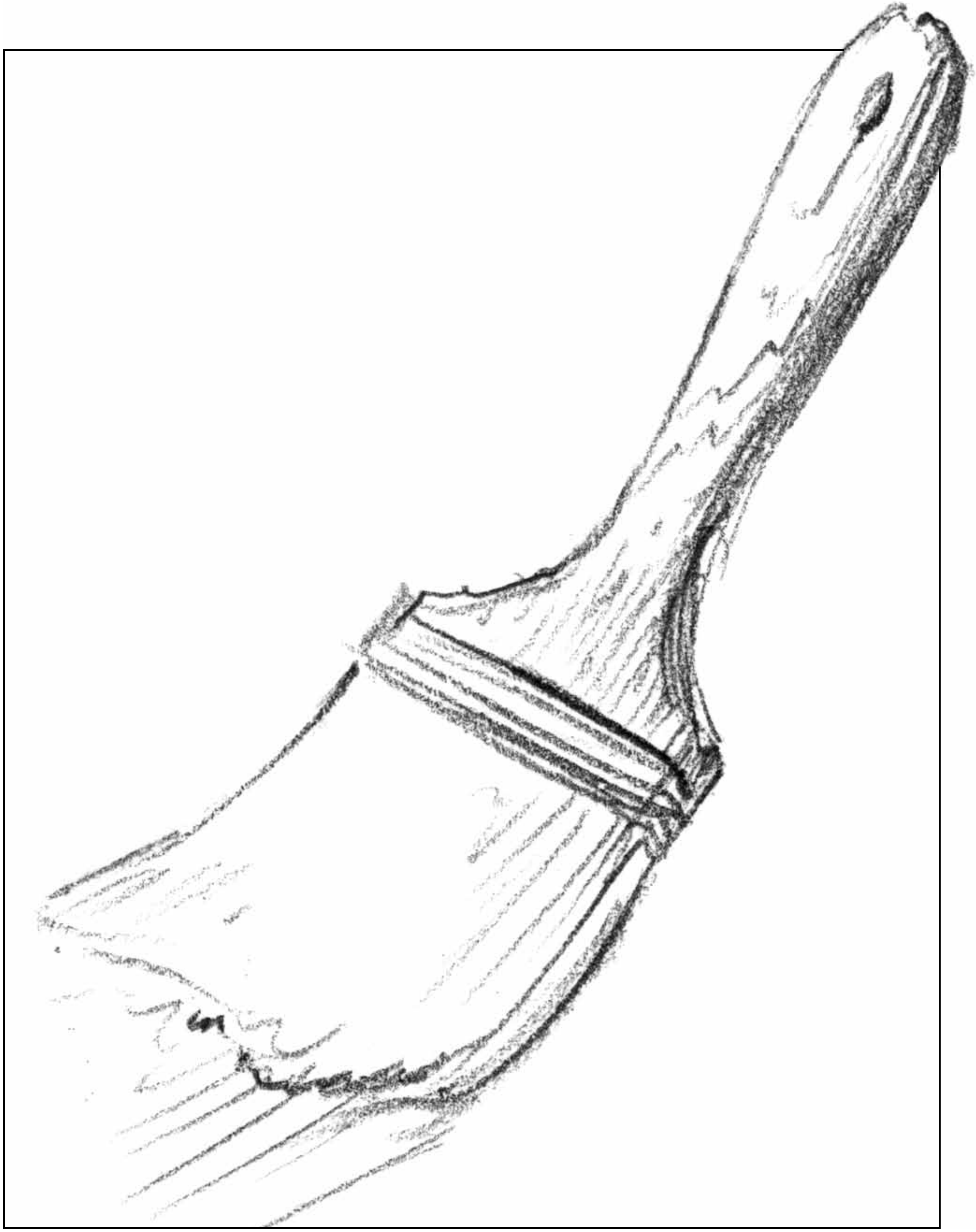



**FIG. 24.7** ***Finishing and pinning the crest.***



# 25

# Finishing

Wood finishing is an art completely separate from the craft of woodworking.

Sadly, this does not mean that all of us woodworkers who rush through the process as amatuer finishers are off the hook. The problem is that we still need to learn the craft of finishing if we are going to practice it.

Too often, flushed with the desire to see our labors complete, we hurry through the process. But the finish is the first thing viewers see. And whether we like it or not, it can elevate our work – or cruelly diminish it.

One solution is to work only with attractive woods and to use clear finishes. This imposes a design limit because certain chair forms get too visually chaotic when the wood grain is visible. The chairs that I make with clear finishes have more subtle shapes to keep from muddying or competing with the images on the surface of the wood. The finish process for these chairs is less daunting. But for the traditional chairs, which are made with woods chosen for their varying strengths rather than their beauty, a unifying finish is, in my opinion, essential.

The most common concern with painting a chair is that you will diminish its beauty by cloaking the natural surface. But in looking through history, this wasn't always the attitude; each era has a different and complex relationship with wood as a material and paint as a finish.

In the times of the original Windsors, paint and bright colors were a luxury and sign of wealth. Just as the restoration of the Sistine Chapel exposed the rich, saturated colors of the original fresco, which shocked and even offended some modern onlookers, we are accustomed to the mellowed and patinated chairs of old. So our solution is to stain or paint our chairs muted colors to

**FIG. 25.1** ***Finishing is the art of enhancing the work done at the bench.***

match our impressions of these venerated pieces. But an exploration of the real paints of old, with verdigris, lead and linseed oil, reveals a green so intense that it would make dayglo appear a subtle hue.

As paint technology advanced and cheapened, coloring furniture with paint became a means to give the masses their shot at glamor, and it was often used to hide cheap wood and inferior construction. Once paint became associated with cheap furniture, then unpainted pieces, using exotic or aesthetically pleasing woods, became the sign of wealth. Flash-forward another century and we have the reaction of the late 20th century against the influx of plastics into our world. In contrast to the uniform, artificial surface of plastic goods, all things natural and earthy were seen as beautiful. Any attempt to cover them was an affront to the material. This elevation of the wood as a material led to lots of garish wood grain becoming the central feature of the furniture, as opposed to a contributing component of the overall design.

Of course, we are all of our time, and each of us has a personal preference and bias. Initially, it was a stretch for me to paint my first chair, but after I witnessed the transformation and enhancement, I was committed to mastering the process.

**FIG. 25.2** ***The variety of woods used in the chair draw the eye in an unpainted chair, while the paint unifies the shape and accentuates the silhouette.***

**FIG. 25.3** ***The surface patterns of the raw wood can overwhelm the subtleties of the forms.***

**FIG. 25.4** ***The mixture of tooled and smooth surfaces will be enhanced by the paint.***

**FIG. 25.5** ***Complex shapes and fluid lines are highlighted by the paint.***

Paint has come a long way from the toxic lead paints of the original Windsors to the stringy enamels of the 20th century. I paint my chairs with milk paint, and while it was not the traditional finish for Windsors, it does a great job of coloring the wood without obscuring the texture. One problem with milk paint is that its manufacturers tend to describe mixing and using it in a way that creates a crude "country" finish. I don't want this for my chairs, so I mix the paint thinner than recommended and follow a multi-coat process to get the refined look I want.

When done properly, the grain and texture of the wood are clearly visible, and the desirable tool marks and edges are sharp and crisp. Not only is the warmth and depth of the wood present, but it is deepened. Over time, normal use will wear the paint, exposing the edges of the chair and highlighting the shaping. The overall effect is far more striking than one dominated solely by the surfaces and colors of the wood.

Before launching into surface and paint preparation, I feel compelled to talk about samples. Committing to

**FIG. 25.6** *Wetting scraped and sanded areas raises the compressed fibers.*

**FIG. 25.7** *Check every joint for glue residue, especially in the highly visible areas.*

**FIG. 25.8** *The tooled surfaces under the seat are a joy to discover and explore, plus, they are ready for finishing.*

**FIG. 25.9** *Most surfaces on the oak can be finished with spokeshaves, leaving an inviting faceted surface, ready to finish.*

making sample boards might just be the toughest lesson in all of woodworking. But until you have a sample – and I mean a completed sample – that you are pleased with, it is more than likely that you will be disappointed in the results on the actual piece.

When working with a new finish, I make samples on the various woods and surface preparations of my piece. I observe all the normal drying times, steps and layers. Lots of notes will help you remember the steps and measurements. Once I love the results, it's time to work on the actual piece.

## Surface Preparation

Surface preparation is vital to getting good results. Any surface that was shaved with a sharp blade, such as a drawknife or spokeshave, is ready for finishing without any further preparation – save making sure that it is free from dirt or grime. This is because the cutting action shears the fibers cleanly without compressing the grain. Even parts that have been put through the steamer will show no raised grain where they were shaved with a sharp tool.

Areas that have been scraped and sanded will have some degree of grain compression that will show up as raised rough fibers on the surface once they contact either water, water-based stain or water-based milk paint. For these areas, I sand to #220-grit, then wet them to raise the grain. This is often easier to do before assembling the chair.

It's important to let the surface dry and harden; letting it sit overnight is best. Then I lightly sand with #220-grit paper, being careful not to apply too much pressure. Instead, I let the sandpaper cut the fibers with multiple light passes. These areas will most likely show raised grain again, but I sand them after the first coat of paint has soaked into them and hardened the fibers. One sanding after the first coat of paint is usually enough, but I inspect those areas carefully to ensure that I am happy with the surface after paint is reapplied.

**FIG. 25.10** ***Inspect the legs for grime or glue and sand accordingly.***

**FIG. 25.11** ***Rinsing the seat with naptha cleans the surface and can reveal surface quality.***

**FIG. 25.12** *The stain will look uneven and splotchy.*

**FIG. 25.13** *Once the stain is dry, check for raised grain or glue spots.*

My turnings in the undercarriage are finished with a skew, but because any burnishing that takes place may resist the paint sticking, I sand lightly with #320-grit while the piece is on the lathe. Be sure to remove the tool rest and any loose clothing before sanding. I also wear a respirator because the fine dust is dangerous. There should be no surface preparation required after that.

The seat is perhaps the most critical place for surface preparation. Pine tends to compress when scraped, and it might also contain considerable sap or pitch. It is difficult for paint to adhere to sap, so I heat the surface of the seat with a heat gun until I can see the pores with sap in them liquify. Then I rinse the seat with naptha or grain alcohol. Always wear gloves when handling solvents. I repeat this if the seat seems quite pitchy. Some manufacturers suggest sealing the seat with a coat of shellac or using an acrylic additive to the milk paint to encourage solid adhesion. I have done both, but have found that the brand of milk paint that I use, from the Real Milk Paint Company, doesn't require help sticking to the surface. If I do use an additive, I only use it on the first coat on the seat and nowhere else on the chair.

If your chair has been sitting around for a while unpainted, oxidation and dust will have contaminated the surface and you might consider wiping the whole chair with solvent such as grain alcohol or naptha before painting.

## Stain

Once the initial surface preparation is complete, I can either go straight to painting, or to staining. Staining is a good way of mellowing the raw wood so that when the paint wears away, you won't see the bright white of raw wood. The stain will also help you to see any areas of roughness you might have missed.

I stain my chairs with a simple stain made from crushed walnut hulls soaked in hot water. Wear gloves when making or handling this stain or you will have orange fingers for a week or so. There is a commercially available stain called Van Dyke Crystals that is basically the same thing.

An alternative is to combine a shellac sealer with stain by simply adding a little alcohol-based dye to the shellac.

Either way, I mix and strain the stain and rub it on with a soft cloth. I never paint or stain the bottoms of my chairs, preferring to just oil them and let the natural pumpkin patina of the white pine show.

As the stain dries, I mix my first coat of milk paint. Each color of milk paint mixes and applies differently. So again, make a sample to be sure that you like the mix. Just because you successfully used proportions and steps to get a good green finish doesn't ensure that your yellow one will work.

## Milk Paint

Milk paint is basically a mixture of lime, pigment and milk protien. I think of it as a very thin layer of colored plaster, rather than a paint. It wears beautifully and it is colorfast. Plus, the textures, tool marks and grain of the wood show through the thin, hard layer of paint. One very popular and successful way to use milk paint is to layer different colors, which creates beautiful wear patterns as the chair is used. I'll describe painting my most popular finishes: black over red and peacock over stained goldenrod. If you wish to paint a solid-color chair, with no undercoat, just follow the instructions for the red undercoat, perhaps adding one more coat before rubbing it down. The concept of creating these layers is simple. A base coat of solid, thin paint is applied first. The key to this layer is that it not be "caked up" or too thick so that it masks the grain of the wood. Milk paint tends to go on a bit thick and uneven, so extra steps are needed to get the best finish. I usually take two coats to apply the base coat, rubbing the first layer with a Scotch-Brite pad and sanding areas with raised fibers. Then I paint the thin areas or areas that have been exposed through sanding or rubbing with a slightly thinner pot of the same color. Again, the goal is an even thin coat of a solid color. Then I either seal the base coat with a thin layer of shellac, or I go directly to the top coat. I follow the same process of painting on and rubbing down the top-coat color until I am happy with the results. Then I seal the paint with oil. You will find that sharp edges and facets tend to "burn through" to the undercoat, which can be avoided or exaggerated, depending on your taste.

## Paint Brands

There are a number of options for purchasing or making paint. I have never taken the time to make my own because there are manufacturers making great paint in colors I find appealing. There are two brands that I have used on my chairs, and they have different qualities on which I base my choices. Both are powdered and mixed with water.

The paint from The Old Fashioned Milk Paint Company is what I started with and the paint has the desirable ability to burnish out to a high sheen. The general appearance (and I believe the intended appearance of milk paint) is somewhat flat, also referred to as matte. I like this quality, but the high sheen and translucence that results from burnishing and oiling has proven to be popular amongst my customers. The problem is that this paint requires straining and care to keep some undesirable results from popping up. I've painted hundreds of chairs with this paint, following a strict regimen of straining that I will detail, but I've still found that I sometimes get a whitish speckling in the paint or adhesion issues. Adhesion issues occur not only because the surface is fouled or too smooth to accept the paint, but because the paint dries very fast,

**FIG. 25.14** *Mixing and applying paint.*

**FIG. 25.15** ***Be sure to work the paint back along a wet edge to keep from painting over the paint that has begun to dry.***

which causes a great deal of surface tension. The tender layer of moist paint below the drier surface is likely to delaminate if stressed, especially if a second layer of paint is applied to soon. This is the main reason to strictly obey drying times.

The other reason that I don't prefer this paint is that the color tends to shift from layer to layer and it is tough to touch up a missed spot without it being readily apparent. I found painting this way to be a one-way street where any misstep could lead to scraping down the seat and starting over, where a simple touch-up might have sufficed. The problem is not with the paint as it is made or its intended use; it's that I am shooting for a result that is very specific and most likely beyond the intentions of the manufacturer.

The paint that I currently use is made by The Real Milk Paint Company. For years, I didn't use this paint for a couple of reasons even though I loved the colors, and the ease of mixing and application. There is no straining necessary and you can touch up all you want and the layers melt together to a singular result, but the paint is hard as nails, and I couldn't burnish it down to the sheen that I wanted or get the translucent effect of layering that the other brand provides. But in recent years, I've added a few changes to my process that have enabled me to get the results that I want.

## Mixing Paint

My basic rule of thumb for mixing paint is three parts warm water to two parts paint powder. You can always add water to thin it down. Because milk paint doesn't last very long before it spoils, I mix up enough for only one chair at a time, usually 4 or 5 tablespoons worth of paint. The Real Milk Paint brand does have the added benefit of lasting longer after mixing.

I mix both brands of paint with warm water and agitate it with a stirrer. I've found that swirling the container by holding the lip like you might a cocktail works well to get the paint to go into solution. Eggbeaters work well, but be careful not to over-froth it. There are additives that reduce the frothing; but for simplicity's sake, I'll suggest minding the agitation or filtering out the froth if you are using the Old Fashioned brand. After letting the paint sit for 30 minutes, reagitate it. Then let it sit for another 30 minutes. The Old Fashioned brand of paint benefits from filtering through a paint filter. If it clogs the filter immediately, pour the paint back into the container and add more water. Don't be surprised if there seems to be a huge amount of froth and muck left in the filter; that's the whole point. Resist the temptation to shove the paint through the filter, that is the dregs of the paint and you don't want it anywhere near your chair. The paint left after filtering should be smooth and the consistency of heavy cream. I find that the filter eats a lot of paint and not having to filter, as with the Real Milk paint, means that the paint that I purchase and mix ends up on the chair instead of in the trash.

If the paint seems a bit thick to apply, add a little water. Experience will soon be your guide. I use a 1½" sash-painting brush formulated for latex paints. It is possible to add too much water, at which point the surface tension of the water will overwhelm the paint and show up as beads on the surface. If you add more paint to the mix, be sure to let it set just as though it were the first mix.

## Applying the Paint

There are a few rules that apply to all paints, milk paint included.

• Multiple thin coats are better than a couple thick ones.

• Always apply the paint to an unpainted area and brush it back into a wet edge of a painted area.

• The first coat will look disappointing; milk paint soaks in and looks splotchy at first.

• Going back for little touch-ups can make the problem more visible, not less (depending on the paint brand that you use).

• Paint that is dry to the touch is not necessarily completely dry.

• Spread the paint as thin as it will allow while still covering.

• If you are not looking at an area while painting it, you are very likely to miss spots … lots of them.

I start on the undercarriage of the chair to check the consistency of the paint. If my brush is still damp from a recent washing, the paint will initially seem too thin. I work fast, painting each part separately and making sure to move my eyes to the spot I am painting. Milk paint doesn't "flow" like other paints, especially on the first coat. It's as though you are shoving it onto the surface, and it's easy to leave large unpainted gaps if you don't focus. I try to make the paint even, but multiple coats are really where this is achieved. In the end, I get a sort of even unevenness.

I paint the uppercarriage second and the seat last. Otherwise, I might drip on the fresh paint while painting at the top. It's important not to go back to touch up "dry" areas. They seem dry, but they aren't. By putting more paint on top of them, it might create so much surface tension that as the second coat dries, it will delaminate the soft first coat.

As I mentioned, I paint the seat last, which is a good reminder to add some acrylic additive to a small batch of the paint if necessary. Additive should be used only on the first coat because its benefit is to the adhesion to the wood, which isn't necessary after the first coat is applied.

**FIG. 25.16** *The chair complete in red.*

**FIG. 25.17** *The seat sanded after the first coat of red paint.*

I try to be even in my painting on the surface of the seat, because it's a wide surface that is front and center.

I don't paint the flat underside of the seat; instead, I oil it and let it naturally mellow. Be careful not to oil it with the first coat of oil that you put on the chair or it will pick up residue of the paint color. After the first coat, the paint is sealed and it doesn't present a problem.

Let the paint dry overnight, or at least 6 hours. Then sand any raised grain and the top of the seat. Don't sand so much as to remove all of the paint, but just enough to knock down the grain and reveal any flaws that you want to catch before proceeding. Also, rub the chair down with a gray Scotch-Brite pad to remove any coarse paint or caked up areas, especially around the joints. Once this is done, paint all of the sanded and thin areas with the a slightly thinner paint mixture. From this point on, all surfaces of the chair will be treated the same.

Once this paint is dry, if the first coat was too thin, give the entire chair a second coat. The surface should look crisp, even and clean. If you are painting the chair a solid color, instead of layering colors, this is where you can either add one more coat of paint or skip ahead to the burnishing and oiling. Note that the burnishing and oiling will reduce the solid appearance of the paint, so painting it to appear more solid than you may desire is good at this point in the process.

## Mix the Black Paint

The black paint in this process is applied thinner than the red. Its job is basically to stain the red paint and build up enough to give a dark contrast, but still show the warmth of the red below. If the paint is too thick, it will simply look like a black chair; if it is too thin, the chair will have a brownish leather look.

I mix my black paint with three parts water to two parts paint, following the same mixing process as before. Regardless of which brand I am using, I add water to the mixed paint until the consistency is less like heavy cream and more like ink.

It is important that the red paint be dry and hard before the black goes on, or you will simply reliquify the red and get a muddy, pinkish mess.

As the first coat of black goes on, you will see some pinkishness showing through and it will not seem very consistent in the way it covers. The consistency will come from the second layer.

The second coat of black will cover more solidly and should be darker than your desired result. The burnishing and oiling to follow will lighten the color and let more of the red show through.

**FIG. 25.18** *The first coat of black over red.*

## Paint the Balloon-back Peacock over Stained Goldenrod

The balloon-back finish shown follows basically the same steps, but with a few minor differences. Unlike the black-over-red finish, where the black is meant to be translucent, the top coat of peacock is meant to be more dense, mostly revealing the stained undercoat of goldenrod only in the high-wear areas. The effect is similar to aged wood under paint. The process begins by skipping the walnut stain and painting the raw wood with the goldenrod.

Once the goldenrod is dry, use Mirlon or Scotch-Brite to wipe off any areas with excess paint.

If the coat seems thin, apply a second and, once again, rub off any excess once dry. Then apply a very thin layer of shellac with dye in it. I use a Lockwood Early American Maple alcohol-soluble dye mixed with orange shellac, but there is no end to the variety of colors you can create.

The shellac mix both seals the goldenrod and gives it a warm brown color that complements the peacock.

FIG. 25.19 *The pinkish tones of the undercoat show through after the first coat.*

FIG. 25.20 *The oil shows the translucence of the two coats of black paint.*

Once the chair is sealed, paint the peacock color. I mix the peacock four-parts paint to five-parts water. I suggest two to three coats to get full coverage, rubbing lightly between coats. Certain colors, such as blues and yellows, take more work to get even coverage. Letting the coats dry for extended periods can help, but you should also be careful not to overwork areas when applying the paint, as it is likely to soften the layers below and make a streaky mess. After the final coat has hardened completely, burnish and oil the chair as with the black over red.

## Burnishing

Once the paint has fully dried (24 hours later) burnish the surface with #0000 steel wool or an extra-fine Scotch-Brite-like pad made by Mirka called "Mirlon." The idea is to transform the dull matte surface to a sheen before sealing. Depending on the brand of paint that you use, you can burnish the paint to a high or low sheen. I like the Mirlon for knocking down the rough paint and the steel wool for bringing the sheen up. Be careful when

FIG. 25.21 *Goldenrod is a bold color before the mellowing effect of the stain.*

**FIG. 25.22** *The goldenrod paint after being rubbed out with a Scotch-Brite pad.*

**FIG. 25.23** *The orange shellac mix stains the goldenrod a mellow brown.*

**FIG. 25.24** *The peacock paint will be streaky after the first coat.*

**FIG. 25.25** *The portion on the right side of the seat is the completed three layers of peacock, the center shows the burnished paint and the left shows the paints both burnished and oiled.*

burnishing sharp corners and details because it's easy to cut all the way through the paint. Then apply a wiping varnish; usually two or three coats is enough to get a hardy finish. Rub any spots that are too shiny between coats with Scotch-Brite or steel wool. Letting each coat dry overnight is essential to getting a good result. There are many brands of finish that will work, but some will require more coats to achieve a durable finish. The Real Milk Paint brand may take extra coats of oil to achieve the desired sheen. The sheen of an oil finish mellows in the first months of its life, so either be prepared to apply more oil at that time or to finish it to a higher sheen than may be desirable at first.

**FIG. 25.27** ***The process of burnishing and oiling tends to reveal the undercoat, which adds visual interest when viewed close up.***

**FIG. 25.26** ***Chairs should be dynamic and interesting, regardless of the point of view.***

**FIG. 25.28** ***Extra rubbing can expose the undercoat, offering a jump-start on the wear of use.***

**FIG. 25.29** ***The black over red offers a striking silhouette when seen from a distance.***

**FIG. 25.30** ***The back of the crest is often seen and appreciated when at the table.***

**FIG. 25.31** ***The tool marks on the back of the ear are accentuated by the paint and oil.***

**FIG. 25.32** ***Extra effort carefully painting and burnishing the spindle deck pays off in the end.***

**FIG. 25.33** ***The appearance of the black over red changes dramatically depending on the distance and lighting.***

Also, note that the varnish takes time to form a water-resistant seal; any water spots on a newly finished chair can eat through the sealer and dissolve the paint. Water drops should either be mopped up immediately or left alone on the surface to dry, after which a quick touch with oil will usually take care of the problem.

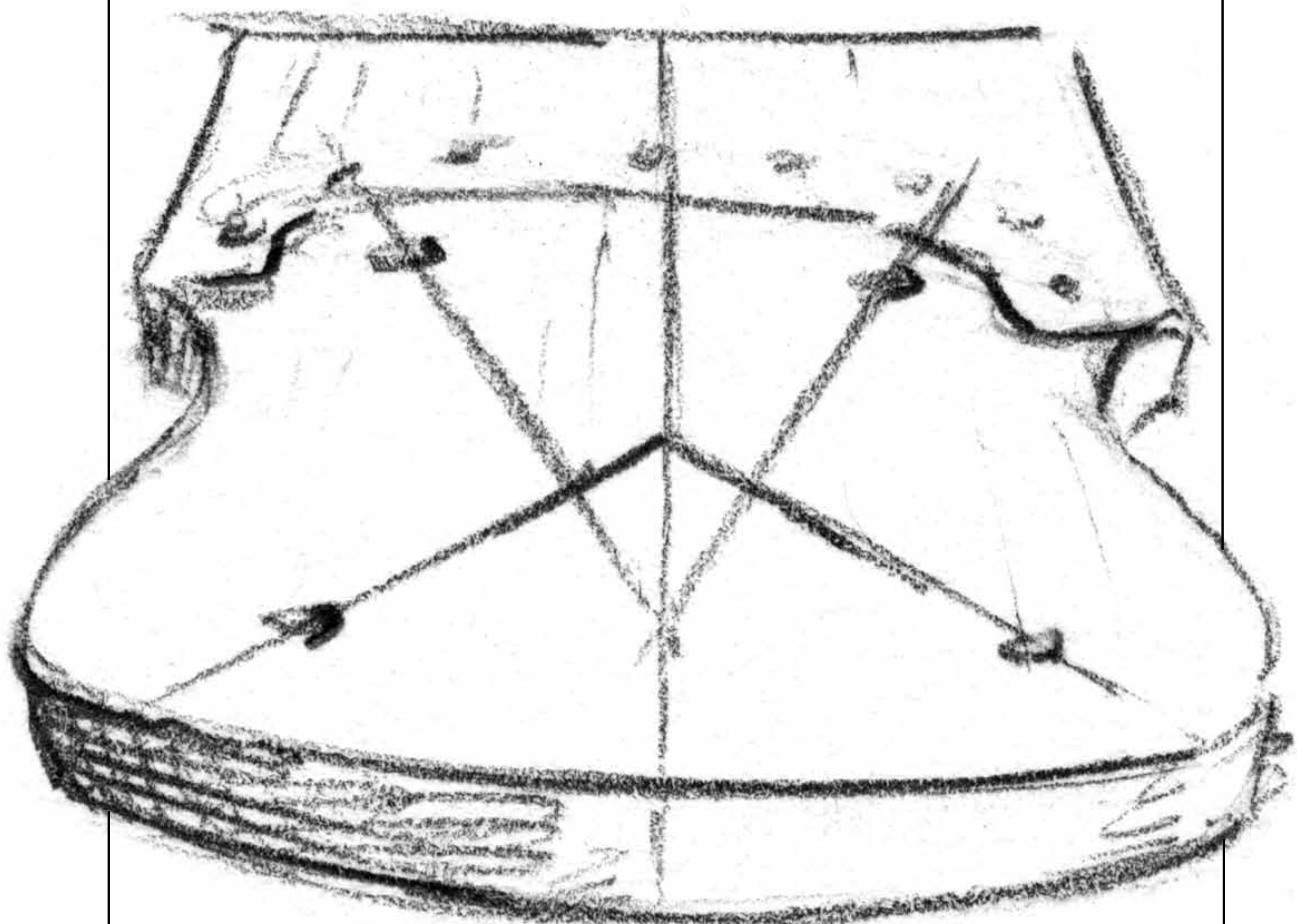
It is common for pine seats to leach a little sap during their lifetime during warm months, or when set next to a fire or in direct sunlight. This is easy to remedy by simply rubbing with a solvent until the sap dissolves. Then buff the surface with a dry cloth to reestablish the sheen.

Dents and dings are a normal part of a chair's life. Prevention is the best course of action, so just be ready when that friend with the huge key ring in a back pocket or cool rivets on his pants plunks down in your newly finished pride and joy. Of course, this isn't always possible, and my house is an especially rough place for chairs to live. It is possible to steam out a ding or dent with a wet cloth and clothes iron, as long as the finish has fully set up. Be careful not to be so aggressive with the steaming that you upset the finish.

That said, chairs are hard-working furniture and I've found that milk paint ages beautifully into a very natural appearance that fits well with the scars of hard use.

**FIG. 25.34** ***Thorough scraping and light sanding reveals the growth rings in the pine seat.***

**FIG. 25.35** ***The seat is an unnameable shape, but has a clear logic and tautness.***



# APPENDIX A

# Creating & Using Sightlines

Before jumping into the mix, it's important to understand the vocabulary used in talking about angles.

## Rake, Splay & the Sightline Method

There are two sets of terms: one for looking at the parts in relation to the chair (rake and splay), and one for looking at the parts divorced from the chair's point of view (sightline and resultant angle). Both give you all the information you need to understand and create the chair, but as you will see, translating from one to the other can make designing and executing the chair much simpler.

***Rake:*** The angle of a part when viewed from the side view of the chair.

***Splay:*** The angle of a part when viewed from the front view of the chair.

***Sightline:*** A point of view in which the part appears vertical.

***Resultant Angle:*** The angle of the part when viewed perpendicularly to the sightline.

When looking directly down the axis of the sightline plane, the leg is vertical.

When rotated so that the viewpoint is perpendicular to the sightline plane, the leg is at the resultant angle. I

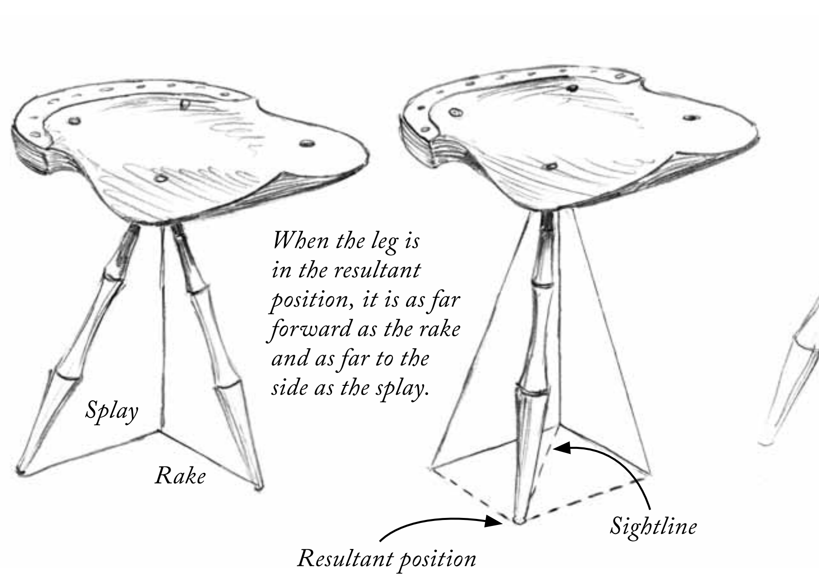



**FIG. A.1** ***The sightline, rake and splay in orthogonal view.***

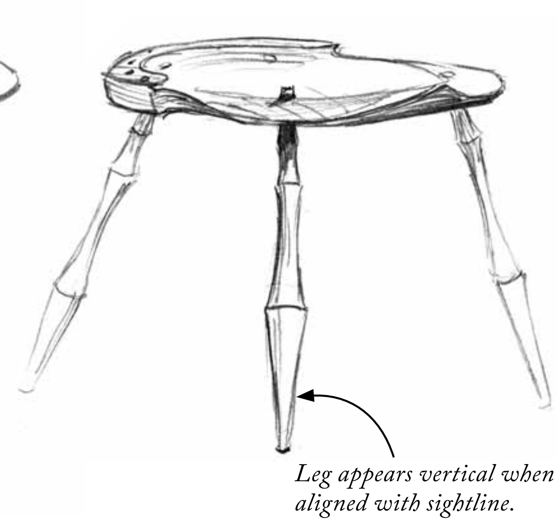



**FIG. A.2** ***Another viewpoint of the leg.***

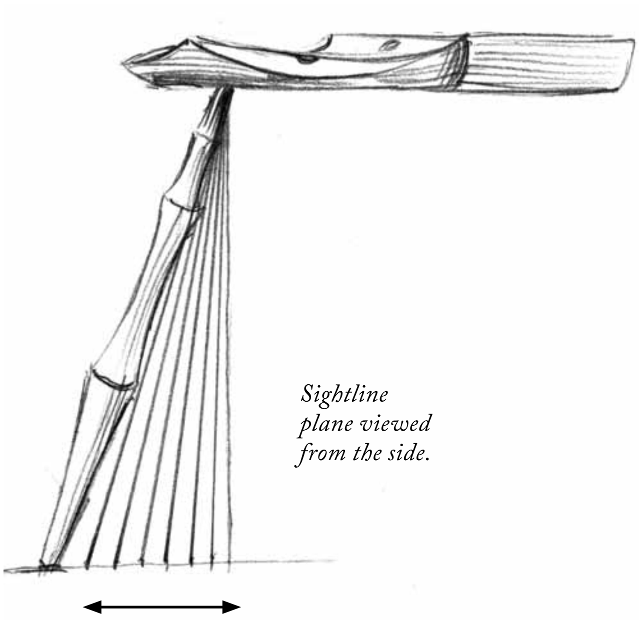



**FIG. A.3** ***The resultant angle.***

like to think of the resultant as the "resulting" angle. This helps me to remember that it is the result of positioning a single part in relation to two axii.

The point of all this information is to create a means for locating and tilting a drill to the desired result.

Most of the time, whether working from a sketch or measuring from an existing chair, the information that we start with is the rake and splay, In this section, I describe a practical method for deriving the "sightline" and "resultant angle" from the rake and splay.

Below, I've depicted another way of seeing where the sightline for a part is located. The image below shows the overhead or "plan" view of the chair seat and a leg. Once the position of the leg is graphed along the rake and splay axii, the sightline and final leg location can be derived.

Notice that the splay and the rake in this view are not represented as angles, but by the distance that the leg extends along both axes. Using this distance to note the footprint of the leg provides a simple means to translate rake and splay into the sightline, as well as the resultant

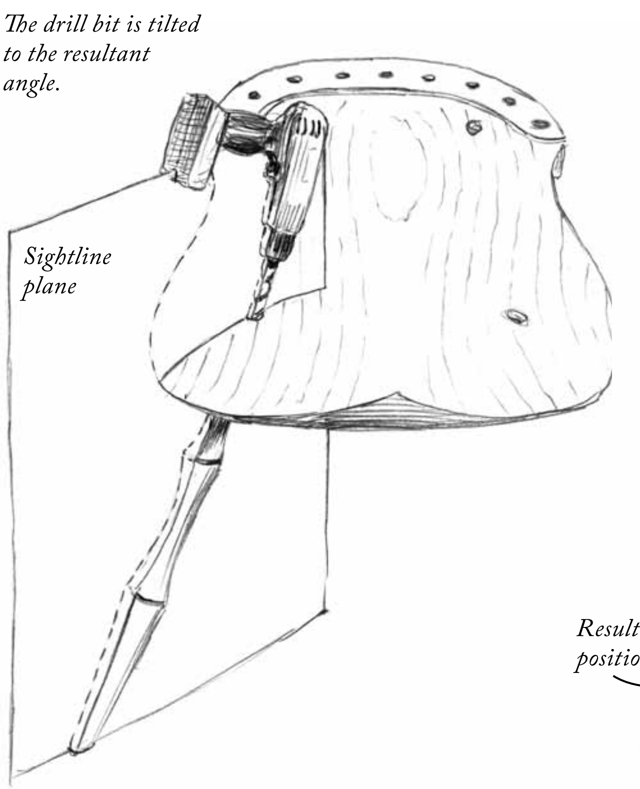



**FIG. A.4** ***The relationship between the sightline, the resultant angle and your drill.***

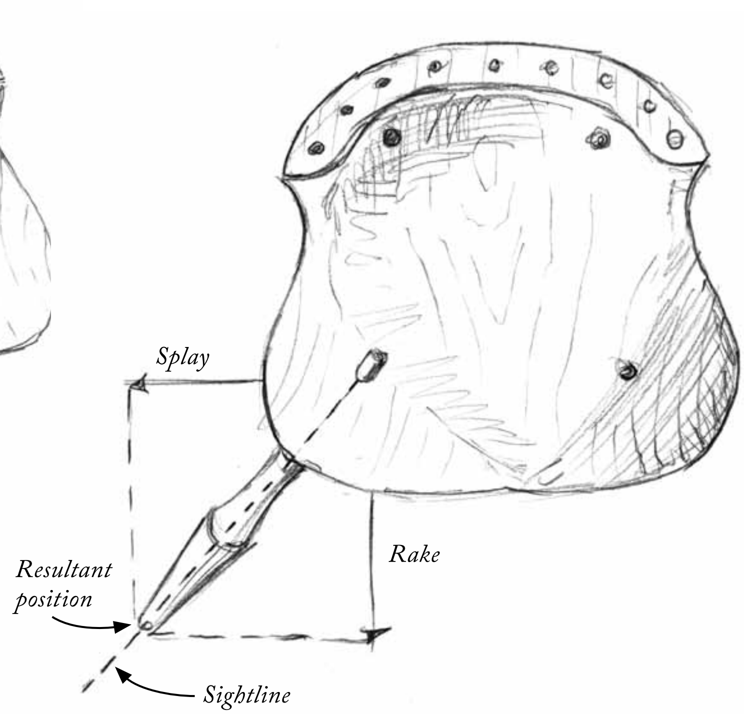



**FIG. A.5** ***The footprint of the leg also reveals the resultant.***

position. Later, I show how to use a special scale to lay it all out and position the drill that is much simpler than diving into trigonometric tables.

Why bother? Why not simply set up two bevel gauges – one parallel to the front of the seat set to the splay, and one to the side set to the rake – and use them to guide the drilling? The beauty of aligning along the sightline axis and drilling at the resultant angle is that it locks one of the angles to 90°. Drilling at 90° in one axis is helpful because we all have an innate sense of what is upright; otherwise standing, drinking and walking would be problematic.

## A Practical Method to Find the Sightline & Resultant Angle

If you are following the plans, you won't need to learn to establish sightlines and resultant angles; they are included on the plans. But as you delve into the craft, you will likely want to create a design or adjust an existing one.

Making one chair is usually enough exposure for the idea of drilling along a sightline to take hold, after which the nuts and bolts of creating them will be less of a leap. There are a few ways to translate the rake and splay into sightline and resultant angles, but this method eliminates mathematics and elaborate graphics, which suits me just fine.

Basically, I use a special ruler that I call a "sightline ruler" to draw a scaled-down image of the footprint of the rake, splay and sightline axii directly on my seat pattern. I then use the same ruler to find the resultant angle from this scaled image.

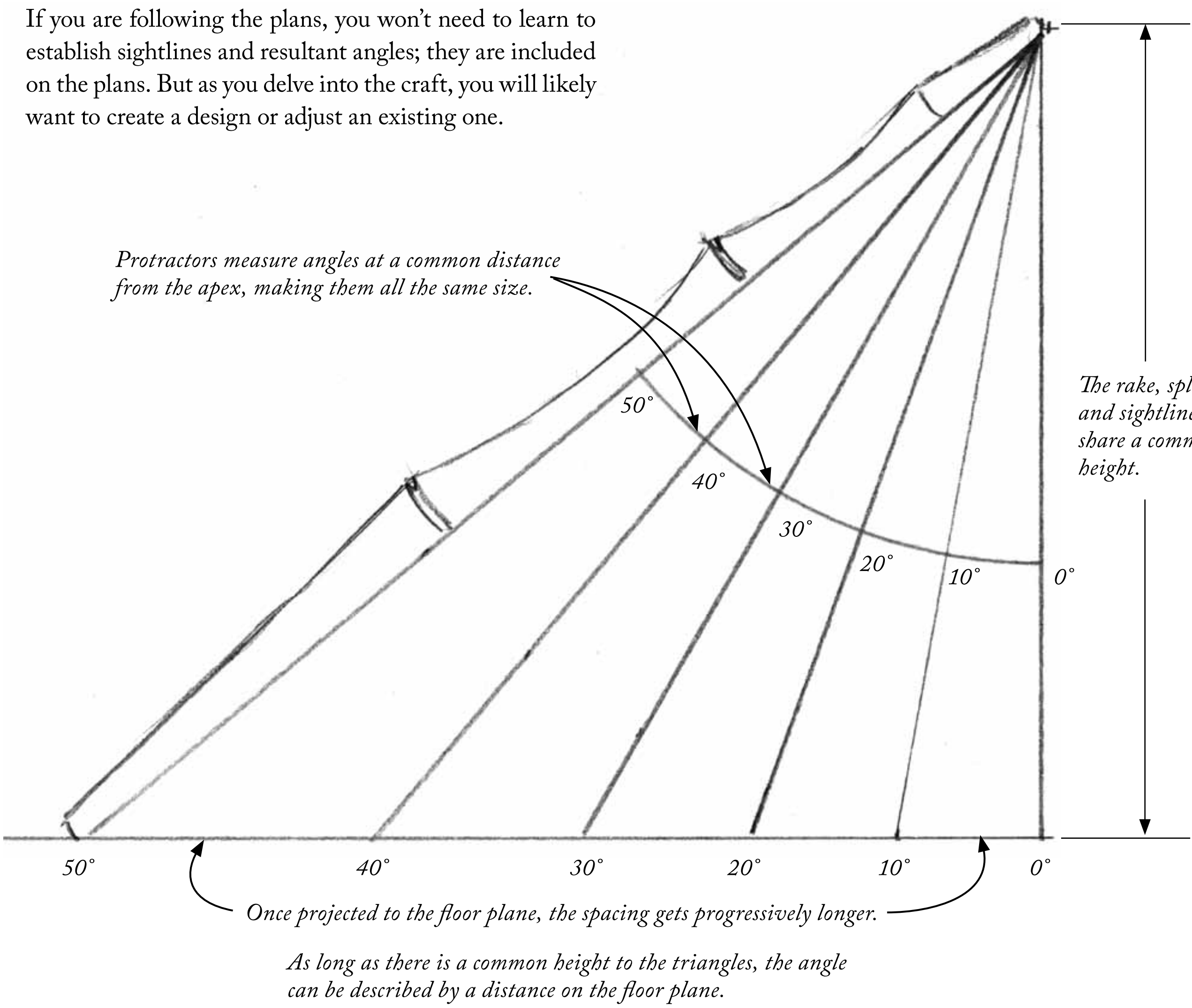



**FIG. A.6** *The sightline ruler charts the angle along the floor plane as shown.*

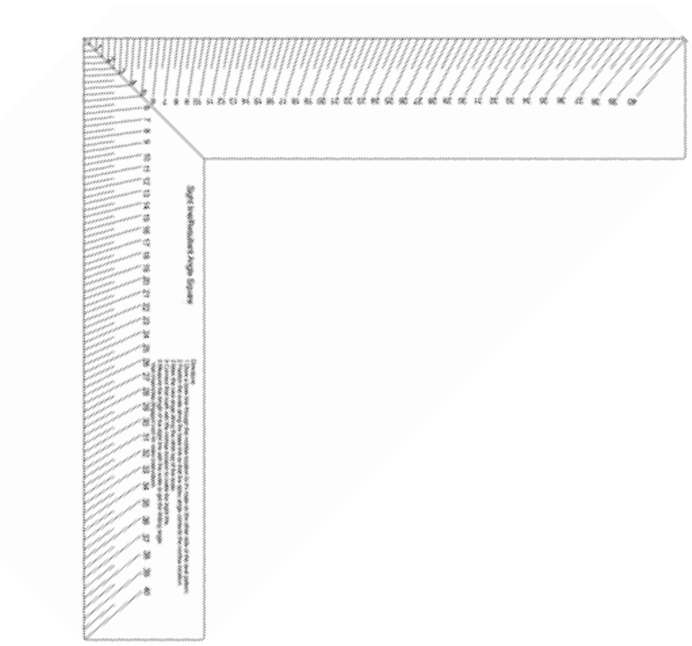


FIG. A.7 *A sightline ruler created with the help of Steve First.*

## How Does the Sightline Ruler Work?

By translating the angles into distances, I can simply graph the end locations of the leg in the rake and splay plane and derive the sightline and resultant, similar to the image below.

Unlike a protractor, which measures the degrees at a point equidistant from the apex, a sightline ruler charts the degrees as they are projected onto the floor plane as shown on the previous page. The increments on the sightline ruler are not spaced evenly; they are spaced by degrees, and the spacing progressively increases.

Notice that the layout drawn on the seat in the image below with the sightline ruler is simply a scaled-down version of the footprint of the rake, splay and sightline seen on the floor plane.

## Drafting the Sightline & Resultant Angle

Here is how you make that scaled-down drawing. To begin, draw a baseline from one mortise to its symmetrical partner on the seat template. Place the sightline ruler on the baseline, with the corner pointing toward the direction of the splay, and the other leg of the scale in the direction of the rake.

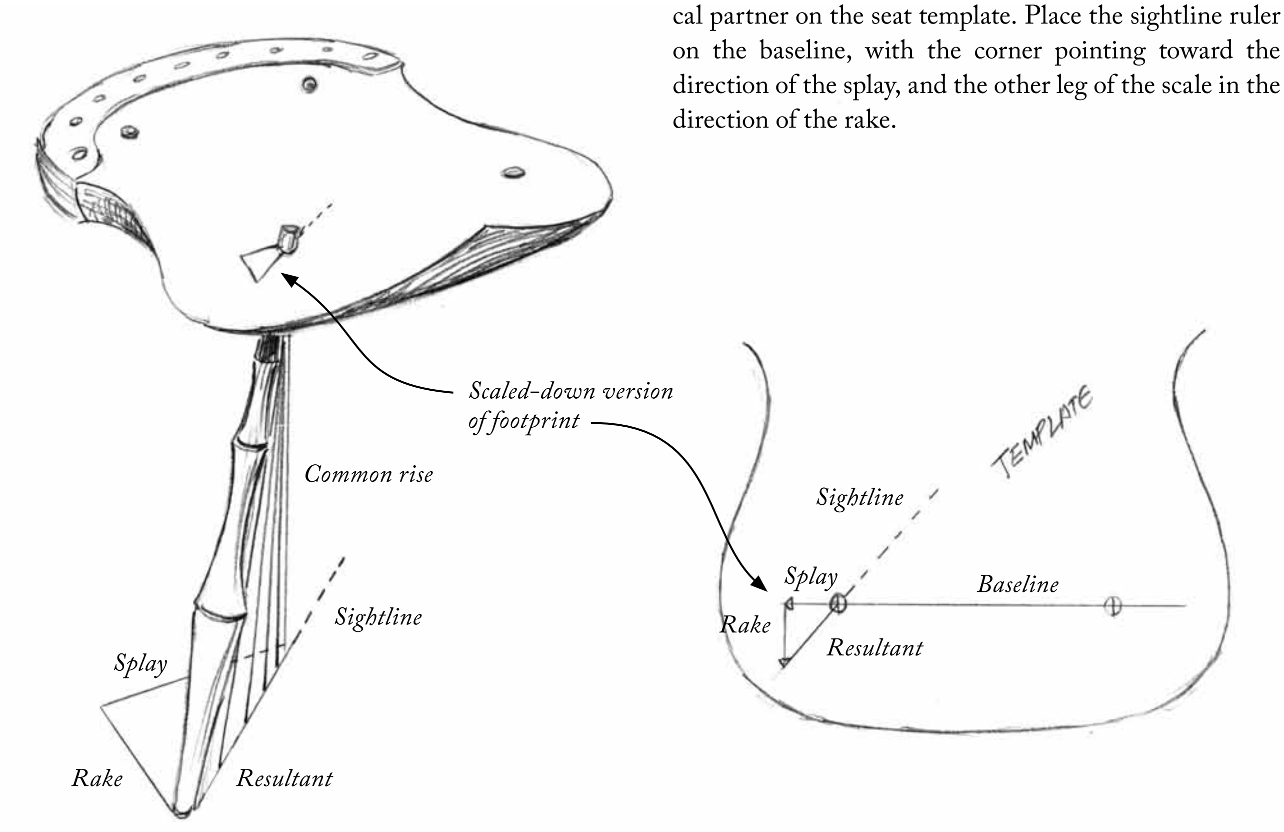



FIG. A.8 *The scaled version of the footprint seen on the seat and the template.*

For example, I'll show a splay of 8° and a rake of 18°. Move the scale along the baseline until the number corresponding to the splay is at the mortise location as shown below. Draw a line up the other leg of the scale, stopping at the number corresponding to the rake.

Draw a line connecting the mortise location to the end of the line on the rake side; this shows the direction of the sightline axis.

Then place the ruler in position to measure the length/angle of the resultant. This number is the angle that you will set your bevel square to and drill. In this case 19.5° degrees.

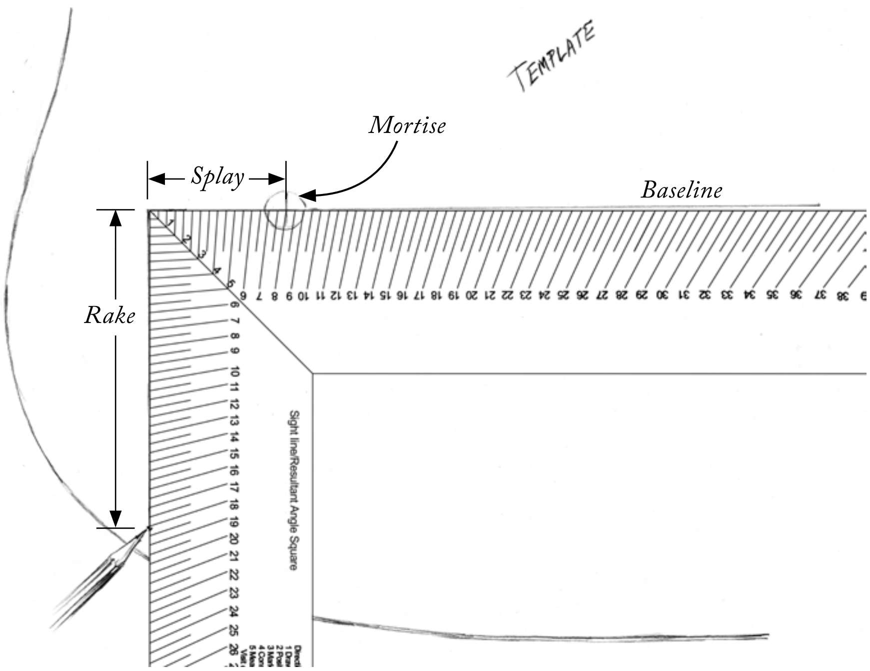



**FIG. A.9** ***Place the sightline ruler on the baseline. Set the splay angle over the center of the mortise. Mark the rake angle on the vertical leg of the ruler.***

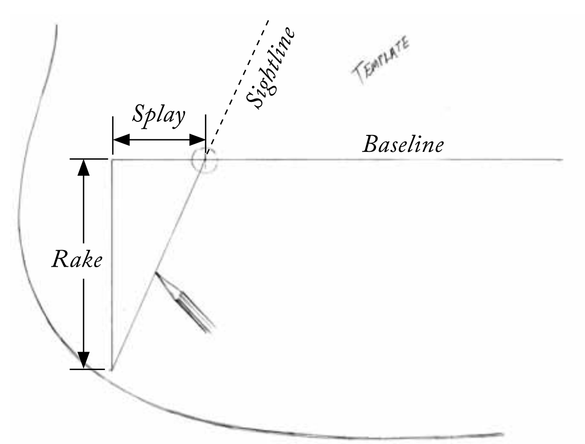



**FIG. A.10** ***Connect these two points and you have the sightline axis.***

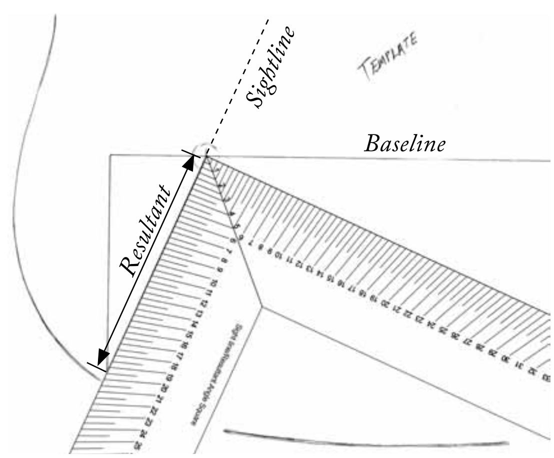



**FIG. A.11** ***Place the ruler along the sightline and read the resultant angle.***

## Working Backward

You may already have a pattern for a chair with the sightlines and resultant angles established and no need to work them out for yourself. It can be helpful, however, to know the rake and splay so that you can alter them to your liking. The sightline ruler makes it simple to derive the rake and splay from a sightline and resultant angle, so that you can revamp the design to your wishes.

Simply mark the resultant angle as a distance from the drilling point along the length of the sightline as shown below.

Then, position the sightline ruler with one side along the baseline (which connects the drilling locations) and slide it until the other side intersects the mark on the sightline.

The rake and splay can be read along the sides of the ruler where the marks land as shown.

It may take more than one glance to understand the information presented, but once you've had a chance to process it, you will find that measuring and creating angles is no more difficult than any other ruler work. I spent lots of time with the trig tables, but after the first time I used the sightline ruler, I never looked back.

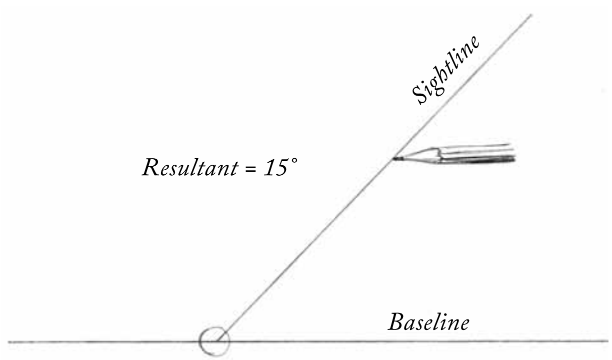



**FIG. A.12** ***If you have the resultant angle and sightline you can calculate the rake and splay.***

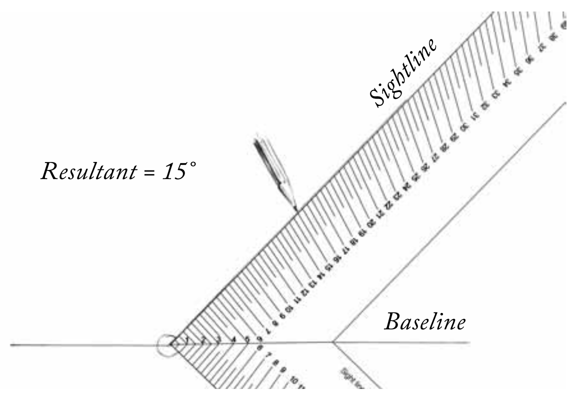



**FIG. A.13** ***First mark the resultant angle on the sightline using the sightline ruler.***

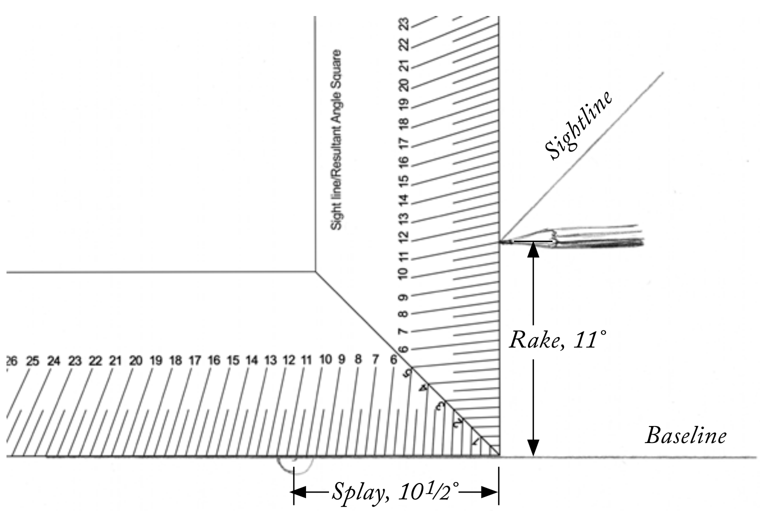



**FIG. A.14** ***Place the sightline ruler on the baseline and touch it to the mark made in the previous step. The X axis is the splay; the Y axis is the rake.***

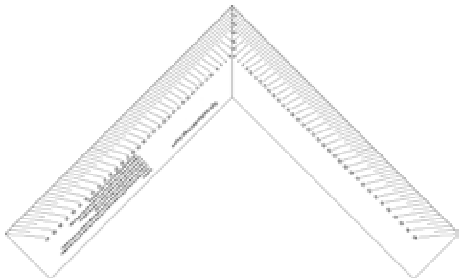
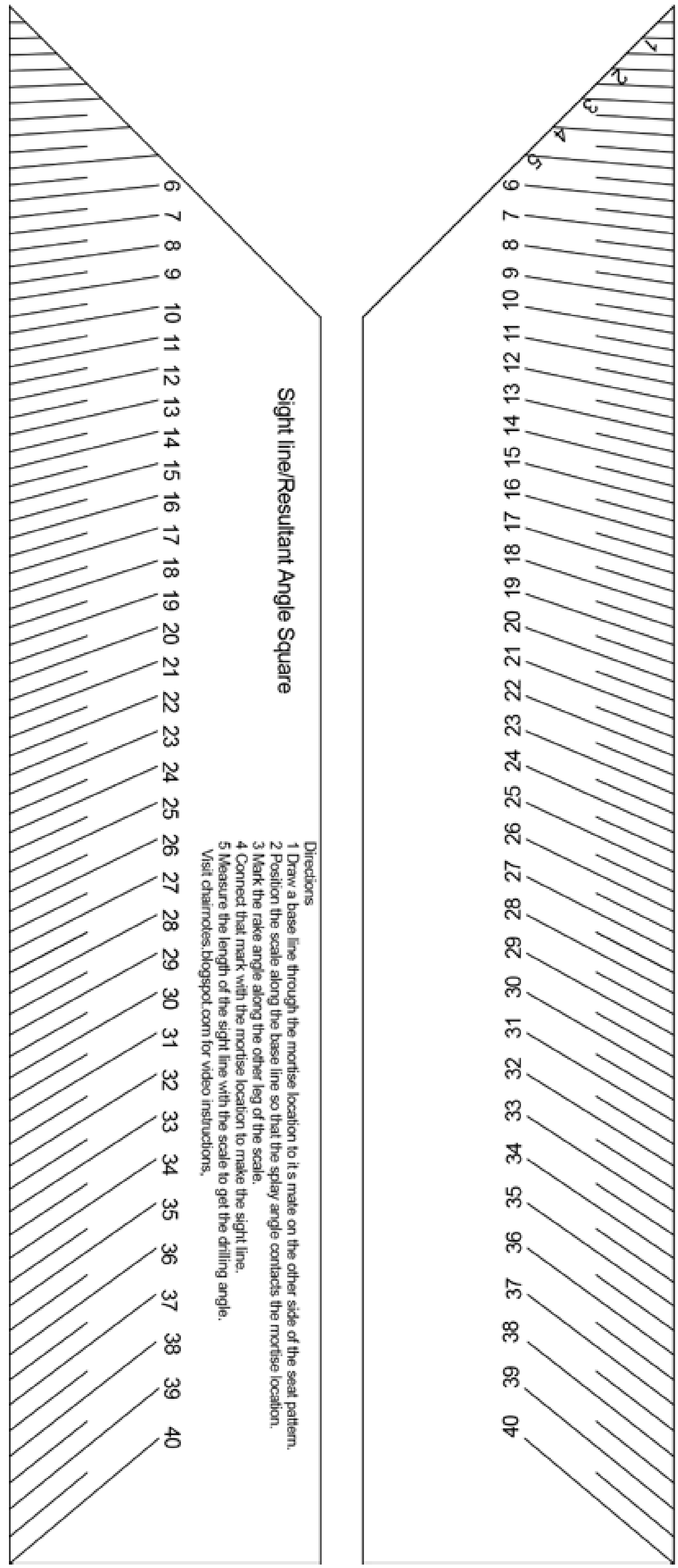
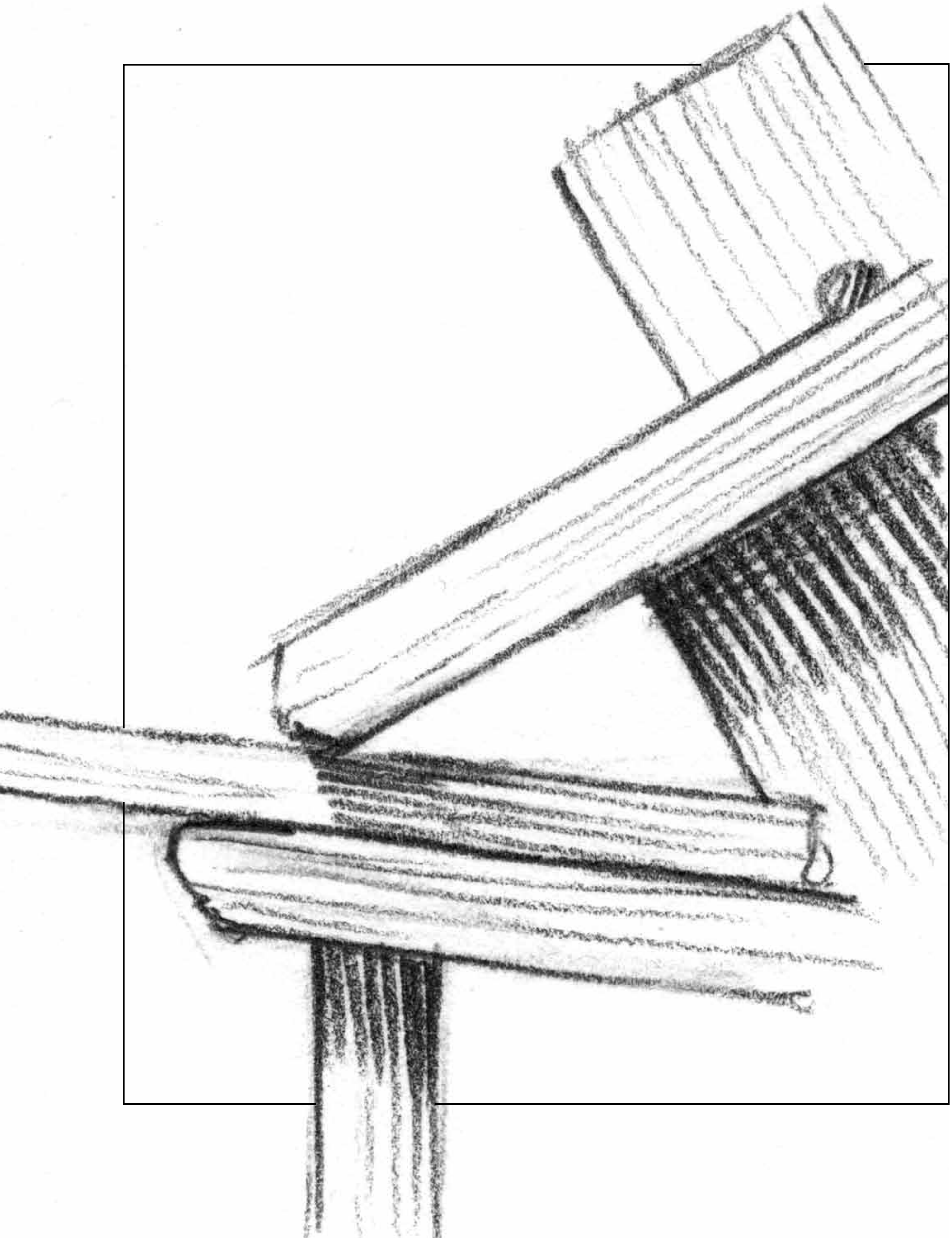


FIG. A.15 *Make a sightline ruler. Photocopy this page, then cut and assemble the two legs of the ruler together on cardboard or thin plywood.*





# APPENDIX B

# The Shavehorse

The shavehorse is an icon of the chairmaking world. It's the centerpiece of my shop, and I look forward to my time on it. I see the shavehorse as a near-perfect machine. The mechanics of it allow a workpiece to be held firmly with little exertion. This is because the pulling force that is exerted on the workpiece comes from pushing off the foot pedal, which returns the force in the form of clamping pressure. It's a circle of force. Because of the placement of the fulcrum, there is also a gain of leverage. A little effort yields a multiple of holding power.

**FIG. B.1** ***The shavehorse has many incarnations, some wonderfully bold.***

But power is only part of the equation. The other part is speed. The simple weight of the foot on the treadle holds a workpiece firmly in place, yet a slight release of pressure allows the jaws to swing open so you can rotate or shift the part. The motions quickly become second nature and the work hypnotic.

There is no end to variations on the shavehorse, and many of them work just fine. That said, I have my preferences. Most of them are based on my requirements and what I think makes the horse function better or makes it more comfortable to use.

One small piece of advice: Don't build your first shavehorse out of prized wood you've been saving. More likely than not, you will want to change or customize your horse, and an ugly one is much easier to alter or put out on the porch.

I suggest reading through the other chapters in this book before attempting to build the shavehorse, as those chapters have a great deal of pertinent information that relate to shavehorse design.

Many chairmakers, including myself, have spent time working to advance the design of the the shavehorse to make it more adjustable and comfortable to use. But for this book, I want to focus on the shavehorse's simplicity, stability and functionality.

The basic concepts at work in the featured design are time-tested and can be made to work even with crude execution. The design is somewhat of a hybrid of the elements that I've found useful in all the shavehorses I've encountered. I like the three-legged design for its solid footing on uneven ground, and the rail-style construction is light and easy to get on and off of. While I don't relish using bolts, they do make breaking down the shavehorse down for travel or storage easy.

It can be built with readily available materials and common woodshop or hand tools. On the great suggestion of Tim Manney, I use Southern yellow pine, available as 2x10 scaffolding planks that are OSHA compliant as far as number of growth rings per inch and allowable grain runout for strength. All of the parts can be made from two 8' planks, although I made the head and pedal from poplar. To work with these planks, be sure to cut off the ends, which will have steel rods passing through

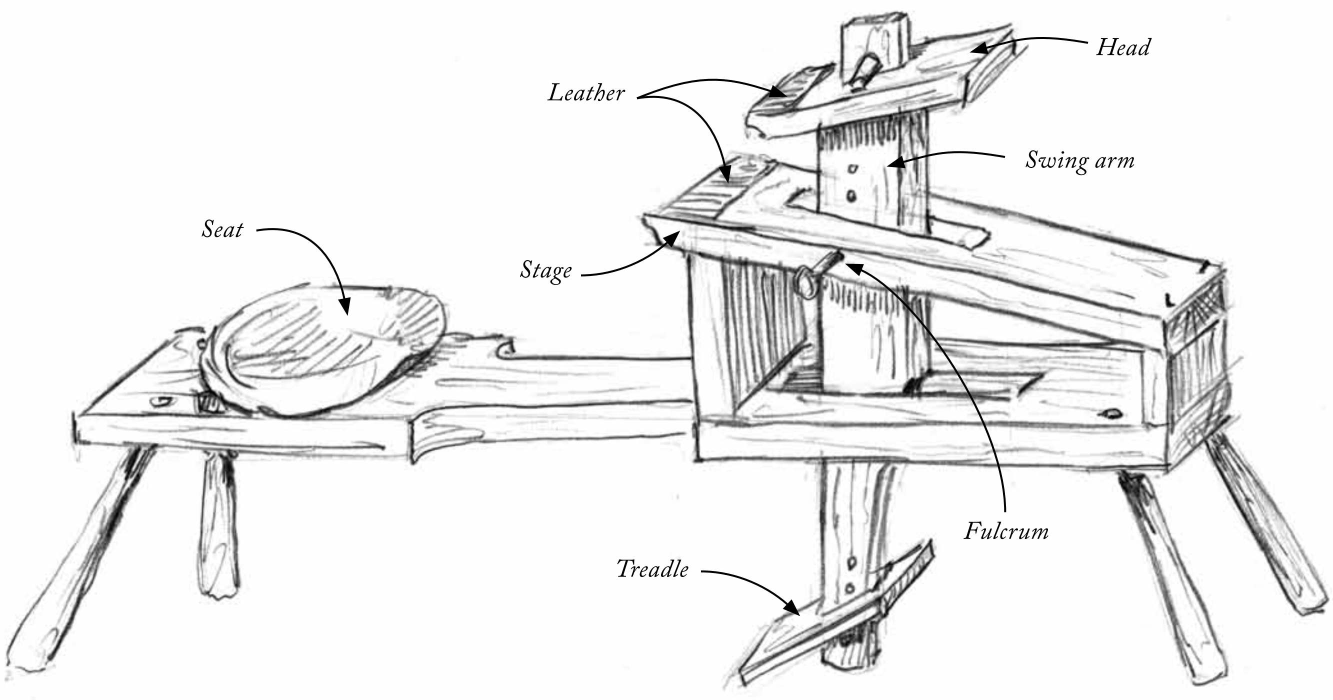



**FIG. B.2** *The "dumbhead" shavehorse.*

them to prevent splitting. The center of the planks can have some checking, but this usually gets cut out when laying out the parts or is relegated to unimportant areas or parts. You can use any straight-grained hardwood as long as it meets the strength requirements. This design will allow for retrofitting other options that you might want to try.

As part of the shavehorse, I recommend making a seat similar to a tractor seat that sits on the plank of the shavehorse to make it more comfortable. Usually, new chairmakers spend a lot of time on the horse to shave their parts and discover that the seat's shape is more than just a luxury. The forward tilt of the seat, supplied by the wedge-shaped base, helps keep you upright while working.

There are a couple of different styles of shavehorses, usually broken down into the Swiss "dumbhead" version and the British or "bodger's bench," which features two sidebars and a crosspiece.

Each has its benefits, but for Windsor chairmaking, I like the ability to clamp long pieces without threading them through the opening between the sidebars on a bodger-style shavehorse.

One advantage of a properly built British shavehorse is that the low fulcrum on the swing arms can lock the crossbar in place when the workpiece is pulled. This is an advantage as long as it is built to release when you take your foot off the pedal; otherwise you have to manually push the crosspiece back, which is annoying.

Two important factors in shavehorse design are the height and angle of the stage, and the position of the treadle. The stage is the platform that the workpiece rests on and is held against by the force of the head.

The height of the stage should follow the forearm at a comfortable height. This allows the user to take a shaving with the tool in one position without having to constantly adjust the wrists. It's also important that the shavehorse's swing arm be counterweighted enough to open on its own when foot pressure on the treadle is released. This should be natural if the pivot hole is biased toward the front of the swing arm, as shown in the plans. But if the materials used for the various parts don't have the weight distribution correct, a bit of weight added to the back of the dumbhead will get it in order.

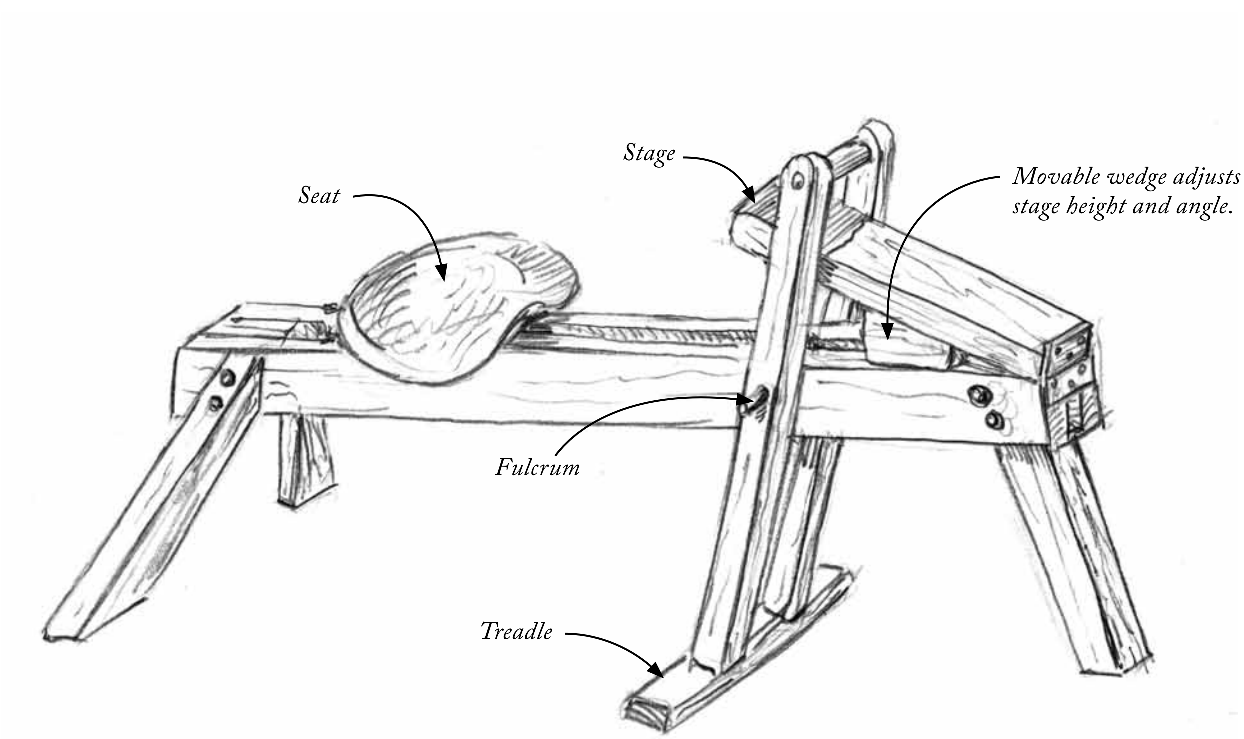



**FIG. B.3** ***The "bodger-style" shavehorse.***

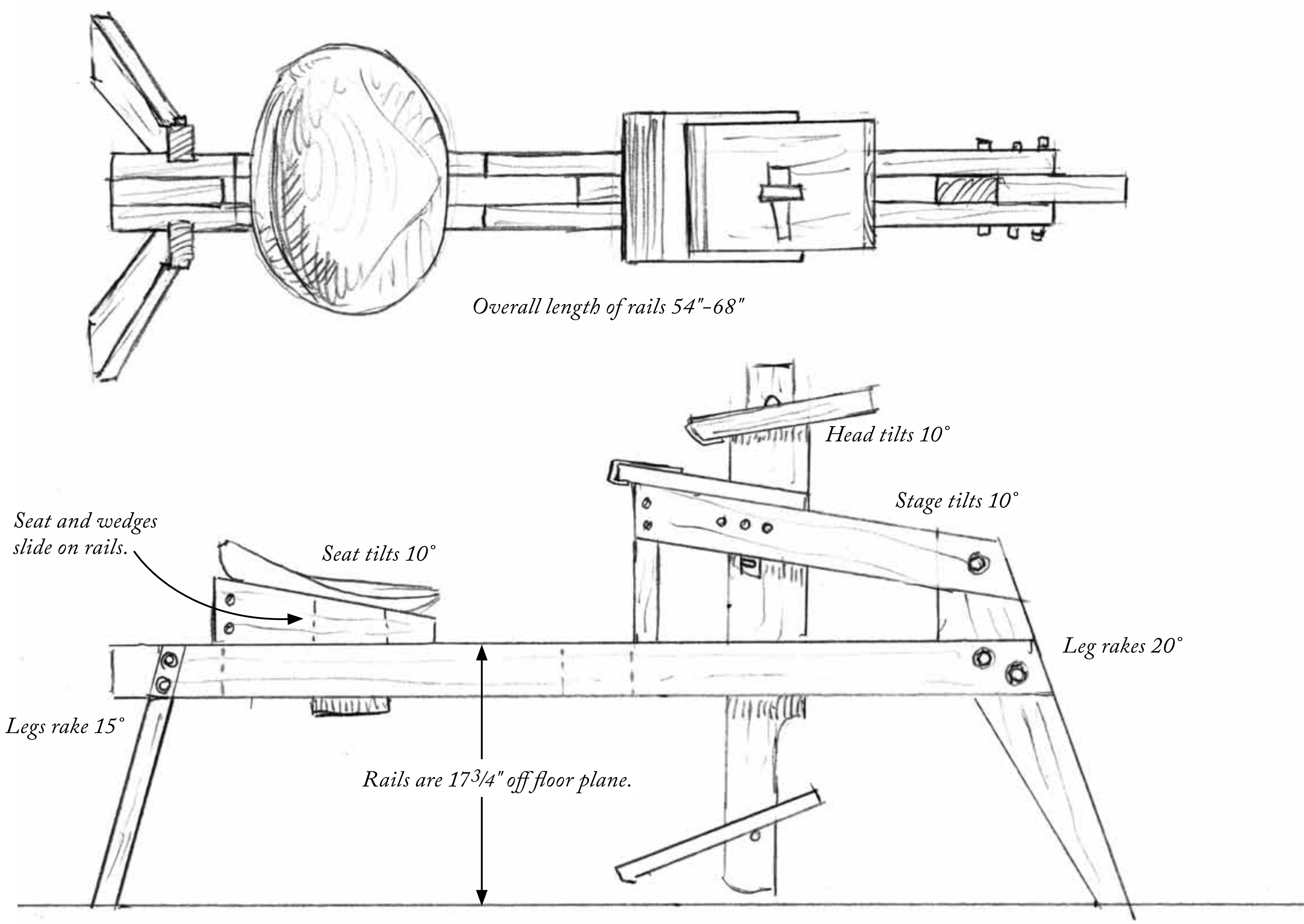



**FIG. B.4** *The project shavehorse.*

The angle of the treadle is another factor that influences the comfort and use of the shavehorse. The angle of your foot to your leg should feel natural when it is on the treadle so that the effort to push the treadle is absorbed by your whole leg.

There are a few small improvements that can be made, such as having different-height stages on either side of the dumbhead and a notch for working on the edge of square pieces. It's important to customize the shavehorse to your own size, although there are adjustments for the height of the treadle. The height of the horse, the length of the rails and the height of the stage should all be made to suit you. I will give suggestions with the plans. The plans offered will be comfortable for users from about 5' to 6' tall, and are easily changed to fit the rest. I chose to make the rails low, making it easier to step over the horse when getting on and off. The height of the wedges under the seat can be adjusted to suit your height.

## Build the Horse

I begin by passing the boards through a planer to get an even thickness (around 1⅜") to the parts. Then I lay

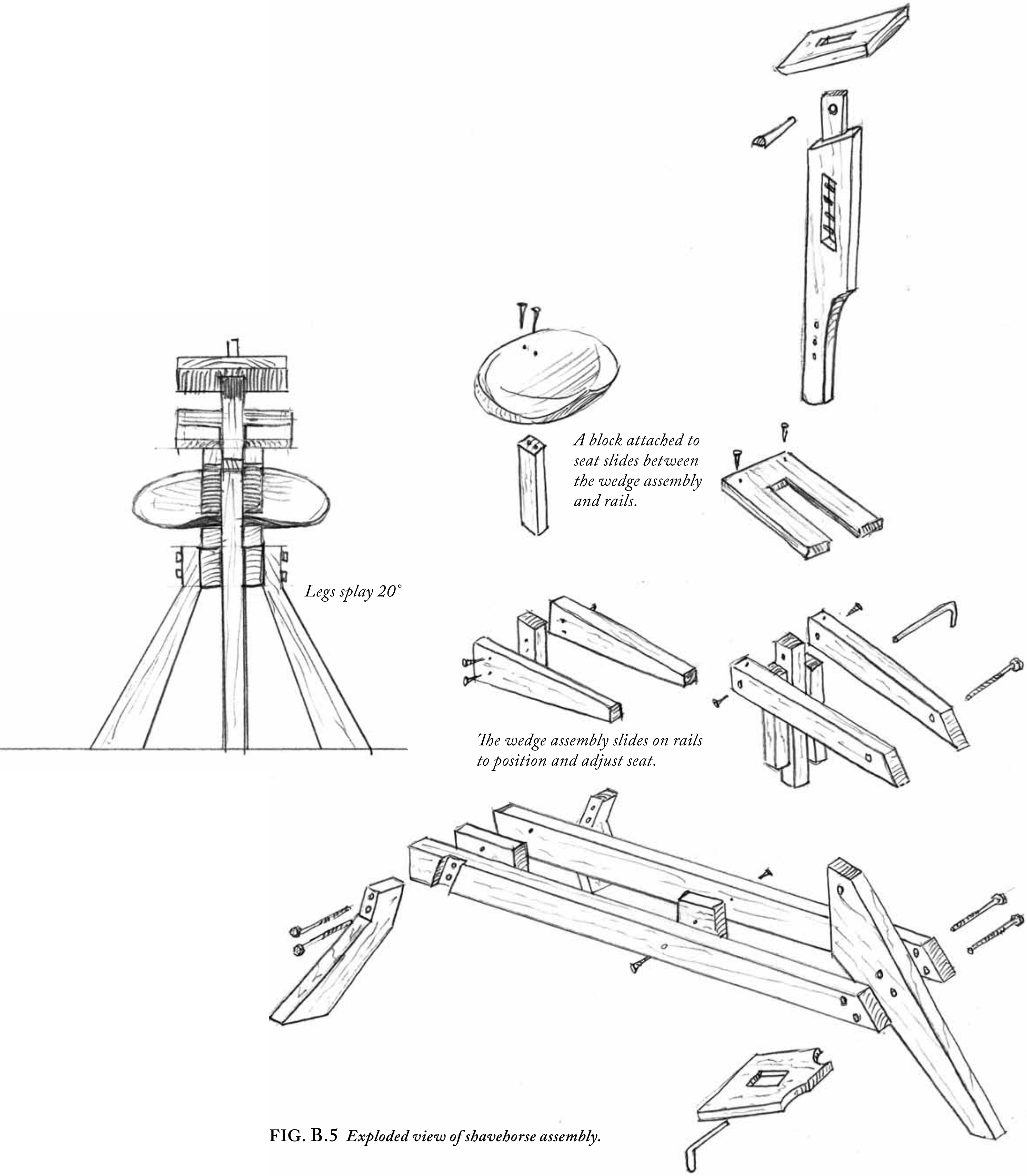



**FIG. B.5** ***Exploded view of shavehorse assembly.***

out the parts to maximize the use of the planks and to make sure that the load-bearing components are cut from straight-grain material near the edges of the boards.

Beyond a few of the parts that have angles cut in them, perhaps the most challenging part of the construction is drilling the holes for the long bolts that hold the sides together and making the dowel-toothed adjuster in the swing arm. To drill the holes through the parts, I've found it easiest to start by clamping or screwing the two rails together and drilling the holes through both sides on the drill press. Lacking a drill press, you can use mirrors and squares to align the bit as shown in the chapter

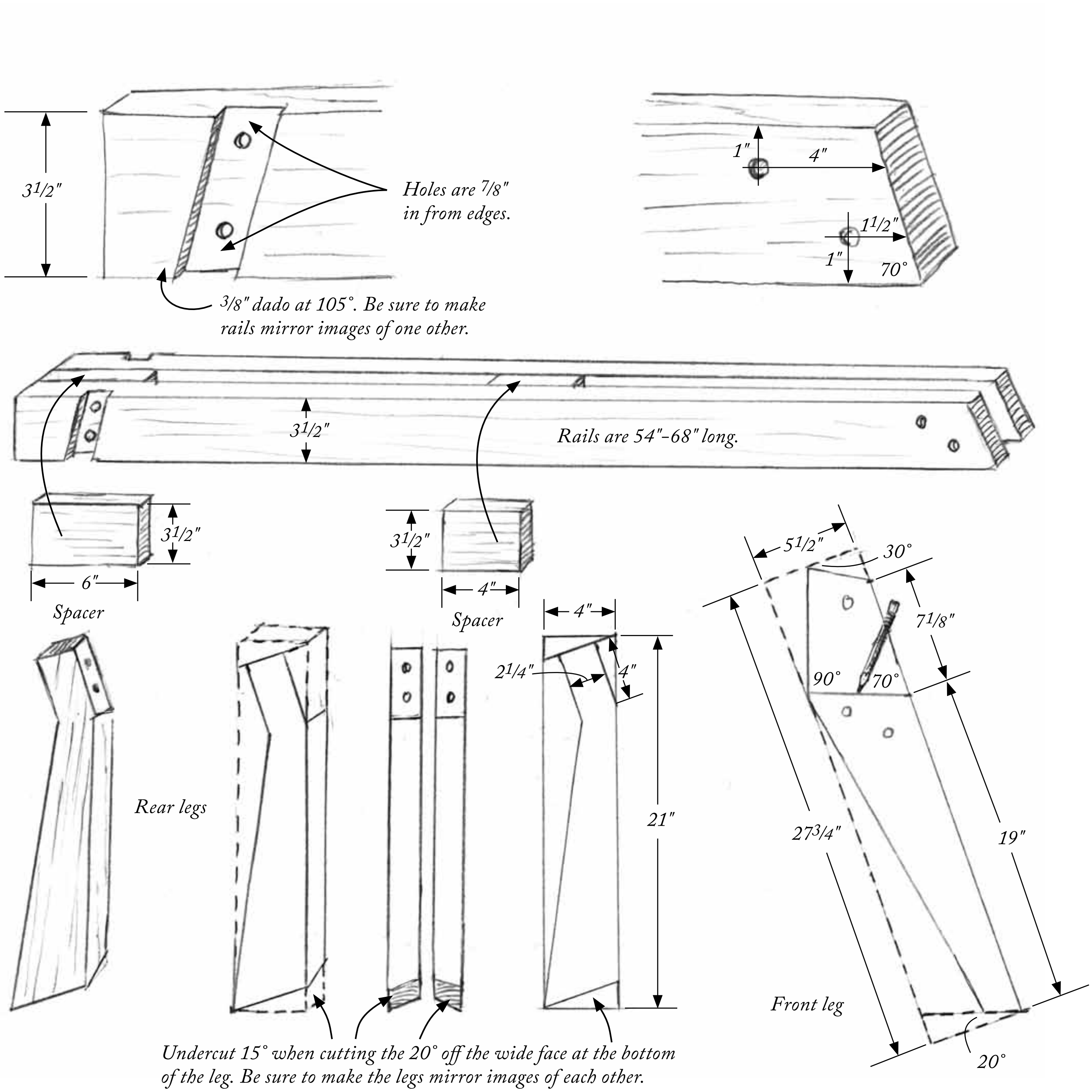



**FIG. B.6** ***The parts for the bench assembly.***

Drilling. Once the rails are drilled, separate them and fit each of the rear legs into their dados in the rail and use the hole in the rail as a guide to drill through the top of the leg. Then fit the spacer block and the front leg in their correct position between the rails and again use the hole in the rail as a guide for drilling through the assembly.

To drill the holes for the dowel "teeth," you can use a drill press with a tilting table, or put a wedge under the swing arm on a horizontal drill press table. I made a simple drilling guide that not only helps keep the angle consistent, but by shifting the jig from one side to the other, the holes are naturally offset to resist short-grain failure.

You can choose to simply drill holes through the swing arm for the pivot rod instead of cutting the mortise and drilling for the dowels. It's a feature that can always be added later. The holes can be any spacing and fall inside the front face of the mortise line detailed in the drawings. My first shavehorse, which is still going strong, uses a series of holes through the swing arm to adjust the height. This works fine but requires that you pull the pin and lift or lower the entire assembly while finding the

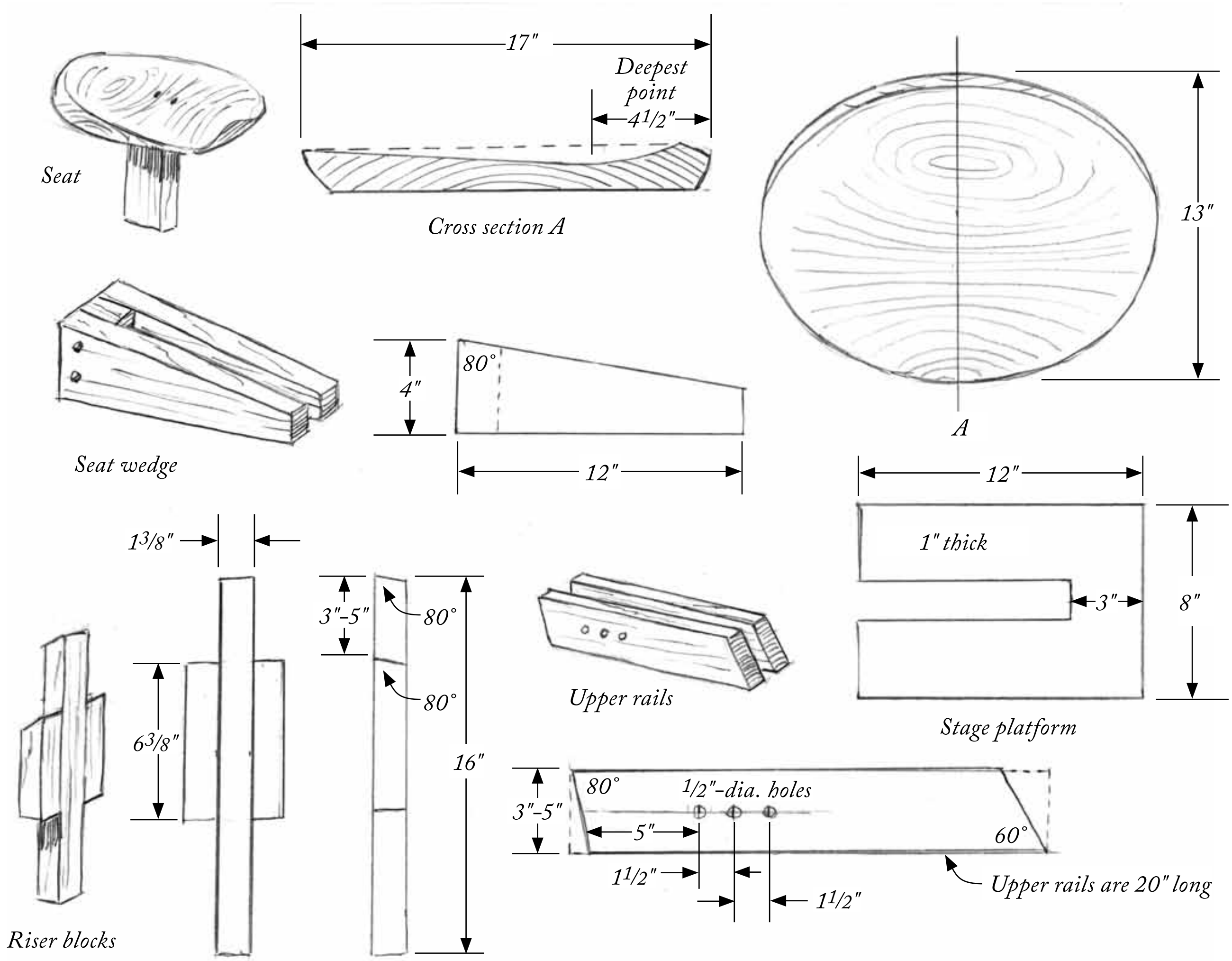



**FIG. B.7** *The parts for the upper bench assembly.*

correct hole. It's not a big issue, but I've found the dowel adjuster to be every bit as strong and much easier and faster to use.

Using the shavehorse is mostly intuitive, but there are a few details worth mentioning. I like to have the option of moving the entire swing arm forward in the housing or changing out the head to reach closer to the front of the stage. By shifting the swing arm forward, you gain access to more of the workpiece, and by moving it back, it can brace the workpiece with more stability.

It is also helpful to have the height of the head close to the workpiece. There is a mechanical advantage to having

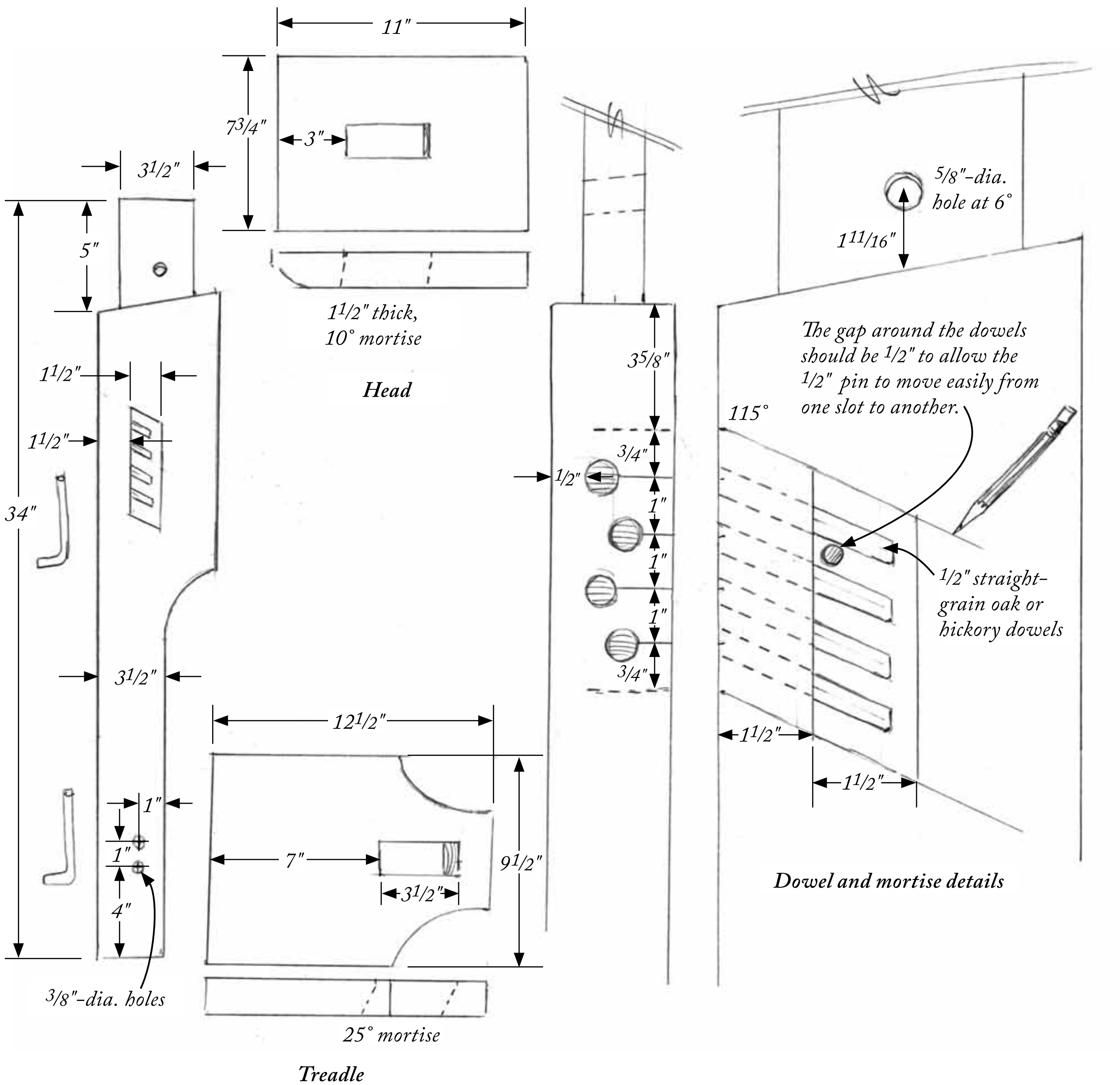



**FIG. B.8** *The parts for the swing-arm assembly.*

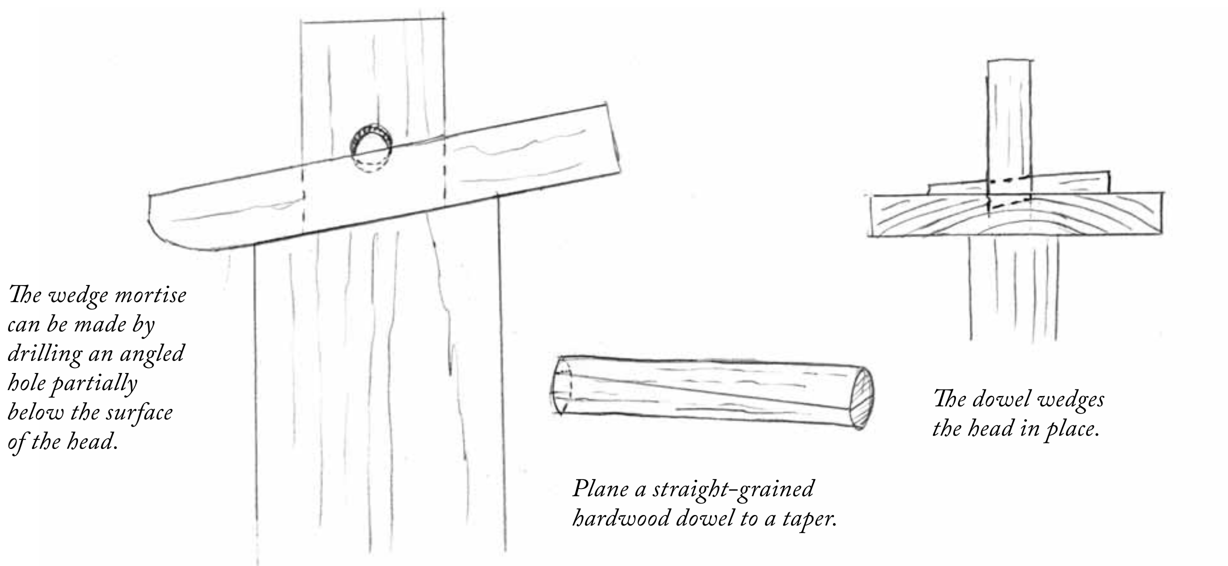



**FIG. B.9** ***Details for wedging the head.***

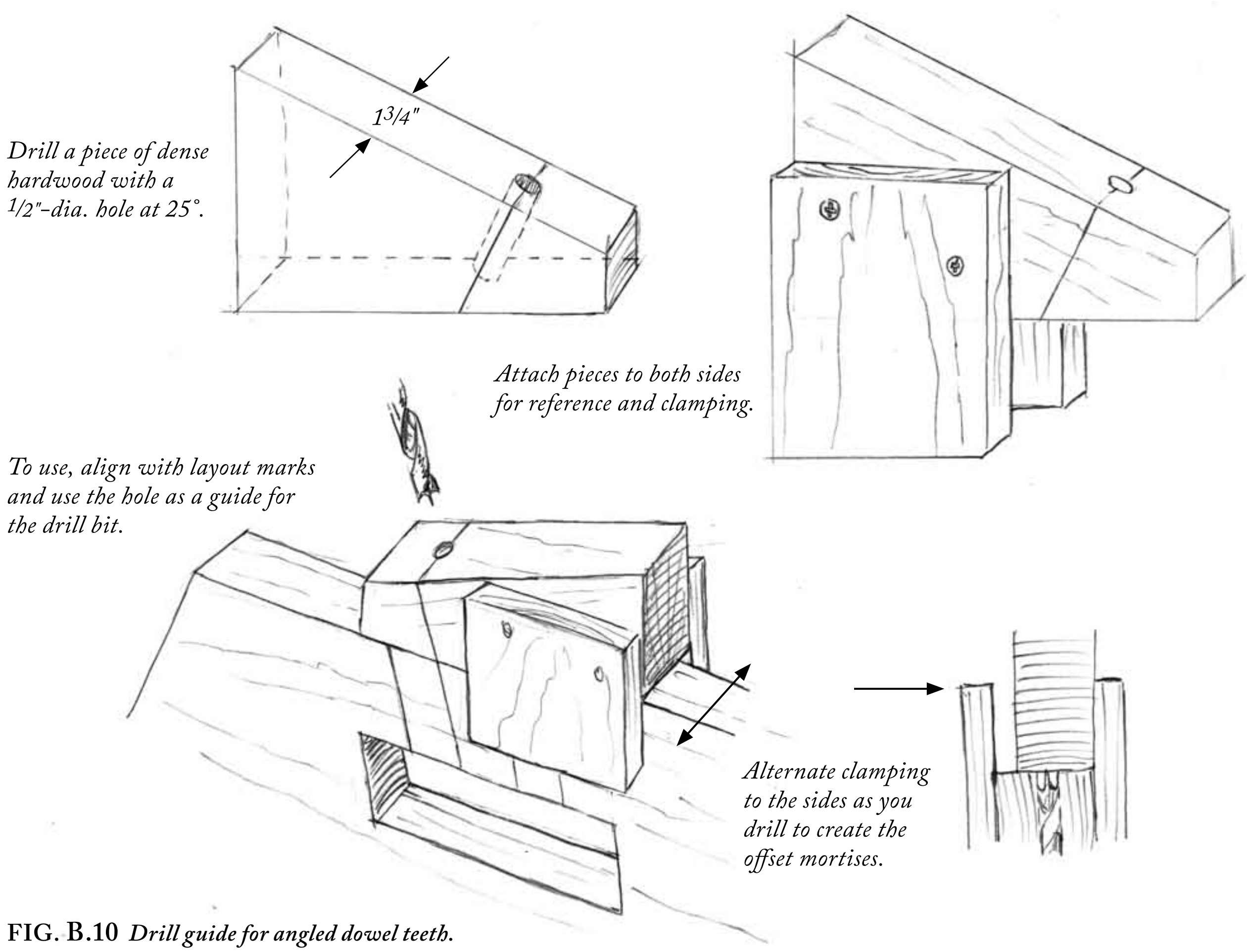
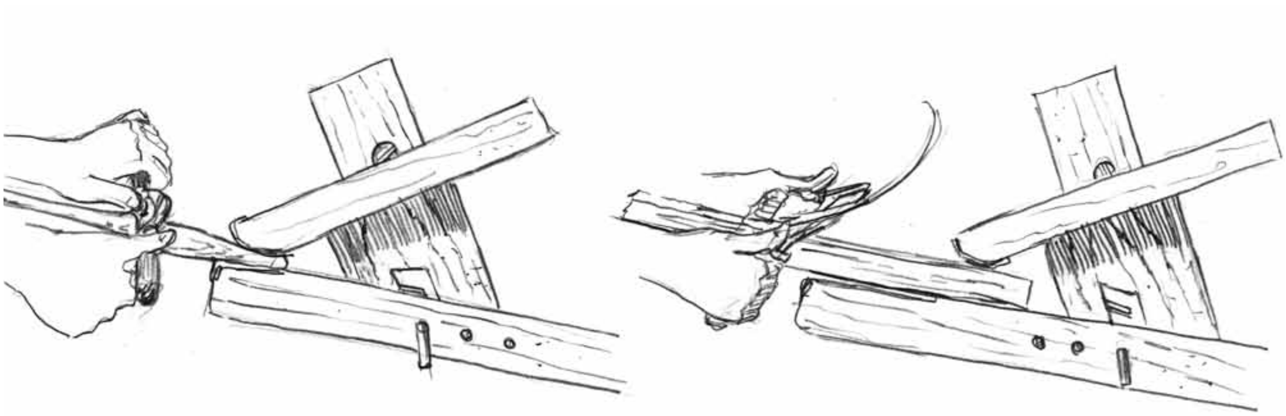



**FIG. B.10** ***Drill guide for angled dowel teeth.***

the head close to parallel to the workpiece when clamped down. The pulling force on the workpiece pulls the head forward and down as well, increasing the power. The other extreme, which is to have the head coming down vertically on the workpiece, is simply pinching the piece using only the force applied via the treadle.

It is also important to set the treadle at a comfortable height so your knees aren't dangerously close the the path of the drawknife or extended to the point where you can barely apply enough force to clamp the workpiece. Working comfortably is safer and permits the full range of motions and holding power required to achieve the task at hand.

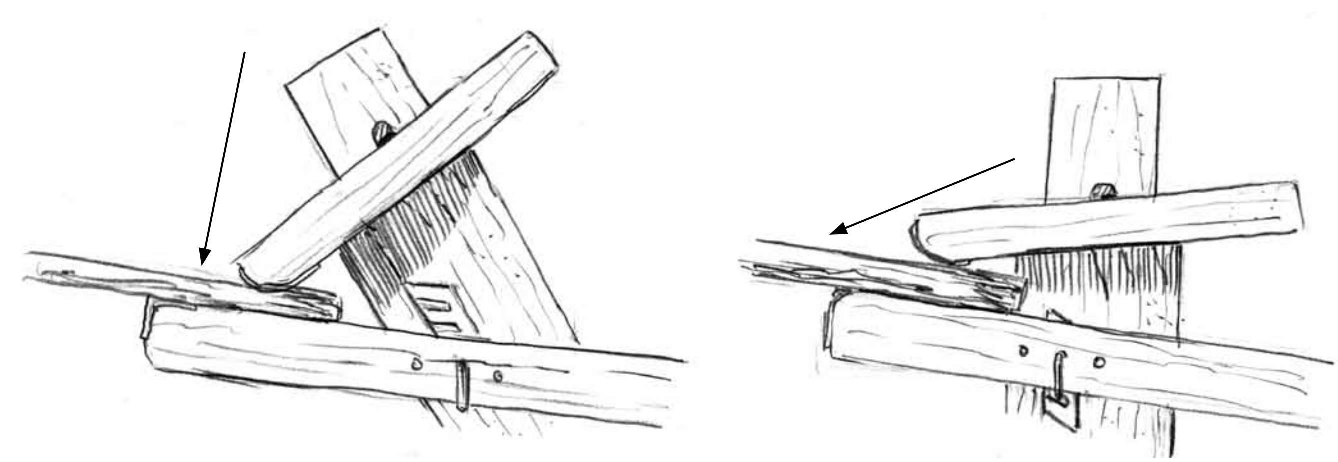
I've used lots of different shavehorses in different workshops. While they all rely on similar concepts, I have found that the design and execution can make the difference between a shavehorse that you curse at while using, and one you don't even notice. I believe that you will find the shavehorse shown in this chapter to be simple to build and a joy to use.



*Moving the swing arm to a forward position helps give more access when shaving smaller pieces.*

*Shifting the swing arm back helps resist the downward pressure when shaving longer pieces.*

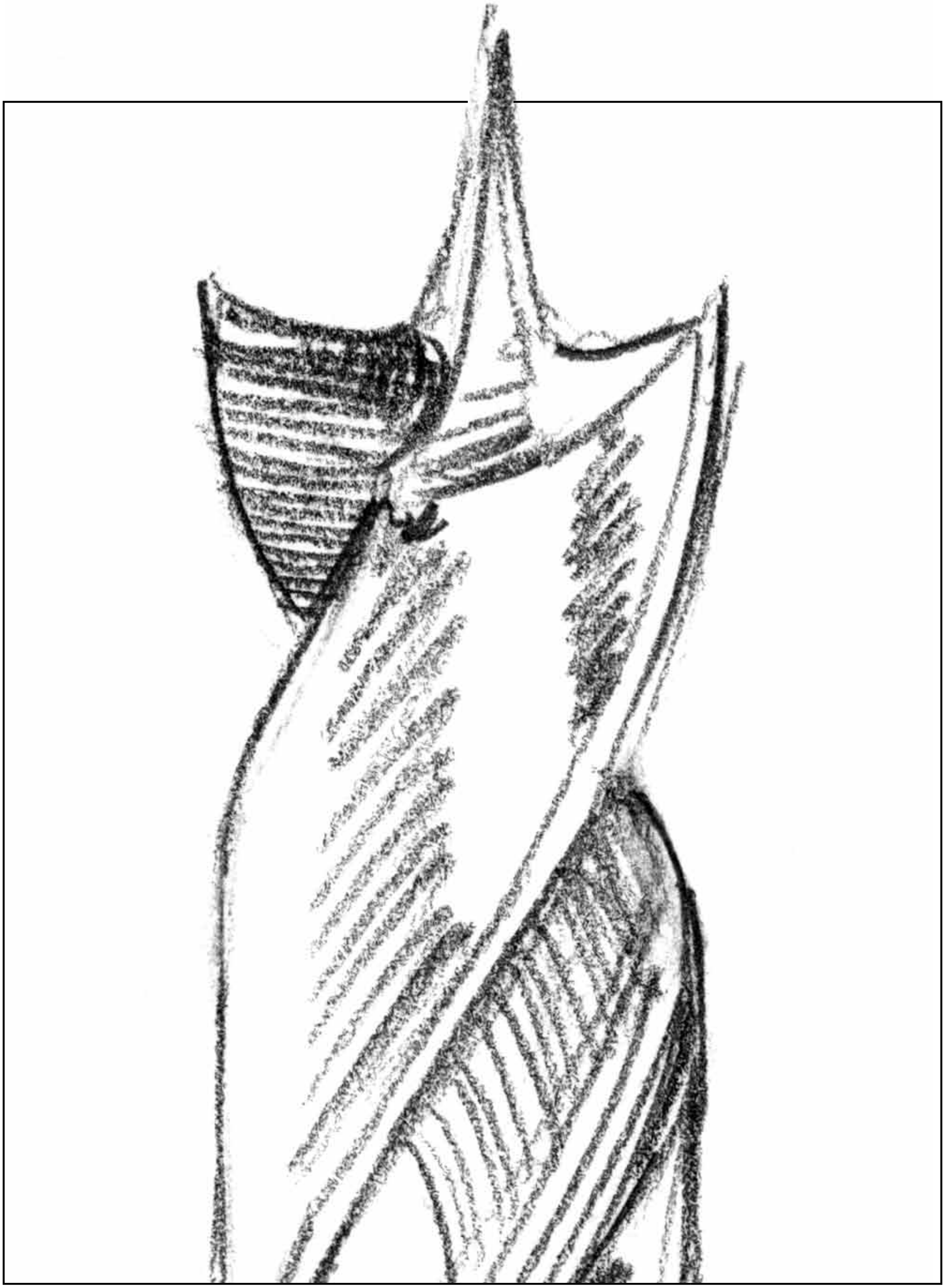
**FIG. B.11** ***Moving the swing arm allows you flexibility when working.***



*When the head is high off the piece, the force is a downward pinching force.*

*When the head is closer to parallel to the workpiece, the forward pulling stress on the workpiece pulls the head forward and down, creating a wedging efffect.*

**FIG. B.12** ***Keeping the head as low as is practical improves holding power.***



## APPENDIX C

# Grinding Drill Bits

This is the process for transforming standard machinist's twist bits into wood-cutting brad-points. I start with high-quality high-speed steel twist bits I purchase from a machinist supplier, Victor Machinery, in New York.

Then I use my wheel dresser to make a shape on the edge of my grinding wheel that will correspond to the wing of the brad-point. Using a coarse wheel for the initial grinding will speed the removal of the material, but any wheel can be used as long as it is well-dressed and used with light pressure. I always make sure that the corner is lower than the flat of the wheel that I use for general grinding. The sharper the corner, the deeper the wings on the resulting bit.

Another factor that determines the function of the bit is the angle that the tool rest is set and the resulting relief behind the cutting edge. I measured the angle of a bit that I used for most tasks and found it to be about 35° (see below). The steeper the angle, the more aggressive the bit; at some point, the edge is too thin to be effective. I always use high-speed steel because it doesn't lose its temper until it is red hot, so a little bluing is fine.

Below is the jig setup that I use while grinding. The simple wood fence positions the bit about 4° off the axis of

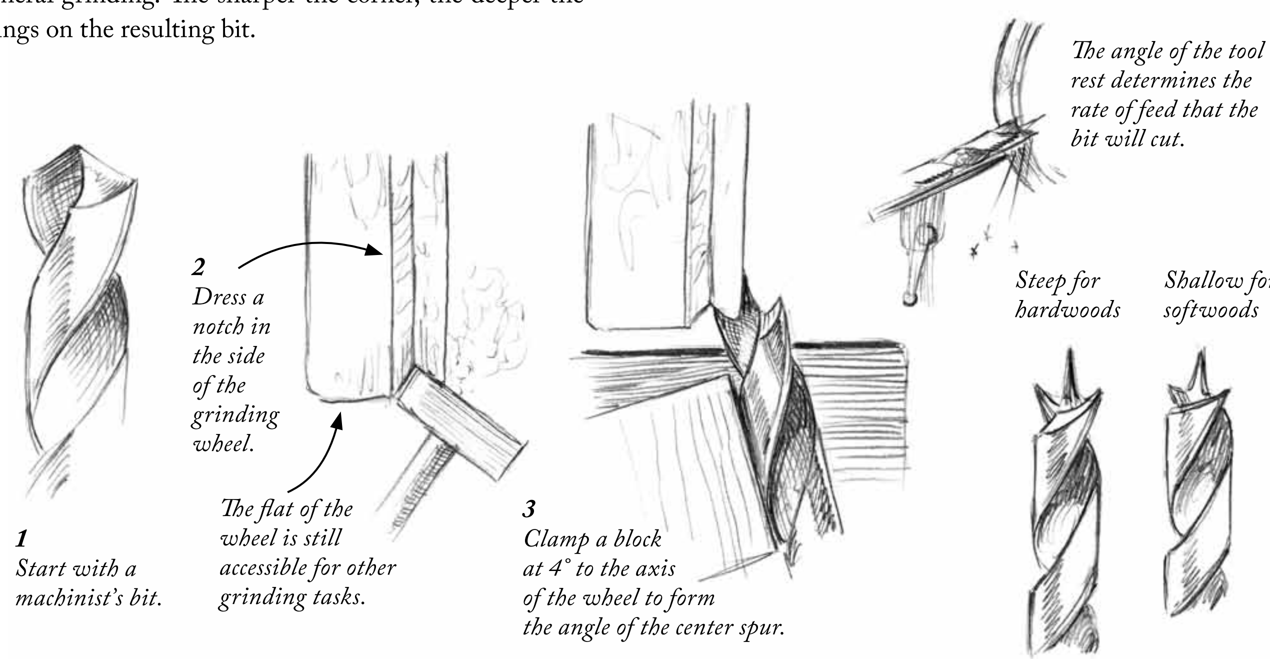



**FIG. C.1** ***The block on the tool rest controls the angle that the bit is presented to the wheel.***

the wheel. As you can see, it is the side of the wheel that actually forms the center point. By adjusting the location that I clamp the block to the rest, I can adjust the length of the bit's center point. The farther that the fence is to the right, the longer the center point will be.

Below is the first cut. I make sure that the existing cutting edge is horizontal and proceed to grind. After a moment, I judge whether the position of the fence is set correctly (left to right) to form the proper point. Of course it's better to have the point be too fat and long because it's simple to move the fence to left to remove more material.

Once the wings are formed, you will notice a thin sheet of metal on the parts of the bit that were vertical during the grinding process. I call these webbing. These are removed using the same setup as the wings, but have a couple of other concerns to be aware of. To start grinding, position the webbing so that it is now in the horizontal position that the cutting edges were in the first step.

The tricky part about grinding away the wings left by grinding the center point is that the wing that is pointing down is dangerously close to the grinding wheel and the slightest encounter will send you back to the beginning. It's not a big deal, but it's better avoided. I avoid hitting it by keeping the wing that is pointing up a little

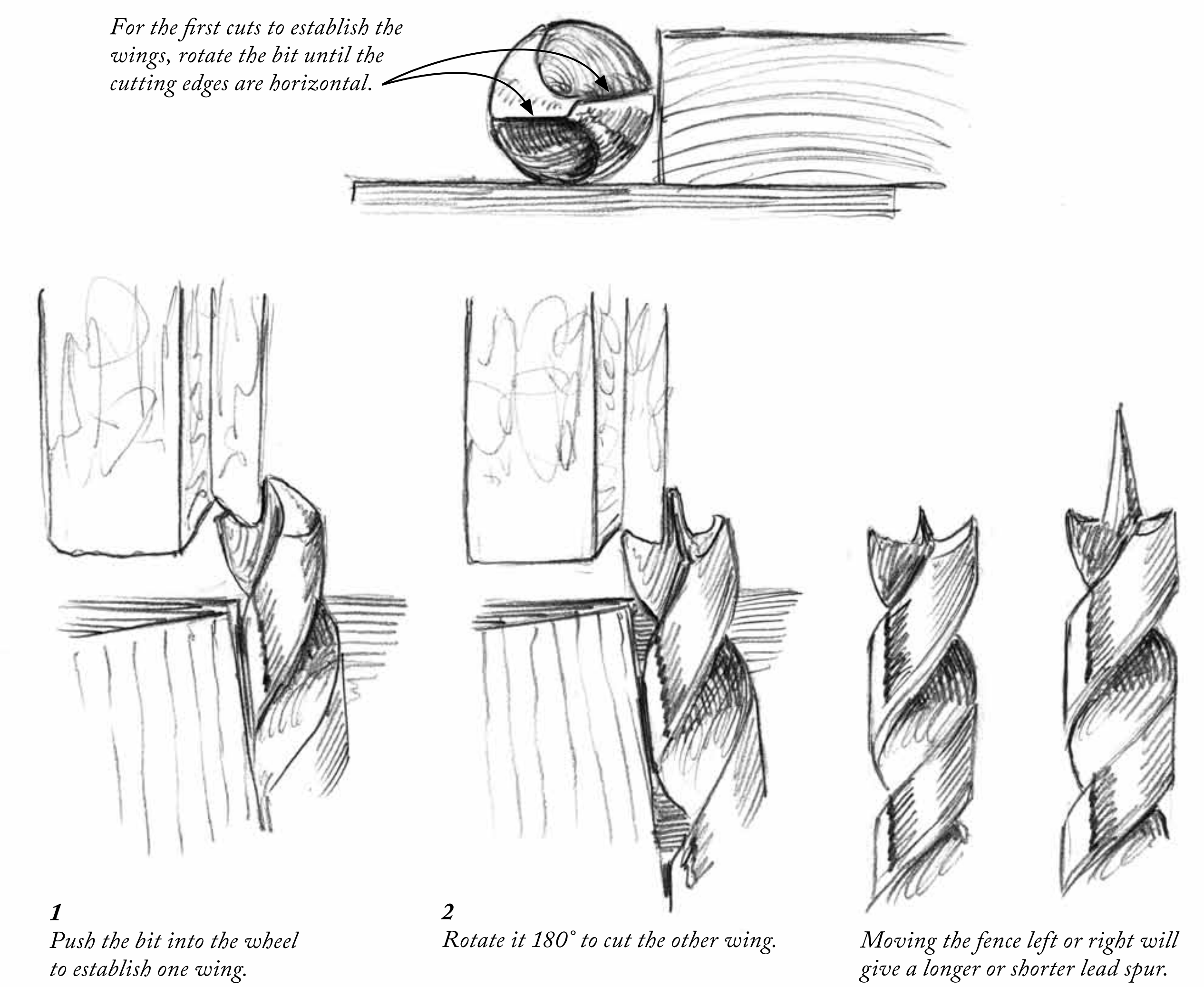
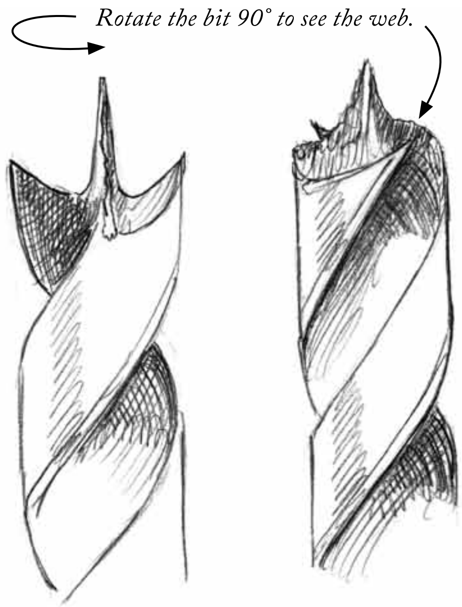
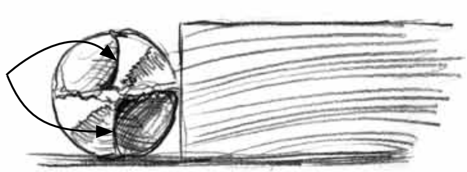



**FIG. C.2** ***The first cuts on the bit to form the brad point.***

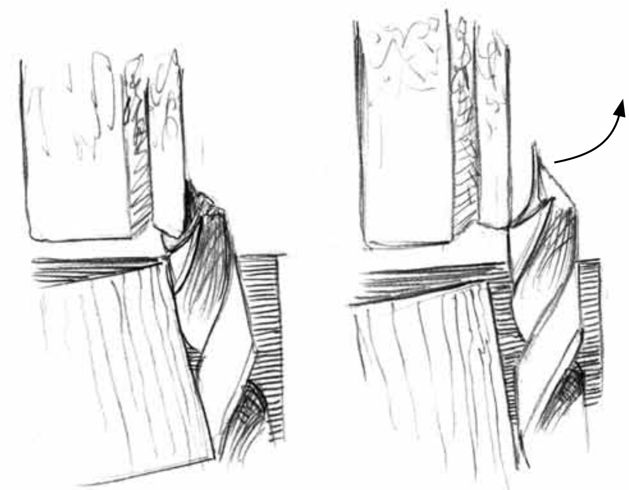
past vertical (toward the grinding wheel). By keeping the wing that I can easily see close to the grinding wheel, I can generally keep the other one in the clear. The other key to grinding the web is that as I proceed to push the bit into the wheel, I let it come off of the block a bit. This happens quite naturally because as I push into the wheel, the amount of metal that is cut gets greater and the bit wants to slide to the side. You can see the result of this in the drawing below.



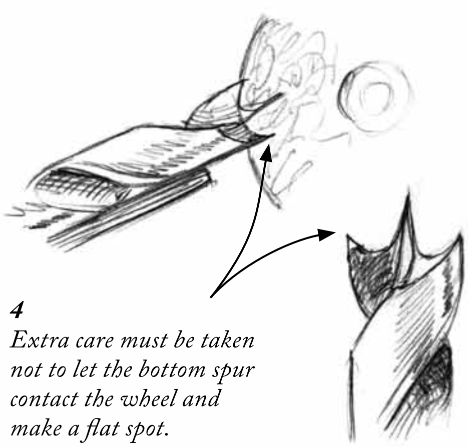

*1*
*After the wings are ground, there will be a thin web of material in the other plane.*



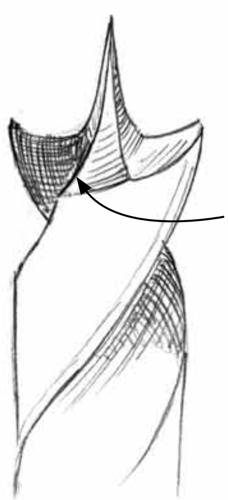
*2*
*Put the bit back on the tool rest and this time rotate the bit so that the cutting edges are vertical.*



*3*
*Push the bit into the wheel the same as when grinding the wings, but at the end of the cut, let the bit come slightly off the fence.*



*4*
*Extra care must be taken not to let the bottom spur contact the wheel and make a flat spot.*



*5*
*Then grind where the webbing was.*

**FIG. C.3** ***Above is the bit with the wings ground. All that remains is to remove the web (you can see it in the center of the bit) that has been left by the grinding.***

## The Bismark Bit

The "Bismark" is basically a twist bit with a center spur, used for end-grain drilling. It has no nickers like the first bit. Where standard twist bits tend to skitter before entering the wood, the lead spur of the Bismark keeps the bit in place and allows it to enter the cut at extreme angles, even more extreme than a brad-point because of the lack of nickers. I find this helpful when drilling blind holes in a bow at extreme angles because the entry is easy. Plus the bit excels, like its cousin the machinist's bit, in drilling end grain. Remember to set the clutch on your drill to "low" for these holes.

To make this bit, I first create one of my standard brad-points then proceed to grind back the nickers until I have a twist-bit geometry.

When most folks hear about grinding drill bits, they immediately assume that it will be difficult and require an accuracy that is beyond them. I am happy to say that this is not the case and that even crudely ground bits will outperform most store-bought brad-points. A drill bit is a tool that deserves attention and will return the favor in performance far more than expected. Start your grinding practice on old bits that you don't care about, regardless of what kind of steel they are and to learn the ins and outs of the process. This skill will serve you well.

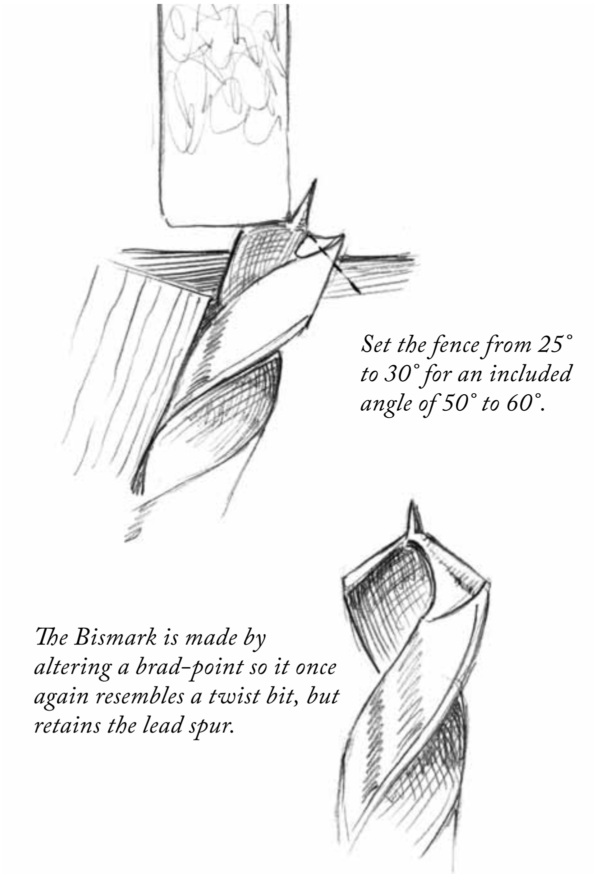



**FIG. C.4** ***Grinding the Bismark bit.***

# Afterword

Building a chair involves many tools and disciplines. Mastering one skill, such as sawing or planing, won't get you far. For me, this is part of the joy of it. I love the challenge and opportunity to expand and test my abilities at every turn.

One of my goals for this book was that it be not just about the successful way to perform each task, but also how you are likely to approach it as a new maker. I often refer to the process as a humane way of building, not only because the process has a wide range of results that will make a functional chair, but because the variety of tasks and the learning curves they present are readily achievable. The years that I've spent teaching others have given me a great appreciation for the risks that a new maker endures, and I wrote the text to reflect my hope that you will be patient with yourself. Learning is full of risks, and I tried to point out some of the pitfalls and help eliminate others.

That said, I warn my new students that it is usually the moment that they become comfortable with a new tool or technique when they should switch to a different tool and process to conquer. Using hand tools is quiet and fun, but it also demands focus. Because of this, building a chair will most likely keep you closer to the edge of failure than just about any project you've undertaken. Of course, that keeps it exciting, as well. The next chair will be dramatically easier, trust me.

If you find yourself perplexed or having trouble, step back and take a break; get out of the shop and go for a walk in the woods. You might see the trees in a new light. You will recognize specimens that would suit your work, as well as others that would not, due to their efforts to survive. Even if you never cut one of these trees down, you will have learned to see differently. And that vision will stay with you regardless of the project on your bench.

Sometimes it's helpful to work on two chairs at once. That way I can use downtime on one chair to switch gears and work on a different process on the other. It's no mystery that the final fussing with the surface quality and applying the finish makes the release of swinging a sledgehammer all the more of a pleasure.

Working on this book has also served to highlight my own interests and tendencies. If I were to state it bluntly, I would have to say that I am more interested in the experience that I have in the shop than what I produce in it. Not to say that I take the long way around just for the sightseeing, but that I ask myself frank questions about what I actually want to spend my time doing. Sure, I have fantasies about thousands of board feet of handplaned boards and lovingly cut dovetails, but this soon gives way to the realities of monotony.

It's amusing when people attribute the quality of patience to the work I do because it's just the opposite. I want a huge bang for my buck when it comes to my focus; and while making chairs, I rarely have to work for it. Of course, the proof of my time in the shop are the finished chairs, but they leave. And what's left is me, my tools and the wood. How I feel and what I do in my shop is truly what I work to refine and sustain. Perhaps this sounds indulgent, but when I reflect on what started me on this path – my desire to work closely with wood – it seems reasonable that guarding and developing my interest is the best way to proceed.

Beyond the challenges in building chairs, I find the objects themselves compelling. I think of times spent with

friends and family around the dinner table, long after the plates are empty as we kick back and enjoy the conversation. Or I think of my rocking chair that is my daily destination where I will rest my bones and get myself ready for the night. Chairs can be as close to us as clothing, and the right fit and quality is always noted and welcome.

There are a limited number of things that one can build in a lifetime, and there are all sorts of concerns pulling us every which way. I hope that this book will inform your own questions and decisions about how to spend your time, or at least give you a good place to sit while you mull it over.

Peter Galbert
January 2015

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*I have designed a few chairmaking tools in conjunction with a few independent artisans who offer them for sale. I do receive some residual income from these tools. Most of the proceeds, however, go to the people who produce the tools.*

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I wish to express my deep appreciation to Sue Scott, for many years of encouragement and sharing as I set out first to become a chairmaker and later start this book.

Thanks to all my students, whose patience and courage enabled me to learn this craft in new and deeper ways.

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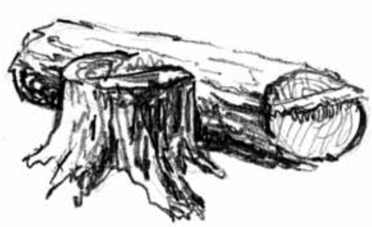
Special thanks to Stephanie Hubbard for her support and encouragement as I jumped the final hurdles to finish the project.

My advice to anyone setting out to write a book, find a Chris Schwarz (I assure you there is only one) and go meet all my friends and family; they will be essential.



# About the Author

Peter Galbert grew up in Georgia and studied art in Chicago where he began working with wood in the early 1990s. Before specializing in chairs, he worked as a cabinet and furniture maker in New York City. In 2000, he began to concentrate on making chairs from green wood. He now lives in Central Massachusetts where he makes chairs and teaches in his workshop, as well as at woodworking schools around the world. He's been featured in numerous magazines and has written articles on chairmaking for various publications.

He also writes the Chair Notes Blog (chairnotes.blogspot.com) and has designed and invented various tools for the trade.

Besides woodworking, Pete raises goats and chickens, and he makes maple syrup for his friends.

His website is petergalbertchairmaker.com.

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