THE STICK CHAIR BOOK

2nd Revised Edition

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By Christopher Schwarz

Lost Art Press

First version published by Lost Art Press LLC in 2021
837 Willard St., Covington, KY 41011, USA
Web: https://lostartpress.com

Title: The Stick Chair Book, 2nd Revised Edition
Author: Christopher Schwarz
Editor: Megan Fitzpatrick
Technical editors: Rudy Everts & Klaus Skrudland
Copy editor: Kara Gebhart Uhl
Technical illustrations: Josh Cook
Endsheet illustration: Lee John Phillips (leejohnphillips.co.uk)
Title page carving: Rudy Everts (underhatchet.com)
Distribution: John Hoffman

First printing of the second revised edition.

ISBN: XXXXXXX

This book was printed and bound in the United States.
Signature Book Printing, Inc.
https://signature-book.com

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For the apprentices, Kale and Katherine.

A PLACE TO SIT

Stick chairs are the dark shadow to every over-carved and plumply stuffed chair that has Roman numerals littered behind its name.

PREFACE
COMMONPLACE CHAIRS

There are only a few things more intimate than building a chair for someone. That's because unlike a cabinet, a chest or a set of shelves, a chair doesn't hold possessions. It holds people, and sometimes tightly.

The Welsh have a word for a chair that holds people snugly: *cwtch* – a hug or a cuddle. And we want to be held. Every night there's the promise of a chair, a beer and Lead Belly on the record player. So you lean back into the chair's sticks, and they flex slightly around your shoulders to receive you. Your thumb rubs the arm, and in time the paint wears through because of this nightly ritual. After a few years, the chairs through-tenons peek out, like pennies rising from the deep. And the exposed oak fibers take on a mellow glow thanks to the oil and dirt from your hands.

In time, the chair and you become like spoons in a drawer. You learn to position your body to sit in the chair for long conversations. One buttock here, the small of your back there. The chair returns the favor as an unfailing skeleton, keeping you upright after a day of hard work.

In some ways, the relationship is like being married to a tree or a turtle. Good stick chairs are designed to outlast us all. You might be its first owner, but you are unlikely to be its last.

Even as the oil from your hands and the condensation from your glass melt into the chair's fibers, deepening the bond between the chair and its sitter, it's impossible to fully separate the object from the woods it came from.

To be fair, all wooden objects carry the spirit of the forest with them to some degree. But high-style pieces symbolize a triumph of people's ingenuity over the woods – the transformation of rough fibers into feats of geometry, symmetry and sheen. The wood traveled across the ocean so it could be cut, laminated, carved, veneered and colored to demonstrate the skill of the maker and the wealth of its owner.

Stick chairs, on the other hand, are a close compromise between nature and the needs of regular people. The chairs take many of their shapes from humble and local raw materials. The seat's curve might be determined by where the knots and splits were located in the slab on hand. The arm's shape might be determined by how the tree grew. The legs might have a bend to them because they were harvested from the bottom of the tree, where the roots spread out.

Also, stick chairs are ultimately simple in their overall form, with little or no ornamentation. Perhaps this was because the chairs were covered in animal skins or blankets for most of the year. Or the chairs were made by the same hands that might make an ox's yoke or a fencepost. So they didn't have time for decoration.

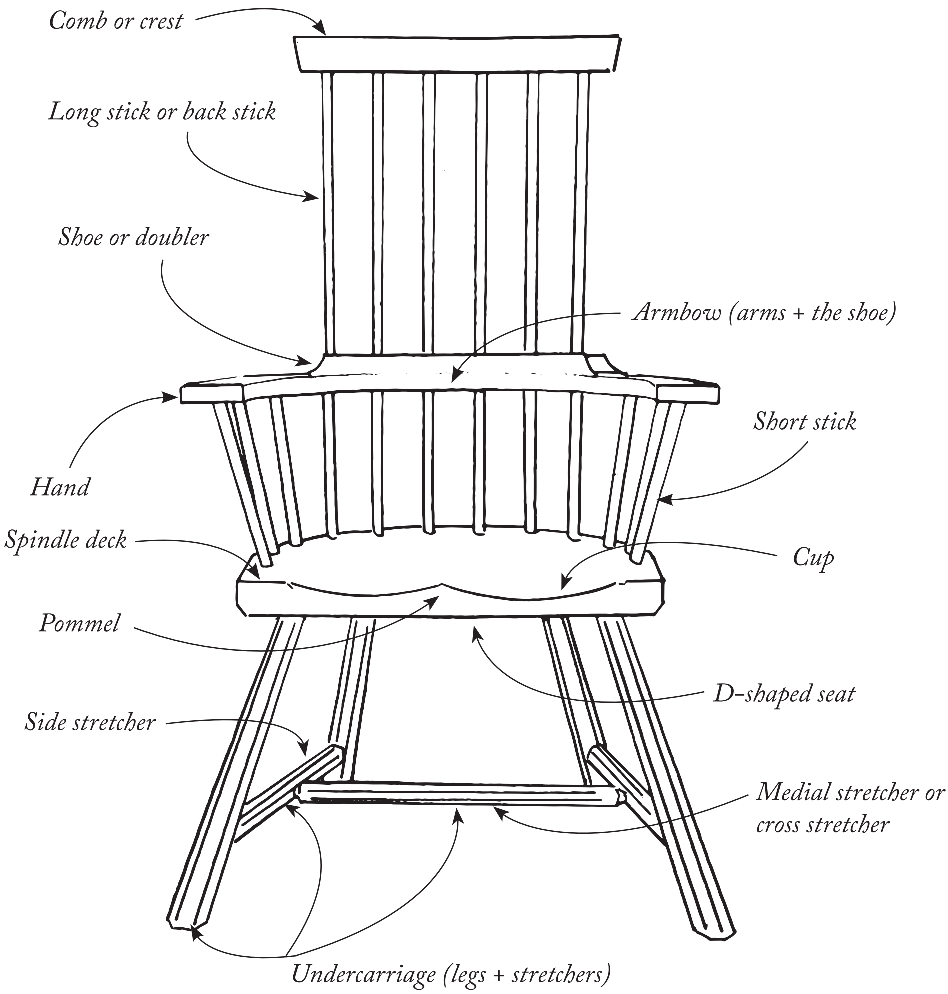
But there's more to the term "stick chair" than the materials and the form. In my mind, it's about who made the thing.

Stick chairs were, for the most part, built by an amateur or part-time woodworker. The old story is that farmers, carpenters or anyone who did seasonal work would make stick chairs in the off-season for their household or to sell to neighbors. As a result, the chairs were made with simple tools, local materials and basic but sturdy joints.

Another important aspect of stick chairs is that you are unlikely to find two identical ones. And if you do find twins, it's likely the two have grown apart. Many of these chairs have been modified and repaired during the last 200 years. And that's because they were prized possessions. Once you examine them closely and see how they were adored, abused, repaired, refinished and reinforced, it's difficult not to fall in love with them.

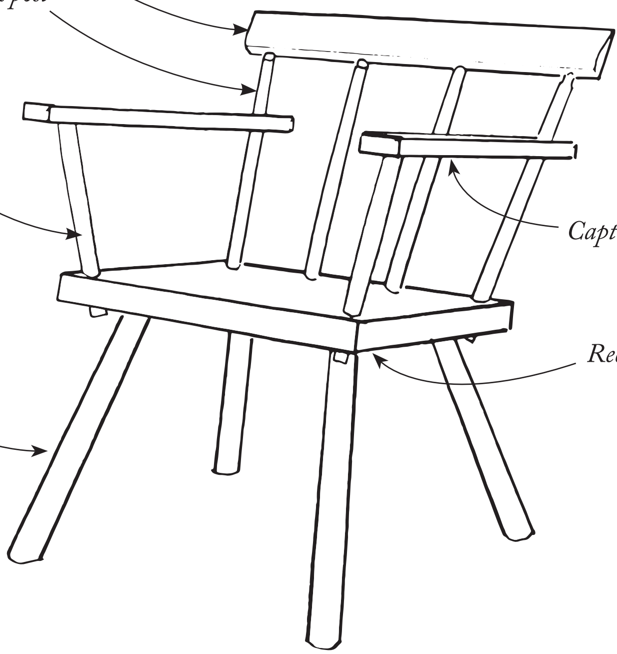
And if you have fallen in love with the way they look, you are probably wondering if these chairs could possibly be comfortable.

I suppose that by modern La-Z-Boy standards, stick chairs cannot compete. I think it depends on what your expectations are. I spend about four hours of every day in a stick chair. I drink my morning coffee in an oak four-stick chair in the kitchen, where I answer my overnight emails and make a list of things to do that day. When I take a break in the workshop, I sit in an unsaddled comb-back chair with a glass of water and decide if my list was too damn long. And at dinner I sit in a green comb-back chair (the third chair I ever made) as I have every night since 2003. It's not like I have a choice in the matter. Every chair at our dinner table is a stick chair.



COMB-BACK ANATOMY

If we're going to discuss stick chairs and understand one another, then it's best we use the same words. Most of the parts of stick chairs are named after parts of the human body. The illustrations in this chapter will help you identify the different parts of common stick chairs and the terms used in this book.



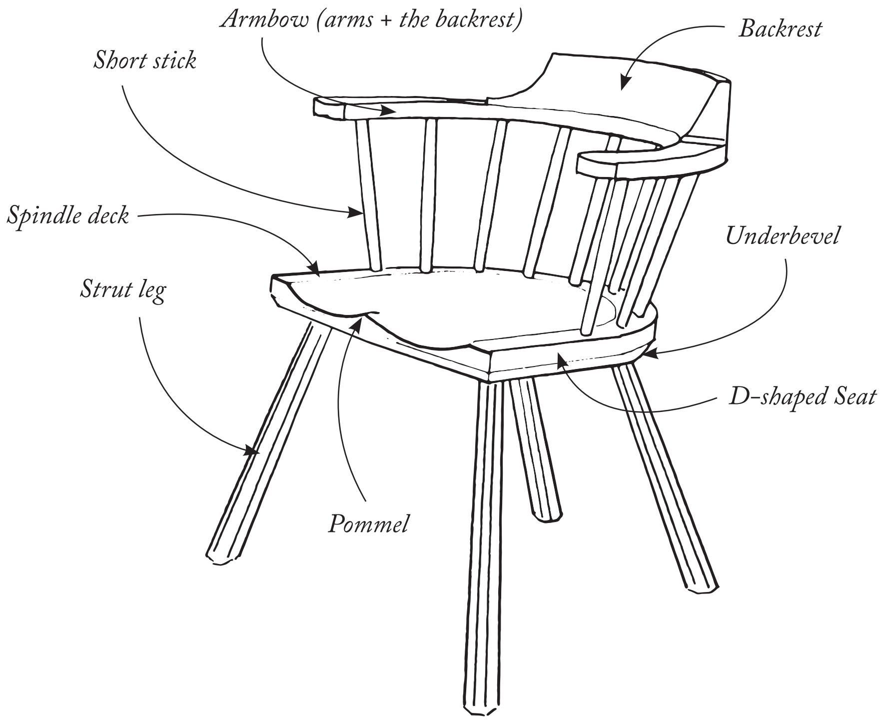
ARMCHAIR ANATOMY
A simple Irish chair with sticks that protrude below the seat board. Note that the seat is unsaddled. And how the piece that joins the back sticks is called a "backrest" and not a "comb."

Some of the chairs have sheepskins on their seats to make them more comfortable. But all of them are scratched, scuffed and shinier in the places that touch your skin.

Since I made my first stick chair in 2003, I have learned how to build stick chairs so they are quite comfortable. Also, and this is important, I have learned how to sit in stick chairs and be quite content.

So yes, they are comfortable.

This book is intended to help you design and build stick chairs for



LOWBACK ANATOMY
A contemporary stick lowback with strut legs and shaved sticks.

friends, family and customers. While I offer detailed plans for chairs that I have refined over many years, I also want to show you how almost any stick chair is within your grasp. The chapter on seats shows 14 different seat shapes. The chapter on legs has a bunch of common forms that can be made with only a couple handplanes. Add those to all the arm-joinery options, hand shapes, stretcher shapes and comb designs, and you could make stick chairs your entire life without ever making the same one twice.

If you have avoided chairmaking because of all the specialty tools and techniques, I think you'll find a way forward in this book. I don't own a lot of specialty chairmaking tools. And I don't use a lot of techniques that are particular to chairmaking.

You don't need a shavehorse or steambox to make a chair. You don't need to rive green wood. You don't need a drawknife or a lathe. Please don't get me wrong, all these tools and processes are great, but you don't have to own them to make a chair.

It's my hope that you will use this book to make a bunch of comfortable chairs using simple tools and basic materials. If you are an experienced woodworker, I think you'll find you already have most of the tools and skills needed to start right away on the chairs in this book. If you are just getting started in the craft, I suggest you first build a three-legged stool with dowels and 2x12 material from the home center. A handsaw, 1" drill bit and block plane will get the job done. Once you make a simple stool, you'll see how making a backstool or armchair requires only a few more holes and sticks. And from there you can make almost any stick chair.

Some of you (like me) will be happy to make these simple chairs for the rest of your days. Others might move on to Windsor chairs (the more elaborate and popular cousin of the stick chair) and then make the great leap to the carved frame chairs (Chippendale *et al*) that grace the world's museums.

Chairmaking in and of itself is a great tradition. And even if you plan to stay in its lower ranks (I'll be there with the beer and the LPs), you are still part of the lineage of people who see geometry and wood in a different way than cabinetmakers, turners, marquetarians, joiners and carpenters.

It doesn't make chairmakers special – just their own kind of weird. And if you haven't noticed, all woodworkers are kind of weird.

"Dude, you can just buy a chair/desk/Järvfjället at IKEA for just $59. What the heck is wrong with you?"

If you can't answer that question, then welcome to our odd club.

Christopher Schwarz
Covington, Kentucky
February 2021

INSPECTING A CLASSIC

If there's one thing that is almost as nice as sitting in a stick chair, it's getting to inspect a gorgeous antique one.

EASIER THAN IT LOOKS
Stick chairs look more daunting to build than they really are. Once you master a few basic principles, a wide variety of chairs become straightforward to build.

INTRODUCTION
THAT'S NOT THE CASE

The list of people who are more qualified than me to write a book on chairs is about as long as my leg. So, if I can make a chair that looks good and sits comfortably, then anyone with a few tools and a little space to work can do the same thing.

If you've never built a chair, this might sound deranged. What about the compound angles? The curves? The riven wood? The steambending? All the wacky tools that look hard to sharpen and master? And how can a mortal ever know enough to design a chair from scratch?

Many of the procedures in this book are short detours around acquiring a lifetime of muscle memory (or buying gizmos and jigs). I think the trick to learning chairmaking is to learn the tricks. After years of working alongside talented woodworkers, I found that many complex tasks are overcome with "workshop witchcraft." Almost every complex task I've ever learned has been defeated with a cocktail of cleverness mixed with a clear understanding of the process.

Veneering, inlay, chairmaking and finishing all have simple (but not immediately obvious) procedures at their hearts. Yes, you need to learn the core skills. But if a teacher shows you a few hard-earned tricks, it doesn't take long to become basically proficient.

So yeah, chair geometry isn't a big deal. I promise that you don't have to understand trigonometry to build a chair with compound-angle joints. People have built great chairs for centuries without the benefit (or burden) of trig.

Another common hang-up is the curves. Graceful chairs look like a dynamic combination of complex curves. Where do these shapes come from? Surely you have to develop an eye for both drawing and sawing graceful, freehand curves to make a beautiful chair.

Wrong. Most curves in the folk chairs derive from shapes you learned in kindergarten. A rectangle plus a half-circle creates a D-shaped seat that can be tarted up with decorative details to obscure its utter simplicity. Arms, crest rails and even crinoline stretchers are mostly basic arcs created with trammel points. Or, in my case, an old yardstick pecked with holes.

False and real ellipses are rare in vernacular chairmaking. And so are irregular curves, which you can create with a set of French curves. Mostly it's all just a few simple arcs and a couple rectangles.

WHERE TO GET WOOD

The next problem, and it's a big one, is finding the material for making chairs. As a budding chairmaker, I was keen to use green wood because riving out parts seemed efficient, economical and kind of amazing (there's no kerf!).

It turns out it's a little more involved than splitting firewood.

I live in a city where getting a giant log delivered to the shop is possible, but not easy. I don't have a good place to break down wet wood into chair parts. I've done it on our patio, but it makes a huge mess. Any time you encounter a knot or twisted grain, that chunk is likely trash. Bark? Trash. Pith? Trash. Curved stuff at the butt of the log? Maybe trash; maybe not.

To split our furniture parts you need some space. And you need a brake (a jig for managing the riving). A chain saw. A cant hook. Many wedges. You should have a sizable tub of water for storing logs that await the froe. You need space to stack up all the material as it dries. And you need a way to deal with the piles of trash created by riving.

If you live in the country, you can throw the waste in a ditch and let the bugs do their work. But when your neighbors have two legs (instead of six) and have law degrees (instead of hindguts) you don't want piles of bark and twisted stock piled up everywhere when the city's code enforcement officer stops by. Yes, you might be able to burn it. But then again, most cities have laws about open flames. And no matter what, you still have to dry it before you set fire to it.

Because I have zero acres, I want to be a good neighbor and there are several lawyers living on our street, my chairmaking has always been about using whatever wood is readily available. Finding this approach was an accident.

LUMBERYARD OAK

Because I live in the inner city, green wood is more difficult to manage than kiln-dried stock. So I get my wood from the lumberyard. You can saw and rive lumberyard wood to get dead-straight grain. And that's what matters.

A LESSON FROM AN UGLY DUCKLING

After I took my first chairmaking class in 2003, I needed to build another chair immediately so I wouldn't forget what I'd learned. But there were problems with that plan. Problem No. 1: I didn't have access to green wood. Problem No. 2: I didn't have a lot of chairmaking tools.

But I had a basement shop in a city. I had a pile of kiln-dried scraps that were sitting around after a bunch of other jobs. And I had a scorp and a spokeshave.

"Screw it," I said. And I decided to build my second chair using the scraps – a chunk of tulip poplar, white oak and a stack of low-quality ash I'd bought in Indiana. I figured the chair would fall apart in short order, but that was OK because the practice would do me good.

I built the chair. It's an awkward thing I made without drawing up plans. I saddled the seat too deeply, and the pommel looks like a gerbil crouched under a blanket. The hands look like a sea creature is trying to hug you – awkwardly. But dammit, that chair is still solid today, even though it defied every rule I'd read about chairmaking. And if it were painted, it might not look so damn awful.

Basically, that awkward chair taught me that:

• Chair parts do not have to be rived. They can be sawn out of solid stock so the grain is nearly dead straight. Yes, rived stock is technically the best. But sawing it out with care works, too.

• Seats don't have to be one solid piece of wood. You can glue them up from two or three pieces. Simply reinforce the joints with loose tenons or splines.

• Arms don't need to be steambent. You can piece together a strong arm with three or four chunks of carefully selected stock.

• Moisture content isn't as big a deal as it might seem. If all your stock is the same moisture content, your chair will be OK. It's not imperative to super-dry your tenons. Or use wet seats.

• You can use almost any species of wood for chairmaking. Yes, oak and hickory are great for the spindles and legs. And it's best to make seats out of a species that isn't easily rived. But you can get by with whatever you have. Maple, cherry, walnut – heck, use construction lumber. The trick is to make the stock a tad thicker when you use a weaker wood. Oak parts can be thin because the wood is so strong

BREAKING A PROMISE

I swore to myself I'd never publish photos of my second chair, but here it is. It's ugly. But it's still in service and taught me important lessons that are in this book.

(especially when rived). But if you add some thickness to an arm, stick or leg, you can substitute other species.

After making my hideous chair, I didn't show it to anyone who knew anything about woodworking. It sat in our sunroom and was "overflow" seating for (hopefully alcohol-impaired) guests. But the fact it was so sturdy amused and interested me.

Of course, my "eurekas" mentioned above were nothing new. Old vernacular chairs built by farmers used the same ideas. The most important rule was this: Use what you've got and use it to the fullest.

But most of all, use it.

If you are too picky about materials, you will never make anything. You'll instead become a curator of piles of almost-good-enough chair parts. Almost straight-enough grain for the sticks. Almost defect-free legs. Almost dry-enough or wet-enough seats, legs and stretchers.

To prove to myself that my ugly chair wasn't an anomaly, I built a bunch of chairs using materials from the home center, including the chair I drink coffee in every morning. That meant tulip poplar or kitchen-grade red oak for the seats, legs, stretchers, arms and comb. And 5/8"-diameter red oak dowels for the sticks.

Yup. Dowels. Whenever I'd visit a home center, I'd visit the dowel section, dump the 5/8" dowels on the floor and pore over each one. Was the grain straight? Was the stick straight? Were there defects? In most cases, I could harvest five or six good dowels per visit.

Grain is grain. If it's straight because of riving or sawing, it's still straight. Or straight enough. (Hint: If the grain in your sticks isn't dead straight, add a few more sticks to the chair to make it stronger.)

If you dismiss everything else in this book, I hope that you'll at least acknowledge that grain is grain. If you can look at a board and think in three dimensions, then you can find a chair part in there where the grain fibers run nearly continuously from one end to the other. Sometimes you can rive the board to obtain that special, strong stick. Sometimes riving won't work because the species isn't easily rived. But you can always saw it out.

A PRACTICAL TOOL KIT

If obtaining the wood for chairmaking doesn't discourage you, try assembling a tool kit. Chairmaking tools can seem rare, expensive and numerous. A single tool such as a travisher or scorp can cost as much as two IKEA chairs. And sharpening these tools seems to open up a Pandora's Toolbox of stuff to buy.

I have flushed away so much money on chairmaking tools it's embarrassing. Back in the 1990s if a catalog said a tool was used for chairmaking, I'd buy it. Most were useless.

These days, I don't use a lot of specialty chairmaking tools. I have a scorp, travisher and some tenon cutters. But I don't use a drawknife, adze, shaving horse, chair devil or beetle. Instead, most of my tools for making chairs are the tools I use for making cabinets and tables. So, I do a lot of work with my jack plane, block plane and spokeshave. I hold my work at a joiner's workbench. A lot of components get finished with a cabinet scraper and a little sanding.

You don't need a lot of specialty tools. This book's chapter on tools goes into detail about the basic kit to get you started.

YOUR NEW CHAIR DESIGN

One last worry: chair design. How do you combine geometry, curves and demanding joinery into something that looks good from many angles and can be sat in for several hours?

Step one: Build other people's designs and keep them in your house. Step two: Examine a lot of gorgeous and horrible chairs. Step three: Design your own chairs.

It's that simple. This book has plans for five comfortable chairs that I've refined through many iterations. If they don't appeal to you, the world is filled with plans from others. There is no shame in building other people's chairs, just like there's no shame in playing Johnny Cash covers until you can compose your own songs.

Once you get the feel of a good chair in your bones, you should venture out into the world. Try out the chairs on the showroom floor at the Unpainted Arizona furniture store. Most will torture your body. A few will not. Why? Examine the slope and curve of the chair's back, plus the seat's slope and the position of the arms. Write this down.

Study chairs in museums. You can't sit in these chairs, so you have to take photos and judge them by eye. Measure their angles in your photos. Compare them to the chairs in your house. Your research will result in a set of numbers that you like. (Don't worry, I'm going to tell

BEAUTY VS. COMFORT

One of the great leaps in chairmaking is being able to marry beauty with comfort. Visually, this chair is fine, but it is torture to sit in. This design pushed me to explore new backrest angles.

you the angles and measurements I like – I have no secrets. But not everyone will agree with my numbers.)

When you are ready to build a chair of your own design, first make a mock-up using the imperfect chair parts left over from previous chairs. I have buckets of half-decent spindles, legs, stretchers, combs and arms. After you build a few chairs, you'll have the same problem/resource/fire hazard/marital talking point.

Leftover parts make it easy to throw together a chair design with little effort. Using junky parts, I can construct a kinda-chair in two or three hours to test it out with my butt and my back (the eyes aren't the best judge of a chair). If the prototype sits well, I'll keep it around as I build a real version using better wood. If the prototype sucks, I'll take the thing apart and use the parts to make some stools. And if the parts are too small for a stool, I'll use them to make a fire.

Also, when you attempt to design a chair, know that it will always derive from another chair. Your first chairs will be based on other people's chairs. After you build a dozen more chairs, you'll find that your chairs are based on … your chairs.

If I am making this sound too simple, then I've succeeded. Chairmaking is no more difficult than building a chest of drawers or a wall cabinet. I am proof of that. I contend that chairs seem difficult to build because woodworkers have become fixated on 90°. That angle – 90° – is no more difficult to achieve than 21.5°. All angles are just lines in space and are as easy to hit as 90° or 45°.

In fact, I contend that chairs can be more forgiving to build than cabinets. That's because 20° and 21° – give or take – will work fine for a chair's backrest. But 91° (instead of 90°) is a visible mistake for a tenon shoulder on a door's rail.

At this point, you might not believe me. That's OK. In 1998, I thought chairmakers needed the skills of Euclid, Archimedes and Apollonius to make a graceful chair. It turns out, however, that even a math-impaired Arkansas boy can do it.

WHY THE REVISED EDITION?

Though I've been building stick chairs since 2003, my methods continue to improve. I'm not alone. Many of the classic chairmaking texts out there have been either revised or abandoned by the author because their techniques have changed so much. This second revised edition is my attempt to keep readers up to speed with the simplest and most straightforward techniques for making these chairs. What's new in this (hopefully final) edition?

The biggest change is the tenons for the legs. When I started making stick chairs, I used cylindrical tenons on my legs because that's what I was taught. When inexpensive tools became available for making tapered tenons and mortises, I tried and embraced those. Tapered joints, used in Windsor chairmaking, have some real advantages. But you need specialty tools to make the joint, and – this is important – I've never seen an antique stick chair that uses tapered tenons. Every one that I've inspected uses cylindrical tenons. Every single one.

Both joints work fine during the long haul that chairs make through time. And I encourage you to explore them and come to your own conclusions. I've decided to use cylindrical joints.

Other changes: I've improved the section on the woods that are suitable for chairmaking. Several of the chair designs have been modified to reflect more what I'm building these days for customers. And I've found some ways to simplify the processes for sharpening curved chairmaking tools.

There is no aspect of woodworking that is static, even though the craft is as old as civilization. And I suspect that in another decade that my methods will be different than they are now. Perhaps then I'll revise this book again – or leave it to another chairmaker to pick up things where I left off.

EVERYDAY CHAIRS
In our house, we use stick chairs for almost every activity – eating, reading, writing, watching a movie or talking with friends.

WAIT, FROM THE LUMBERYARD?

You can build a stick chair with almost any wood. Yes, you can rive it from green wood. But you can also buy it at the lumberyard and get parts that are plenty strong.

WOOD FOR STICK CHAIRS

Most chairmakers are ridiculously worried about the wood they use in their chairs. Me included. Is it strong enough? Is it dry/wet enough? Is the grain straight enough? Can I get the parts I need from this chunk on my workbench?

But aside from those narrow concerns, there is a lot of flexibility when it comes to the wood for a chair. The wood can be:

- almost any species
- air-dried, kiln-dried or vacuum-dried
- a softwood or hardwood
- sawn, riven or both
- ring-porous, semi-diffuse-porous or diffuse-porous
- from the lumberyard, the log yard or your backyard.

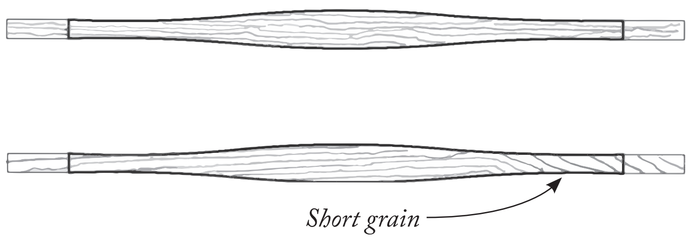
Put another way, almost any wood can be used in a chair as long as it is strong enough, dry enough and the right size. What follows is how to evaluate your stock in terms of its strength, moisture and size – without turning you into an intern at the Forest Products Laboratory.

TWO KINDS OF PARTS

Stick chairs have two kinds of parts: the "sticky" parts, which are the legs, stretchers and sticks. And the rest of the chair – the seat, arms and comb/backrest. In an ideal world, here is how the different parts should behave.

The sticky parts should come from a species that is easy to split out so that its grain is dead straight. The species should be strong and flexible. Some common examples of "sticky" species are the oaks, ash and the hickories.

The rest of the chair should be made from a species that is difficult to split out. The species can be soft or hard, but it needs to absorb the heavy blows when the sticky parts are driven into it. Some common



TWO STICKS, ONE DISASTER

The stick at top has grain running its entire length. The one below has short grain and is doomed to snap. Training your eye to see short grain at a glance is helpful.

examples of woods that are ideal for these parts of the chair are elm, soft maple, American sycamore, beech and tulip poplar. But there are many others out there.

Basically, if a species is ideal for firewood, it's probably a good candidate for a stick. If it's not ideal firewood, you probably can use it for seats, arms and combs.

Gathering good stick material is more difficult than gathering the other stuff for the chair. So let's talk about sticks first.

STICKY STRENGTH

Every stick of wood is a bundle of wood fibers. If the fibers run continuously from one end of the stick to the other, that perfect stick will take far more abuse compared to a stick where some of the fibers run across the width of the board (sometimes called "short grain").

You can create one of these super-strong sticks using a few methods. You can rive the wood – like firewood – so it splits along its fibers. You can saw it out by following the direction of the fibers with your saw blade. Or you can use a combination of these two methods.

None of these methods is magic. As long as the fibers run straight through the stick, you have done your job.

The other aspect of strength derives from the species of wood. A

SLEDGEHAMMER TEST

When I make a chair, I make a few extra sticks and hit them with a sledge. I recommend it. You will learn a lot about how wood breaks and how some species (like ash) seem indestructible. Below are two sledgehammer victims. Short-grain walnut (left) and brash cherry.

strong species, such as white oak, can be extraordinarily tough when it is only 1/2" in diameter and its fibers run continuously from one end to the other. A similar stick of cherry or walnut might need to be 3/4" in diameter (or thicker) to possess equal strength.

While it sounds like I am about to offer a chart, graph or equation to determine the optimal-sized chair part, I'm not. Instead, I'm going to suggest you find a sledgehammer.

You can easily test a sample chair part by propping it up on two blocks of wood, one on either end of the stick. Hold the stick in place with one hand and strike the stick with a small sledgehammer (2 lbs. or 3 lbs. will do). If the stick survives, the part is strong enough – in my book. If it snaps, you should increase the bulk of the stick or find one with straighter grain.

Why isn't there a Holy Chart of Diameters and Species with recommendations for chairmaking? Because wood is so variable. For example: Slow-growth and fast-growth oak can be radically different when it comes to strength. (Slow-growth oak is far more porous and easily snapped.) How the tree grew, how it was dried and how straight you cut it all play a part in how strong a stick is. But one way to resolve all the variables is to hit a sample stick with the sledge.

The idea for this test came from fellow chairmaker Chris Williams, who was looking for a way to test wood for brashness – a defect where the wood is so brittle it can snap like a corn chip. It's also a method that the USDA Forest Products Laboratory has used to test brittle woods.

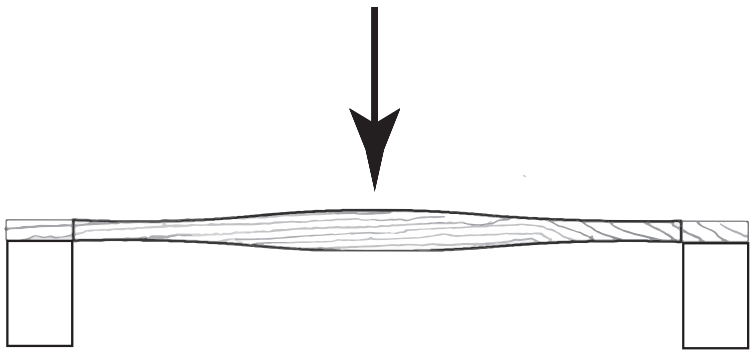
How hard should you hit the stick? Like you are striking a nail. Should you use a surviving stick in the chair after you hit it? That's your call, but I usually use them if they aren't too dented.

ANOTHER OPTION

If you don't want to pummel your sticks, here's a different way to evaluate the parts of your chair. It starts with this idea: You can increase the strength of a piece of wood in two ways:

1. Use straighter grain (if possible).
2. Increase the thickness and/or diameter of the part by 1/8".

Why 1/8"? Two reasons. Eighths are a pretty standard interval



MODULUS OF RUPTURE

To test a stick's modulus of rupture (aka its bending strength), you support it at both ends and exert a force at its center. The "modulus of rupture" is the amount of force-pounds per square inch required to break the stick.

when changing the thickness of your parts. Is 5/8" too thin? Try 3/4". Also, using eighths helps illustrate how the strength of wood increases or decreases, as you will soon see.

It's easy to assume that if you make a chair part one-eighth thicker, then it would also be one-eighth stronger – that there's a 1:1 relationship. But that's not how wood works. When you measure wood's strength via its breaking point (such as its "modulus of rupture" or its "shear strength") then the strength can increase by the square of its thickness. In other words, small changes to the diameter of a chair part cause large changes to its overall strength.

Let's back up. I used a math term without waving a warning flag. Apologies.

People who sit on chairs exert a complex series of forces on its components. Some forces are directed at the floor. Other forces strain the chair's back. Or the forces thrust the chair's arms outward when the sitter pushes out of the seat. Abuse can also come from outside the chair. Wicked children might stand on the stretchers. Chairs can be used as a weapon. Or they can be a victim.

What makes this all the more complicated is that wood is not a

‘Modulus of Rupture’ for Some Wood Species

Size of 12" stick	*White oak*	*N. red oak*	*S. red oak*	*Cherry*	*Hickory*
1/2" x 1/2"	158	148	113	128	210
5/8" x 5/8"	309	290	221	250	410
3/4" x 3/4"	534	502	383	432	710
7/8" x 7/8"	848	798	608	687	1,127
1" x 1"	1,267	1,192	908	1,025	1,683

Note: Modulus of rupture is calculated using table 5-3b from the "Wood Handbook" published by the U.S. Department of Agriculture. Numbers in the table are the force-pounds per square inch required to break the stick. The results assume the wood is at 12 percent moisture content (MC) and the sticks are straight-grained.

homogeneous, factory-extruded substance. Every stick is different, depending on the species, how the tree grew, its moisture content and how straight its grain is.

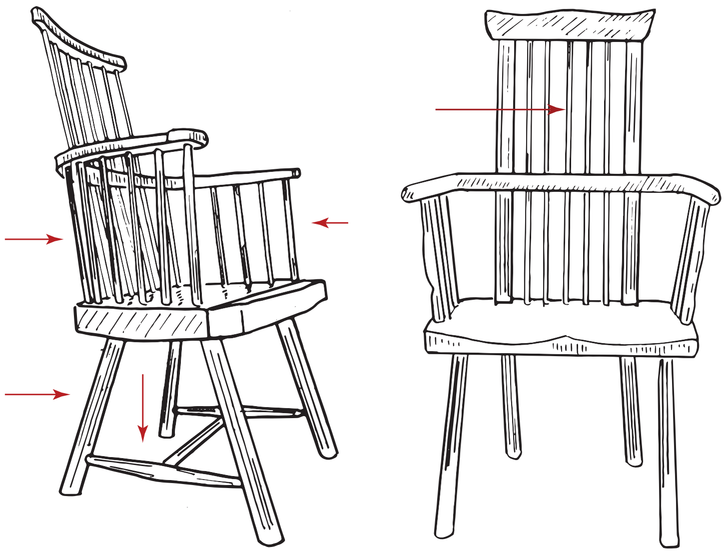
It would be easy to say that the engineering is too complex to be practical for the workshop. But here's a crack at explaining it.

One of the important measures of strength is wood's "modulus of rupture." Imagine a stick that's supported at either end above your benchtop (and is at 12 percent moisture content). Then a force presses down on the stick at its centerpoint. The "modulus of rupture" is the amount of force-pounds per square inch required to break the stick.

There is a published formula that allows you to calculate the force needed to break a stick of given dimensions and species. You can look up the formula if you like (it's also in the back of this book).

To demonstrate how the formula works, let's pretend we have an ideal 12"-long stick of wood for a chair. The chart above shows the force needed to break the stick as it gets thicker or thinner.

In other words, if you double the width and thickness of a stick, its strength increases by eight-fold. Small increases in thickness and



MODULUS OF RUPTURE

The red arrows show forces on chair parts that are governed (in part) by the modulus of rupture.

width increase the stick's strength significantly.

So what parts of a chair are governed by the modulus of rupture?

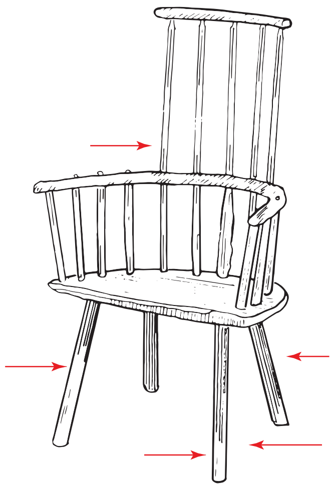
• In a chair with stretchers, the legs are subject to this sort of force at times. Kicking the chair's leg might break it.

• The stretchers of a chair are definitely subject to the modulus of rupture. People put their feet on the medial stretcher and – snap – game over. Kids like to stand on a chair's side stretchers, also a modulus of rupture problem (and a historical source of yelling).

• Also, consider the sticks between the arm and the seat. Whacking these sticks could cause them to break.

• Then there is the case where the thin back sticks of the chair are framed by stout posts, plus the arm (or the seat) and the chair's comb. Dramatic forces against the back sticks could cause them to snap.

The other common indignity against chair parts is "shear force." In



SHEAR FORCES

Shear forces affect legs without stretchers. But I would argue they also can affect sticks above the arms. The top of the sticks do not receive a lot of reinforcement from the comb.

'Shear Strength' for Some Wood Species

Size of stick	*White oak*	*N. red oak*	*S. red oak*	*Cherry*	*Hickory*
1/2" dia.	375	335	261	320	457
5/8" dia.	587	523	408	499	714
3/4" dia.	845	753	588	719	1,028
7/8" dia.	1,151	1,025	800	979	1,399
1" dia.	1,504	1,338	1,045	1,278	1,827

Note: Shear strength is calculated using table 5-3b from the "Wood Handbook" published by the U.S. Department of Agriculture. Numbers in the table are the force-pounds per square inch required to break the stick. The results assume the wood is at 12 percent MC and the sticks are straight-grained.

a chair, this happens when the component is secured at only one end. For example: A leg without stretchers. Or a back stick that isn't surrounded or protected by stout posts. Kick that leg or yank that back stick and you will apply shear forces to the poor component.

Shear forces can be devastating. A leg can snap. Back sticks can break. I have even heard of an entire (expensive and handmade) chair collapsing under the weight of a sitter due (primarily) to shear forces. The legs broke free from the seat. Sticks above the seat snapped like the twigs that they once were.

Let's look at some shear-force numbers (assume that all of these numbers apply to a perfect stick at 12 percent moisture content with dead-straight grain). The chart is at left.

In other words, doubling the diameter of a stick will increase its strength by four-fold when dealing with shear forces.

If you want to explore these ideas, the formulas and important raw data on common chair woods is in an appendix at the end of the book. I encourage you to dig into these formulas when you start designing your own chairs. Or when you use an unfamiliar species. The formulas are pretty simple (even for a former newspaper journalist).

But if you just want some hard-won advice on strength, here it is: If you are concerned about the strength of a component, increase its diameter (or thickness and width) by 1/8". That small change will increase the strength significantly. Or fetch that sledgehammer.

MOISTURE

Wood for chairmaking can be moist or dry. What's important is that you know how wet or dry it is as you build the chair. Put a wet leg into a dry seat, and the leg will shrink and plop out in short order. Put a dry stretcher into a wet leg, and you can create an almost-indestructible joint that can last 100 years without glue. While there are books devoted to moisture content, here are the approaches I have taken:

• Buy kiln-dried wood from a reputable source. Or buy Whatever Wood and let it sit around for a year. Then it's likely fine.

• Buy a moisture meter and check the wood against pieces of the same species that have been sitting around the shop for a year.

• Trust your gut.

MOISTURE METER

I resisted owning a moisture meter for years. The first time you find a problem while using the tool, it pays for itself.

I recommend the first two methods for beginners. Yet, after a few years you'll be able to pick up a stick and know if it's dry or too wet. Wet wood feels heavier and cooler to the touch than dry wood.

Side note, you'll also be weirded out by wood that is too lightweight. This stuff is even more dangerous than wood that is too wet. Wood that feels too lightweight is likely brash (brittle) or punky (rotted) and unsuitable for chairmaking. Brash wood can be caused by how the tree grew. If it has wide bands of porous springwood and narrow bands of dense summerwood, there is a better chance the stick will be brittle and brash, according to the U.S. Department of Agriculture.

Other factors can cause wood to be brash. In young trees, the sapwood is tough; in older trees, the sapwood can be weaker or brash. If the tree was a softwood and grew on a hill there is a chance it will have developed compression wood on the downhill side, and it's brash.

Let's get back to moisture content. If you have the money, buy a moisture meter. They aren't expensive, and they're a great way to explore the wood in your shop and get a feel (literally) for how wet or dry each stick is.

What's a good target for the moisture content of your wood? It's not a particular number. Instead, you want to determine the equilibrium point for your stock – where it is neither expelling water or sucking up water from the air. If this sounds abstract, here's a real-world example.

Let's say I'm collecting wood for a chair, and I find some oak that registers at 7 percent MC, which is at equilibrium with scraps of oak that have been sitting around in my shop for a long time. Then I find some other wood that registers at 11 percent MC.

If possible, I'll use the wetter wood for the chair's seat, arms or comb. That way as that wood dries, it will shrink around the tenons of the dry sticks/legs and tighten the joints.

OK, what if I have some stock that comes in too dry? Sometimes this happens during the change in seasons, when the wood has been in a climate-controlled place that is bone dry. If I get some oak that is 3 or 4 percent MC, I use that for the chair's sticks. It will expand as it heads toward equilibrium (7 percent MC in our example). As its tenons swell, they'll tighten in their mortises.

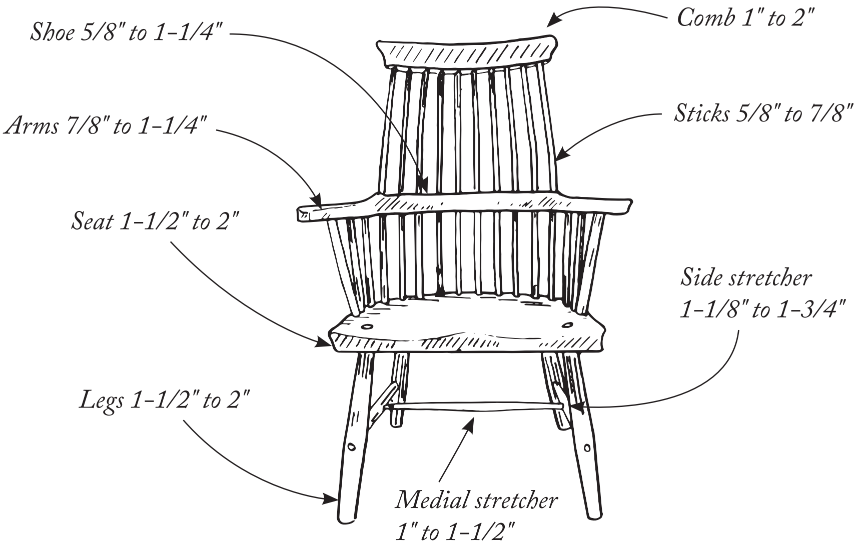
If all this sounds like more than you want to deal with, just let your wood sit around for a year or so. It will all be at equilibrium, and you don't have to think much about moisture.

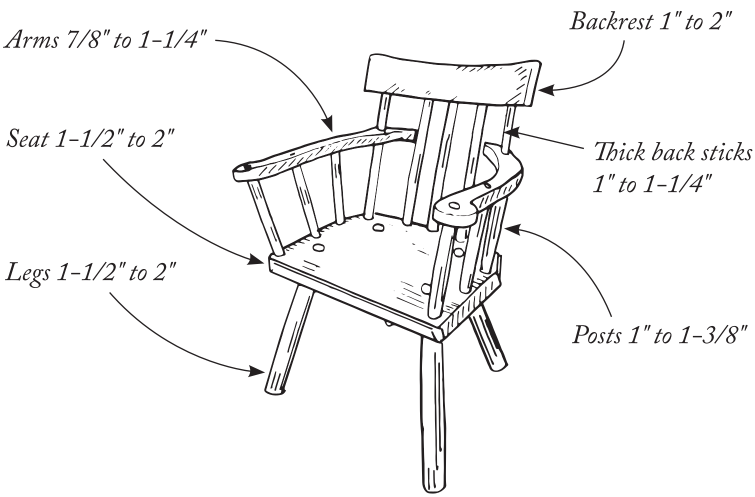
THE SIZES OF PARTS

Chairs can look like a complex combination of parts that have widely variable shapes and sizes. While that's true with many highly technical modern chairs, most vernacular chairs are a pretty simple collection of parts of standard thicknesses.

No matter where I buy wood – from a sawyer in the forest or an inner-city lumberyard – it is cut to a number of standard thicknesses that have been used for hundreds of years.

As a result, most chair parts fall into the same sort of thicknesses that a cabinetmaker is comfortable with: 4/4 (which is 1" thick in the rough and pronounced "four-quarter"), 5/4 (1-1/4" in the rough) and 8/4 (2"). The parts might end up tapered, curved or carved. But in the





COMMON DIAMETERS & THICKNESSES

After you build a bunch of chairs, patterns become obvious. Many stick chairs have similarly sized parts. Knowing this makes it easier to buy rough stock.

end, they aren't all that different from the materials you use to make a box. Let's start at the floor and work our way up.

Legs are generally made from 8/4 material, which is sawn roughly at the mill at 2" thick. So, a 2" x 2" leg is possible (but not probable. And probably too chunky, visually). So, you'll often see legs that are 1-3/4" square or 1-5/8" square. Sometimes legs can be as slender as 1-1/2" square. These legs can be tapered, turned, octagonal, hexagonal or cigar-shaped. The shape doesn't matter too much when it comes to strength. What matters is the legs start with 8/4 stock, and that once the legs are less than 1-5/8" square you should be a bit worried about their strength.

Stretchers can be made from 8/4 stock, which is ideal when they bulge dramatically in the center of their length. Or they can be as thin as 5/4 (1-1/8" to 1-1/4" finished) for a more Spartan look.

The seat is also made from 8/4 stock, so it's common to see seats that are 1-3/4" thick down to 1-5/8". Thinner seats are possible if you thicken up the joinery areas with battens (a Germanic construction).

The sticks of a chair, sometimes called "spindles" when they are turned, typically start life as 4/4 stock (or they are sawn out of 8/4 stock). Typical chairs will use 3/4"-diameter sticks that taper to 5/8" tenons at either end. Chairs that look delicate might use sticks that begin at 5/8" in diameter but taper to as thin as 1/4" in diameter.

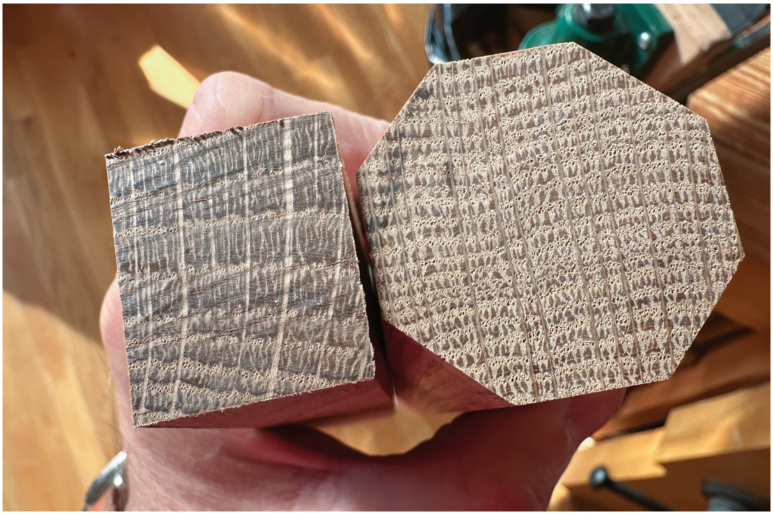
Some chairs have "posts" – thicker sticks that hold up the front of the arms or frame the backrest. Posts are 1" up to 1-3/8" in diameter and can taper or be curved.

The arms of a chair are typically made from 4/4 or 5/4 stuff. If the arms have a "doubler" or "shoe" (which thickens the arm at the back) it can be 5/8", 4/4, 5/4 or even thicker – really anything goes once you start looking at historical examples.

The crest or comb can be made in many ways. It can be a simple flat 4/4 board. You can bend 4/4 material to make a curved comb. Or you can cut a curved comb from solid 8/4 material.

PICKING & PROCESSING WOOD

Once you get a handle on the strength, moisture and general size of a chair's parts, you are ready to go to the lumberyard, mill or woodlot. There you need to sort through the stock to find boards that are ideal for chair parts.



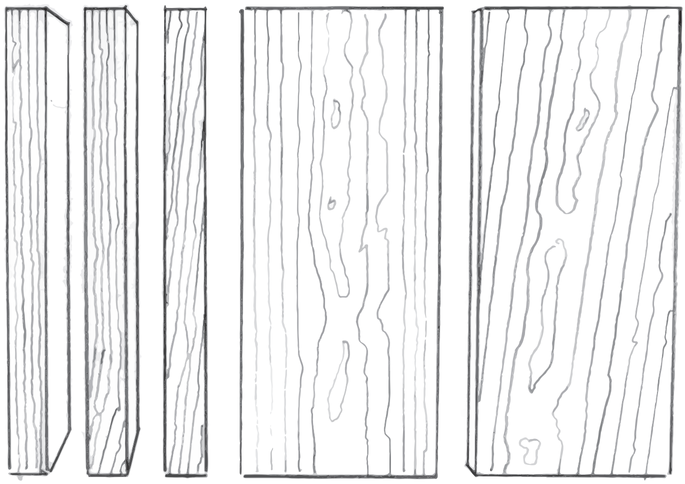
RINGS OF POWER

With ring-porous species, a fast-grown tree is better than a slow-grown one for chairmaking. At left, fast grown white oak. At right, slow-grown white oak.

In general, boards that have curved, irregular or wavy grain can be used for seats, arms and the comb/backrest. Really, almost any stock can be used for these chair parts as long as it is difficult to split. If I want to be picky about the seat stock (and I usually do), I choose quartersawn wood for the seat. Quartersawn stock is much easier to saddle than flat-sawn or rift-sawn wood. Quartersawn costs more, but it saves an immense amount of time while saddling.

For legs, stretchers and sticks you need boards with straight grain. It is easy to become neurotic (and paralyzed) when seeking dead-straight grain for your legs, stretchers and sticks. The goal is to find the straightest stuff possible. But if the wood's not perfect, remember that you can make it 1/8" thicker than planned.

How do you get straight grain? If you've read books about making Windsor chairs, you know that many makers split out the legs, stretchers and sticks from green wood. And if you have the trees and space to do this, great.



LEARNING TO READ (AGAIN)

Spotting straight, angled and curved grain is essential. Starting from left: (A) Dead-straight edge grain. (B) Straight edge grain that curves at one end. (C) Angled grain. (D) Straight face grain (note the lack of cathedrals) (E) Angled face grain.

If, however, you don't have access to green wood, or you live in town and can't transform your front yard into a work yard, read on.

The search for straight grain begins at the lumberyard or sawmill. When I build cabinets, I pay attention to the broad faces of the boards. When building chairs, however, I barely look at the boards' faces (at first). Instead, I peer first at the narrow edges of the boards. The grain on the board's edge must be dead straight and not run out for about 80 percent of the board for me to consider buying it.

When you start looking at the edges of boards, you'll notice a pattern. On many boards, the grain runs arrow-straight along most of the edge. Then it curves – sometimes dramatically – for the last 12" or so.

This curved section is either from the bottom of the tree – where the fibers spread out to form the tree's root system. Or it's from the top of

RIVED & DRY

Using a froe or other wedge, you can split kiln-dried dry stock to produce ideal chair parts. Here are three white oak splits ready for squaring up.

TROUBLE?

Riving follows the grain. The grain on the edge of this board was dead straight. But it was angled on its face. I might be able to salvage some short sticks from this board.

the main trunk – where the tree spreads out its branches or splits into two trunks. Sometimes I'll use this curved-grain stuff for a comb, but rarely for legs, stretchers or sticks.

After I find a board with a long run of dead-straight edge grain, I'll pull it from the pile and look at its broad faces. If the grain is nearly straight on the face (and free from fatal defects), then the board is a keeper. If, however, the grain on the face is angled, I can still use it, but I won't get as many parts from the board as from an ideal board.

One final tip on selecting stock (and I know I'm repeating myself

WHACK-A-LEG
In straight-grained boards, it takes little effort to split your parts from kiln-dried stock. (I usually wear work gloves when riving.)

here – I'm doing it for emphasis): When it comes to ring-porous species – such as oak, ash and hickory – fast-growth wood is stronger than slow-growth wood. I know this sounds contrary to what seems correct. Think about it this way: Slow-growth wood has annular rings that are really close together. The rings are pores. And the pores are air. So having lots of pores isn't ideal. Fast-growth wood, on the other hand, has more of the tough fibers and fewer air-filled pores.

With a pile of boards in hand, I head home and mark out the parts for the chair. After crosscutting the stock, I'll decide if I am going to rip the legs, stretchers and sticks from the boards with a saw or rive them out with a froe.

RIVING DRY STOCK

Years ago, I started riving chair parts from kiln-dried wood. No one told me this wasn't normal, so it didn't seem weird. It began when a customer requested a stick chair in walnut, and he insisted that all the parts (except the seat) be rived. I managed to find two decent-looking walnut logs from a local tree service and rolled them into my driveway.

STRAIGHTEN THE GRAIN

You can remove straight sticks from a board by sawing them out. First mark a line parallel to the grain lines. Use a band saw or handsaw to cut that line. Then you can rip straight sticks from the board.

When I split the first log, I discovered the tree had been sitting on the ground for a long time; the wood was quite dry. I thought this was bad news and panicked a little. I had just left my day job to make furniture full-time, money was tight and I needed to somehow make these two logs into a chair – no matter what.

So I split both logs up. One of the logs had wavy grain, which became firewood. The other log was dead straight and split out nicely.

In addition to splitting dry stock, I also did a naughty thing. At first, I couldn't get my froe to split the wavy walnut. I put down my wooden maul and picked up a small metal sledge (about 2-1/2 lbs.). I looked at the sledge and remembered the admonitions about how you should never drive a froe (or set a holdfast) with a metal hammer.

Then I thought, "Hmmm. I hit nails all day with a hammer. And blacksmiths hit metal with metal all day…" Before I could finish my thought, I clanked the froe with the sledge (yes officer, I was wearing safety glasses). After two or three strikes, the wood split.

I've been doing this for many years now. The back of my froe is a little mushroomed, but it still works fine. Someday I might grind away the mushrooming. (Gosh, that's an odd sentence.) If hitting metal on metal offends you, use a wooden club, or buy a metal mallet that has a rawhide striking face (Garland Manufacturing in Maine makes these and makes them well).

After splitting out the dry walnut logs, I built the chair, delivered it and got paid (whew). Intrigued, I tried splitting some kiln-dried scraps in my wood rack. It worked (of course it worked – grain is grain). And that desperate accident opened a whole new world for me.

The riving process is simple: Stand the board on end on the workbench or on the floor. If the grain is angled across the face of the board, first rive off a wedge of grain so you can see how the grain is running.

Once you can see how the grain is traveling through the board, mark out the chair parts you want on the end grain. I do this with a magic marker. I usually make my leg blanks so they're square in cross-section. So if the stock is 2" thick, I'll try to rive it 2" wide. Stretchers are rived to 1-1/4". Sticks at 1" or so.

Then it's just a matter of riving off a part, marking the next part and riving that one. Repeat until you run out of wood. After you have your parts rived out, you can square them up using handplanes or machines.

If you are unsure if this riving technique is for you, buy a cheap hacking knife at the hardware store (the knives are used to bust up old putty around windows). Or swipe an old butter knife from the kitchen. Use the knife and a hammer to split out some small pieces of 3/4" oak. The exercise will teach you to read the grain in a board – both the face grain and edge grain.

As you practice, first try placing the blade of the knife across the annular rings. Then split off a piece with the knife blade parallel to the annular rings. Compare the surfaces of the different kinds of splits. This exercise is the fastest (and cheapest) way to learn how wood splits.

SAWING STRAIGHT STOCK

Some people aren't interested in splitting stock. That's OK. With a band saw or handsaw, you can saw out straight pieces from a board, even if the grain is angled through the face of the board. Here's how:

On the face of the board, align a yardstick parallel to the angled grain and mark a line in magic marker. Saw the board along that line.

Now saw or rive the rest of the parts from the board, using that angled line to guide the process.

When we prepare wood for classes, we bring the table saw into the equation. We'll use the band saw to straighten the grain on the face of a board. Then we'll joint that edge and rip the rest of the straight parts on the table saw. If I'm unsure how the grain is running – sometimes it's hard to see it in rough stock – quickly riving off an edge with a froe points me in the right direction.

No matter what method I use to extract the parts from a board, they then need to be squared up at the bench or by machines. After you square them, the next step is to turn them into octagons. And then bring them to their final shape.

SOME FINAL WORDS ON WOOD

Every few months, we host an open forum with readers where they can ask our editors and authors questions on any woodworking topic. When people ask me questions about stick chairs, about 90 percent of them boil down to this: Can I use XXX wood to make a stick chair?

When you look at the furniture record, the answer is clear: Almost any wood can work. Wood is incredibly variable. And so I encourage you to answer your own question with the following simple tests.

1. For stick material: rive out some narrow bits of the wood species in question, about 3/4" x 3/4" x 12". If the grain pops open with little effort, that's good sign. If the splitting tool gets wedged in the split, that's not so good. Put one end of the piece in a vise and try snapping the piece with your hands. Does it bend and fight back? That's good. Does it break? That's bad. Prop it up on blocks and hit is with a sledge, as mentioned earlier. Good stick material is strong and bouncy.

2. For material for seats, arms and combs, here is the test I prefer. Take a piece of stick material measuring 3/4" x 3/4" x 12" (oak is always a good choice). Cut a 5/8"-diameter tenon on one end of the stick that is 2-1/4" long. Now fetch a piece of the material you are considering for the seat, arm and comb. Cut a piece that is 1-3/4" x 4" x 4". Drill a 5/8" hole through the middle of its face.

A TEST FOR SEATS, ARMS & COMBS

Here I drove a white oak stick into a red elm mortise. The tenon's shoulder is buried inside the mortise. And the elm is curling up against the oak stick. The elm refused to split. This is why red elm is great for seats, arms and combs.

Now drive the stick's tenon into the mortise. When the shoulder of the tenon hits the mortised material, watch what happens. If the piece splits immediately, that's bad. If the tenon shoulder gets buried in the wood without any splitting, that's good.

These two tests give you real-world answers that no guru or book can provide. This sort of experimentation will show you which rules you can bend or break (literally). And they will open your eyes to using species that other woodworkers might dismiss or ignore.

And these tests are far less heartbreaking than splitting a seat or an arm during assembly. So feel free to ask questions of other chairmakers about wood, but in the end, you need to provide your own answers.

A BIT OF INFORMATION

These are all the sizes of bits you need to make the chair joints in this book. From left, a 1" (25mm) auger for leg mortises, plus 3/4" (19mm) and 5/8" (16mm) bits for the mortises for sticks and posts. These bits can be either spades or fancy hex-shanked bits.

TOOL KIT FOR STICK CHAIRS

Unlike me, I hope you can purchase your chairmaking tools with guidance, caution and thought.

When I began making chairs, I bought every tool that looked useful, or professed to be essential. In fact, I had a large plastic toolbox devoted to these chairmaking tools. And when I'd make a chair, I'd open the toolbox and try these tools out on its parts.

It was like looking for a peculiarly shaped block to fit an odd-shaped hole. Would this doming plane do anything worthwhile to my sticks? (No.) Can this Windsor beader create a gutter on the seat? (Nope.) Does this rounding plane really make spindles? (Yes, it does.) What does this odd French drawknife do? (I still don't know.)

I learned a lot. Mostly, I learned that I was a sucker for a well-written catalog description and a dramatic photo (curse you, Garrett Wade).

Today I have only one tray in my tool chest that is devoted to chairmaking tools. That's because most of the tools I use to make chairs can also be used to make cabinets, bookshelves and boxes.

Don't get me wrong, I love good tools, and I gladly spend money on them. But I want to have the smallest working set possible because tools are a psychological burden. Every edge tool comes with an obligation to sharpen it, oil it and store it properly.

Plus, I quickly realized that I enjoyed making tools dull more than I enjoyed making them sharp. Ergo, the fewer tools I have, the less time I spend on maintenance and the more time I spend on woodworking.

Here's what I use in the shop every day. You don't need all these tools to get started, however.

JACK PLANE

The jack plane is one of the most-used tools in my chairmaking (and in hand-tool woodworking in general). I use mine to shape the seat, sticks, arms and legs. And sometimes the comb. Because it is in

THE BEAVERS OF THE WORKSHOP
Jack planes do most of the flattening, tapering and shaping in my work. I prefer the lightweight vintage jack planes that Stanley made by the millions.

my hands for hours, I prefer a lightweight tool. That means a vintage Stanley No. 5. While you can invest months learning about the iterations of Stanley tools, just know that the older planes are better. I prefer Stanley planes from the 1890s to the 1930s. These planes are still plentiful because Stanley made millions of them. They are not rare.

Avoid the new Stanleys (unless you enjoy lighting your money on fire and flushing it down a pay toilet). And I'm not wild about the added weight of the modern premium planes for a jack plane. I often use the jack one-handed – so ounces count.

Likewise, I don't like wooden jack planes for this job. Yes, they are lightweight. But they are bulky and too tall for me. If you prefer wooden-bodied planes, however, you'll be fine with them.

The jack plane I have used since 1996 is a Stanley No. 5 Type 11 (1910-1918). Its iron is ground with a curved cutting edge. I use a 10"

FINISHING UP

Though some woodworkers prefer a smoothing plane for final finishing, I tend to use a block plane for chairmaking. This plane can be quickly reconfigured to deal with tear-out.

radius curve. Some people prefer a tighter radius; others prefer looser. The plane's mouth is wide open so it can pass thick shavings.

BLOCK PLANE

The block plane cleans up the surfaces the jack plane leaves behind. Because the jack takes a big bite, sometimes it leaves torn fibers in behind. The block plane can fix that – if you have the right block plane. The block plane should fit your hand like an old baseball glove. It should have an adjustable mouth so you can set its mouth tight. This fine mouth aperture allows you to clean up tear-out.

I prefer a premium block plane for this tool. The irons are bedded better, all the parts move smoothly and the tools work out of the box.

The block plane I have been using since 1997 is the Lie-Nielsen No. 60-1/2 with a stock iron. I have yet to encounter a better-made block plane, whether new or vintage. Some people find the tool big for their hands, so definitely try one out before you get hitched.

As with all tools that leave a finished surface, sharpen it with a slightly curved cutting edge – just enough to tuck the corners of the iron into the plane's body.

DRILL OR BRACE

The type of drill you own – cordless, corded or a brace – pretty much determines what sort of chairmaking you can do.

If I had to pick one tool, it would be a quality corded drill with a 1/2" chuck, a variable-speed trigger and a side handle. This sort of drill allows you to work with any wood (hard oak or white pine) and with any sort of tooling – especially reamers and large augers.

A serious heavy-duty cordless drill can drill the harder woods, but the batteries are a liability because they will have to be replaced some day. Also, low-voltage cordless drills can handle only softwood seats. I have seen underpowered cordless drills catch fire while trying to bore holes in a white oak seat.

If you own only a brace, you can do a lot of chairmaking as long as you pick your battles. With a sharp auger, you can drill mortises for legs and sticks in almost any wood. But it will be a struggle in a tough hardwood seat. If you want to use a brace, get one with a 10" or 12" sweep to get more leverage.

AUGER & SPADE BITS

You need three bits to make all the joints in this book (1", 3/4" and 5/8"). But you'll probably end up with more as the years go by. Here are some of your choices when you get started.

For the leg mortises, you need a 1" (25mm) auger bit with a lead screw. There are lots of these on the market to choose from.

If you use an electric drill – either cordless or corded – spade bits are an inexpensive place to start for the 3/4" and 5/8" holes for sticks. They cut cleanly at high speeds. You can grind their long edges to modify the hole size (which is helpful at times). Plus the bits are cheap and plentiful. The downside to spade bits is they dull quickly. If you are lucky, you will get two or three chairs from a spade bit. (Tip: Cool the bits between holes in a cup of water. This extends their life quite a bit.)

DIFFERENT WAYS TO DIG A HOLE

You can build chairs with a brace, a cordless drill or a corded drill. It helps, but is not necessary, to have all three.

SPADES ALL AROUND

Spade bits, sometimes called "paddle bits," are inexpensive, easy to find and cut quickly. They dull fairly quickly, but can be resharpened with a file.

You can touch up the cutting edges with a file, but it's critical to not change the bit's cutting geometry. Many people treat spade bits like plastic cigarette lighters. When they stop working, they pitch them and spend another $10 on a new one. I sharpen mine until they stop cutting cleanly, then I recycle them.

I usually buy the extra-long spade bits. These allow me to drill through an arm and into the seat without a lot of fuss.

Buying quality spade bits has little to do with price. In fact, the most expensive spade bits I've used cut slowly and leave a hole like a gunshot wound. Here's what to look for and to avoid.

1. Avoid spade bits that have a lead screw. These pull the bit into the work too quickly and leave a jagged entry hole.

2. Avoid spade bits that aren't surface-ground. These sorry bits have a coarse gray finish, like they were sand-blasted. Surface-ground bits

WHAT TO LOOK FOR

The spade on the left will struggle to do its job in Swiss cheese. It hasn't been ground on its flat faces and lacks sharp edges. The bit on the right cuts much faster.

have semi-circular milling marks and the bits are shiny.

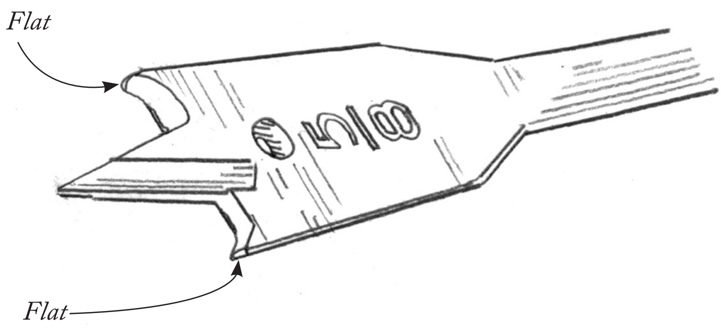
3. This comes with experience, but when you buy an extra-long spade bit, pay attention to how straight the shaft is. Some brands have excessive runout and wobble.

4. Some spades lack "spurs" – the triangular cutters on the rim. Bits without spurs cut slowly, despite the PR you'll encounter.

5. The thickness of the paddle section of the spade is important. Thin bits cut slowly and heat up faster. Thicker is better.

Another good choice for the 5/8" and 3/4" bits are modern hex-shank bits with advanced cutting geometry. These bits, which typically come from Japan, are fairly inexpensive, cut cleanly and can be used with a "bit extension" to increase the reach of the bit. With a bit extension, these bits can drill through an arm then into a seat with ease.

Many of these modern bits also have cutting geometry that allows



DULL WON'T DRILL

This is one of the more expensive spade bits on the market and it cuts impossibly slow. The flats on the tips of the spurs are the primary reason. You can file these sharp, but you shouldn't have to.

SUPER-SHARP JAPANESE BITS

WoodOwl makes a wide variety of quality bits with different characteristics. These Wood Owl Ultra Smooth Auger bits and Star M F-type bits cut cleanly. However, the flutes also cut, so it's easy to waller out your hole.

you to drill through your work without backing up the exit hole with scrap. They leave few torn fibers on the exit side.

There are three downside to these bits: One, they dull quickly when they get hot. Dip them in a cup of water between holes to extend their life. Two, you must hold the drill dead steady while cutting. The flutes of the bit are so sharp that you can ream out the top of your hole with little effort. The bits cut sideways as easily as they cut forward. (I dull the long edges of these bits with #220-grit sandpaper, which helps.) Three, they cannot be resharpened.

The above suggestions are a place to start. Below are the bits and sizes I own to make all the chairs in this book.

• A 1" auger bit with a lead screw for drilling mortises for the leg tenons. I use a Wood Owl auger for this. It's OK to use a metric 25mm auger for the mortises for the legs.
• 5/8" and 3/4" bits for mortises for the sticks and stretchers. You can use 16"-long spade bits, or you can use a bit extender in conjunction with short hex-shank spades or the fancy Japanese hex-shank bits (I prefer the Star M F-type bits). It's OK to purchase these bits in metric sizes (16mm and 19mm).

BIT EXTENSION

A bit extender is basically a long steel rod that makes a 6"-long bit act like a 17"-long bit. They are essential to have around. These accessories make drilling the mortises in the arms and seat a breeze.

Most bit extenders are designed to work with a hex-shank drill bit, so they work well with modern bits.

Sadly, about 80 percent of bit extenders aren't worth beans for chairmaking. Their failing is the chuck that grips your drill bit. Some use a magnet to hold the bit. Its grip is worse than an infant's – the bit and extender will become detached in every single hole.

The second type of crappy chuck is spring-loaded. You slide the chuck backward, insert the bit and release the chuck. A collar snaps into the detent on the bit's shank. These grip the bit's shank OK. But the bit wobbles in the chuck. Ergo, wallered-out mortises.

The only decent chucks I've encountered uses two Allen-head grub

EXTEND YOUR REACH

There are lots of bit extenders out there. I only like the ones that secure the bit with a hex key or collet.

screws to grip the bit. Or a collet system like an electric router.

SPOKESHAVES

Most chairs have inside and outside curves, so spokeshaves are ideal for fairing curves. They come in a dizzying array of sizes and styles. I use metal-bodied shaves based on Stanley's No. 151 shaves. These shaves have two depth-adjustment knobs, which make the shaves easy to adjust.

Most metal shaves have the blade pitched like a handplane, so they are ideal for shaving dry hardwoods. In my experience, wooden-bodied shaves with low-pitched cutters are ideal for rived stock and green wood. A lot of smart people disagree with me, so keep that in mind.

The metal shaves come with either a flat sole or a slightly convex sole (the convexity is from the front of the sole to the back). Flat-sole shaves are for outside curves and flat surfaces, such as legs and sticks. Convex-sole shaves are for inside curves. You need both.

TWO SHAVES FOR EVERYTHING
A flat-sole spokeshave handles convex curves. A curved-sole shave tackles the concave ones.

BAND SAW

If I had to own only one machine, it would be a band saw, either a 14" model with a cast iron frame, or one of the quality 10" benchtop band saws. Band saws have a lot of tempting accessories, most of which you should avoid. Here's a short list of things to skip:

• Don't buy a riser block to increase your resaw capacity to 12". You'll mostly increase the saw's vibration and reduce its accuracy.

• Don't buy aftermarket blade guides unless the saw's existing guides are broken. Most stock blade guides are fine.

• Don't buy an upgraded tension spring unless yours is missing. The stock one is fine.

• Avoid quick-tension levers and other tensioning gizmos. They only add complexity. And they break.

So what should you buy?

MORE THAN ENOUGH
A quality 10" or 11" benchtop band saw will handle all chairmaking chores with ease. And it stores in a closet.

• A decent fence that can be adjusted for drift.
• Some sort of mobile base.
• A task light.
• Good blades. We use 1/2" Wood Slicer blades for everything. They have a 3-4 TPI variable pitch and a nice flat weld. They are great for cutting thick material and the gradual curves in chair parts.

The only downside to the classic 14" band saw design is its poor dust collection. You can improve it with a little metalworking and some plastic fittings. Plans for these modifications are widely available.

SCRAPERS

Card scrapers are essential for chairmaking. I like a scraper with a shallow curve to its edge. This was a modification I learned from Welsh chairmaker Chris Williams. I liked it so much that we started manufacturing and selling scrapers with a curved and machined edge. You don't have to buy one. Buy any scraper and use the full-size pattern on the next spread to make your own. You can shape the scraper with a grinder or a stationary belt sander.

The curved edge is ideal for cleaning up the seat. And it works great on flat surfaces, too. Because of the curve, you don't need to bend the scraper in use, so it's much easier on your thumbs.

PENCIL GAUGE

Most furniture makers use a marking gauge with a flat fence that has a knife or pin that cuts the wood. Chairmaking requires a different kind of gauge. The gauge needs to follow inside curves, outside curves and straight surfaces. And instead of a cutter, a pencil is best.

I recommend you modify an inexpensive wooden marking gauge for chairmaking. Add two half-dowels to the fence and drill a hole to grip the pencil. Note that Stanley used to make gauges with an attached metal fence that allows you to follow curves. So you might luck into one of those old gauges at a flea market.

Another option: Skip the gauge and use your fingers as a fence. This is surprisingly accurate.

MALLET

While you can use a traditional all-wood square-head joiner's mallet for chairmaking, many chairmakers like to use something with more

SCRAPE WITHOUT STRAIN

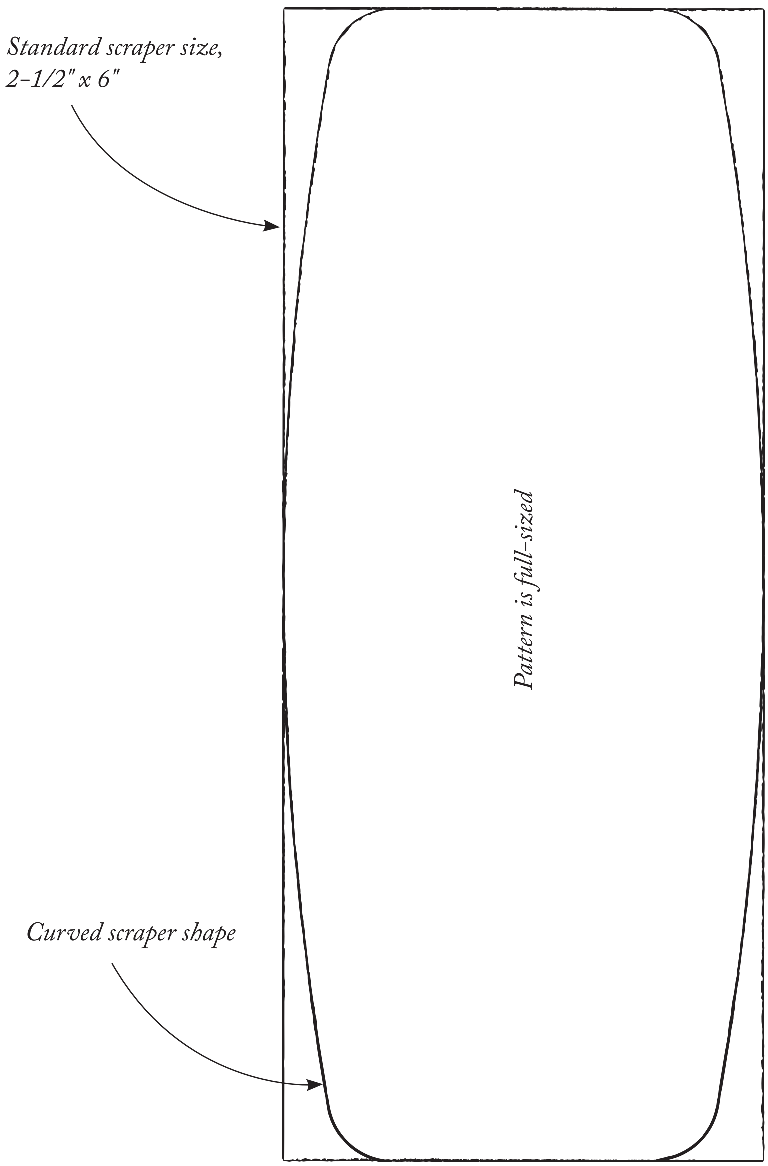
The gently curved edge of this scraper allows you to use the tool without bending it. This allows you to use the tool for longer periods of time.

kick. When assembling a chair, there are times when the glue seizes the parts. Or you need to sink the legs a little deeper into their mortises for a tight fit. For that, I like to use a small metal sledge, about 2-1/2 to 3 lbs. These are inexpensive – basically it's a hunk of iron ore on the end of a stick. These small sledges are indispensable for assembly and disassembly. Sometimes even for emergency disassembly.

DOZUKI

While most of my work is with Western tools, I recommend a Japanese-style Dozuki for beginning chairmakers as the one handsaw for their toolkit. These saws cut a fine kerf quickly. The saw's small teeth make it easy to start a cut on round parts. And you can even cut tenons almost perfectly flush with it.

I use a Dozuki with replaceable blades. The downside to this sort of


Standard scraper size,
2-1/2" x 6"
Pattern is full-sized
Curved scraper shape

A HOMEMADE GAUGE

This simple pencil gauge allows you to mark lines on curved and flat surfaces. Once you have one, you'll wonder how you worked without it.

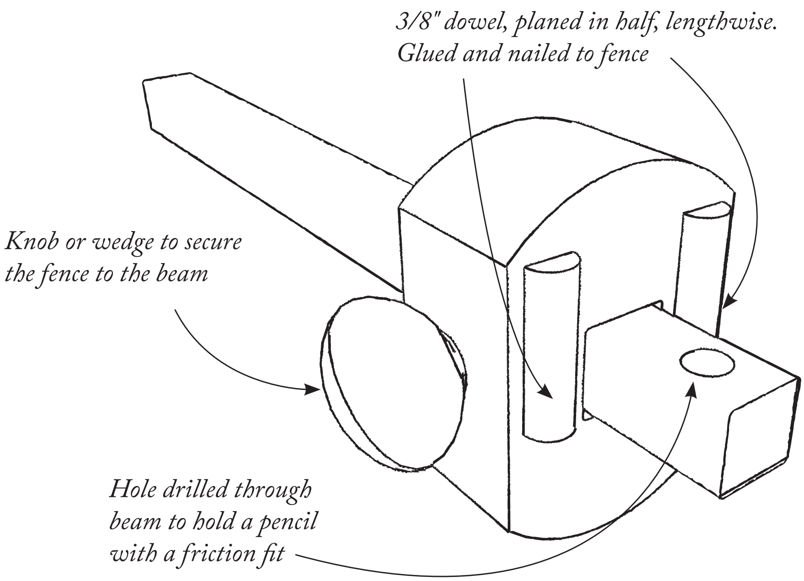
saw is that you cannot resharpen the blades, so they end up being used to make other tools or go to the scrap yard. I am fond of the Gyokucho Razorsaw Dozuki, which is widely available. Replacement blades are about $20, and they last about a year before being recycled.

RASP

A good hand-stiched rasp is a godsend for shaping curved work. It ignores the wood's grain direction (for the most part) and allows you to do things to wood that handplanes and spokeshaves struggle with.

Handmade rasps have teeth that are individually punched out – or stitched. Machine-made rasps do not compare.

Hand-stitched rasps come in a variety of shapes, lengths and coarseness/fineness – referred to as the "grain." The grain is a number from



CHAIRMAKER'S PENCIL GAUGE

You can modify an inexpensive marking gauge to mark around curves. Plane a 3/8" dowel lengthwise to create a significant flat. Crosscut the dowel then glue and nail the two half-dowels to the fence. Drill a hole in the beam to grip a shop pencil.

#1 to #15 and refers to the size of the rasp's teeth. The #1 teeth are huge; the #15 teeth are tiny and used for fine finishing.

Visit any rasp website, and you will likely get confused. The variety of rasps is insane. Here's where to start. Buy one rasp: a cabinetmaker's rasp with a half-round profile that's 9"-12" long. With a #9 to #12 grain. That rasp will teach you how to shape wood. It also will show you what rasp (if any) you might want to buy next. I also use a 6" modeller's rasp with #15 teeth.

You'll also need to buy a stiff-bristled brush to clean the rasp's teeth. The teeth clog quickly, particularly with oily or sappy woods.

METAL MALLETS

A metal mallet with a 2-1/2 lb. head might seem like overkill. Once you use one, however, you'll be pleased by the gentle but heavy pressure it can exert.

SANDING BLOCK & WOVEN ABRASIVES

Abrasives are not evil. Despite what you'll hear from the "finish from the tools" crowd, abrasives have been an important part of the woodworker's tool kit since (at least) the ancient Egyptians.

I don't use abrasives to shape my work (that's what planes, spokeshaves and rasps do). I use them to remove small bits of tear-out and to blend together the scraped and planed surfaces into a cohesive whole. While it might take me 15 hours to build a chair, I'll spend only 20 minutes of that time with abrasives. But they make a huge difference in the finished chair.

During the last 20 years, manufacturers have turned to a woven abrasive. It looks like a drywall sanding screen but is far superior. These are so fantastic they cannot be called "sandpaper." They cut

A SAW FOR EVERYONE

Inexpensive Dozukis cut quickly and smoothly. Compared to Western saws, the thin saw blade is delicate, but it can be easily replaced if/when you kink it.

quickly and last for months (even in a professional shop).

You also need a sanding block to work flat surfaces (arms, the spindle deck, chamfers). I use a piece of cork. My favorite block of cork is 1" thick, 2-1/2" wide and 7" long. You can make your own from a cork "yoga block." These solid pieces of cork measure 4" x 6" x 9" and cost about $20. You can cut them with your band saw into a lifetime supply.

Wrap your bits of woven abrasive around your sanding block or a "sanding fid" (more on that in a bit), and you will find it's like using a flexible rasp. I use #80-grit for fairing curves and #120 for smoothing. I have some #180 for finishing parts that will get a clear finish.

SLIDING BEVEL

Sliding bevels are as essential to chairmaking as a try square is to cabinetmaking. I have three sliding bevels: two small ones with a 4"

SHAPING & SMOOTHING
My rasps refine the surfaces left behind by a saw or a plane. Then the woven abrasive and cork sanding block get the surfaces ready to finish.

blade and one with a 7" blade. The small ones guide my drilling. The 7" is used for larger layout chores and for general chair design (does this angle look right?).

Small bevels can be hard to find. So feel free to use a 6" or 7" bevel for everything angle-related. You can also make blocks of wood to guide your drilling. A block of wood with one end cut to 16°, 23° or whatever can substitute for a small sliding bevel.

In general, I prefer the "butt-locking" bevels. These have the locking mechanism at the end of the tool, and the lock doesn't interfere with the tool sitting flat on your chair seat. Some bevels that have the lock at the top of the tool interfere with how the tool sits; some don't. A good budget option is the vintage Stanley No. 18, a 6" model that you can buy used for $20 or $30.

DIVIDERS/COMPASS

Laying out the locations of the spindles and sticks in a chair is easy to do with dividers or a good compass. For chairmaking, start with dividers that can open up about 6" or so. Smaller dividers lay out dovetails, and larger ones lay out railroads.

I am partial to dividers that have one leg that can be removed and replaced with a pencil. These allow you to scribe arcs and circles, which is helpful.

If you are on a budget, scour the used tool market. It's tempting to buy a plastic compass at the grocery store. These, however, do not lock well. Instead, find the cheapest dividers that have a locking mechanism. Then, when you inherit a small fortune, buy a Starrett No. 92-6.

TAPE MEASURE, RULE, COMBINATION SQUARE

You need a good tape measure (a 6' or 12' is more than enough). A 6" rule should always be close at hand. And 6" and 12" combination squares are constant companions. All of these tools are available in prices ranging from a fast food value meal to a black-market kidney.

If you've been woodworking for a while, you already own these tools. If you are new, try looking for new and used tools from Starrett, Brown & Sharpe, Shinwa and Mitutoyo.

YARDSTICK

Find a good wooden yardstick. I have an old maple one from a hardware store. It is finished in shellac and is a pleasure to use. (Cost: $1.)

Yardsticks are an important tools in my tool kit. They become a beam compass for laying out patterns and parts. They help gauge how deep a seat saddle is. They help visualize the location of parts in 3D space. They determine if your arms or legs are crooked. They lay out straight lines on your patterns.

CHAIRMAKING VISE

Though you can manage most chairmaking operations with the vises on a regular workbench, an additional vise is remarkably helpful. I use the iron carver's vises that attach to any flat surface that has a hole in it. These vises have swiveling jaws that allow you to pinch tapered and curved work. Other vises, sold as "hi vises" or "machinist's vises" are also great at holding work above the benchtop so you can shape it.

SLIDING BEVELS

Butt-locking bevels are ideal for chairmaking. If I had to own one, it would be the small size, though it is nice to have a few sizes in the tool chest when building a chair.

MEASURE WITHOUT NUMBERS

Dividers and a compass lay out the position of the sticks in a chair. Stepping off the dimensions is more reliable than using a ruler.

SPIRIT LEVEL

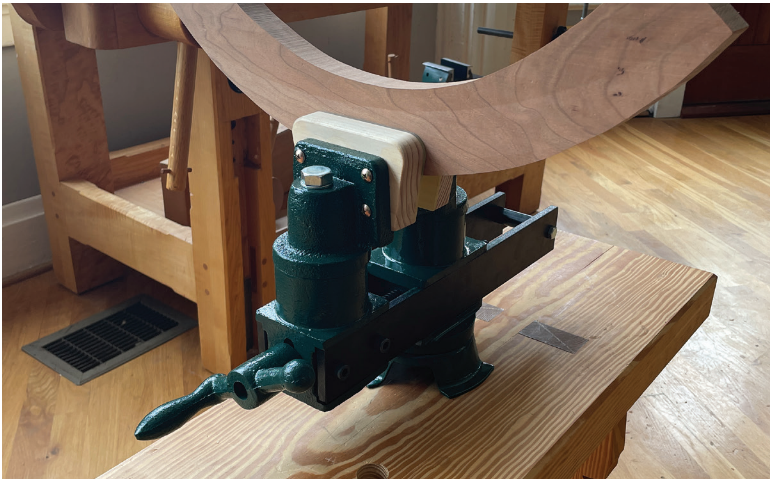
I know, this seems an odd tool for a woodworker. Aren't spirit levels for carpenters? I use a spirit level every day when making chairs. It helps position sticks in a vise when cutting tenons. And it is indispensable for cutting a chair's legs down to the proper length. You don't need a big one. I have a 12" level and an 18" one – both vintage.

PROTRACTOR

Here is one instance where a cheap plastic tool from the grocery is fine. I have a green one I've used for more than a decade. It's a huge help at the bench and when drawing out chair designs in a notebook.

SOFT-JAW PLIERS

Many times you will want to reduce a tenon in diameter slightly so it will fit into a mortise. You can shave the tenon, of course, but most



CHAIRMAKING VISE

A vise that can hold odd shapes above the workbench makes many chairmaking operations easier. I would buy one of these before I bought or built a workbench. You can install it almost anywhere.

times it's better to compress it with pliers. The compression is easy to get uniform all around the tenon (squeeze the pliers and twist the tenon in the jaws). The compression also works in your favor at assembly. Once the glue hits the tenon, the tenon expands and locks the joint.

TRAVISHER

We are now into the specialty chairmaking tools section. A travisher is a chairmaker's smoothing plane. It is a curved-edge tool that scoops out a seat to add comfort and style.

Traditionally, a travisher was used after roughing-out tools (such as an adze or an inshave). You can, however, use a travisher alone to shape seats. It will just take longer.

There are lots of travishers in the marketplace, and I have yet to try them all. Vintage travishers are hard to find, expensive and difficult to restore. It's best to buy new because they are almost guaranteed to work out of the box.

You get what you pay for when it comes to travishers. Good ones are expensive. They also work well and last a lifetime. One good path to

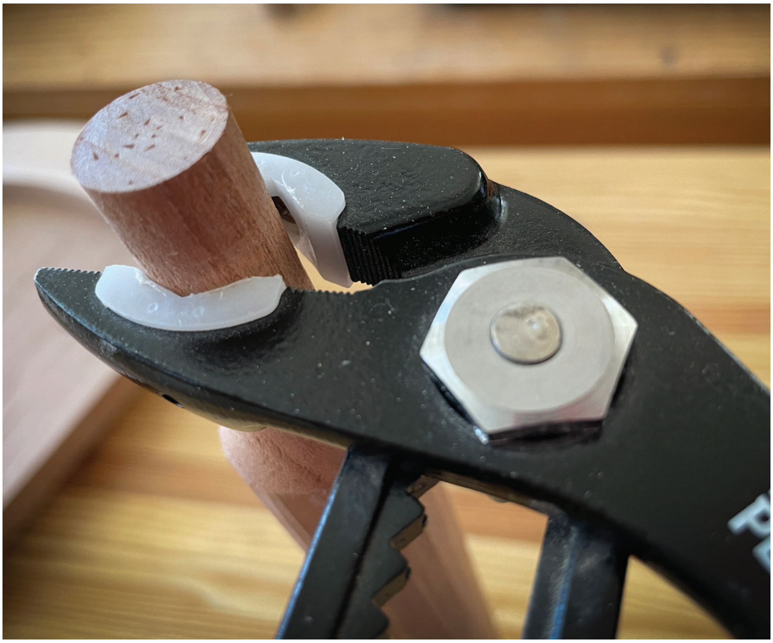
SPIRIT LEVEL
A spirit level ensures your chair doesn't lean left or right. And it helps you figure out how far back to tilt the seat. Even a cheap plastic one is fine for chairmaking.

take when buying is to get one from a chairmaker who sells or designs tools on the side. In my experience, these tools always work. Plus they come with a knowledgeable seller who can help you diagnose any problems you might have.

Side note: What about the rotary cutting tools that you attach to an angle grinder? Aren't those good for shaping chair seats? I'll answer that question with this question: Do you enjoy having skin? I have worked with these tools and (opinion follows) find them unacceptable as far as safety goes.

SCORP/INSHAVE

This tool looks like a drawknife that has been bent so its blade is curved. This is the tool that roughs out a seat, removing wood quickly so it can be finished up with a travisher (followed by a scraper and abrasives). For my first 17 years as a chairmaker, I used a Barr Tools scorp with a tight and consistent radius (2-1/4"). Why? It was the only good tool I could get my hands on. And I made it work just fine for



A JOINERY TOOL

Getting a tight fit between your sticks, seat and comb ensures your chair will last. Soft-jaw pliers allow you to precisely and easily compress your tenons.

more than 100 chairs. I still recommend Barr. The steel quality is as good as any I've ever used.

Recently I started using a scorp/inshave with a different shape. The majority of the blade has a flat, gradual curve, but it has tight curves at its ends. Plus, the handles are lower and the tool is lighter. All in all, I prefer this new design (believe me, I didn't want to). It is easier on my wrists. And it takes a wider shaving when I use the middle part of the blade, and a smaller, tighter-radius shaving when I use the curvy ends of the blade.

The scorp was designed by chairmaker George Sawyer and blacksmith Lucian Avery. If you can afford it, don't hesitate. If you can't, don't fret. Buy a scorp you can afford. Take care of it, and it will serve

SMOOTHING YOUR SEATS
Travishers shave a curved seat. They are subtle tools that can take a light or heavy cut depending on how much you tilt them forward or backward in use.

THE SCORP/INSHAVE

My old scorp (below) has a tight radius. Recently I have started using a version with a different shape. Both tools do a fine job, but I prefer the flatter curve (above).

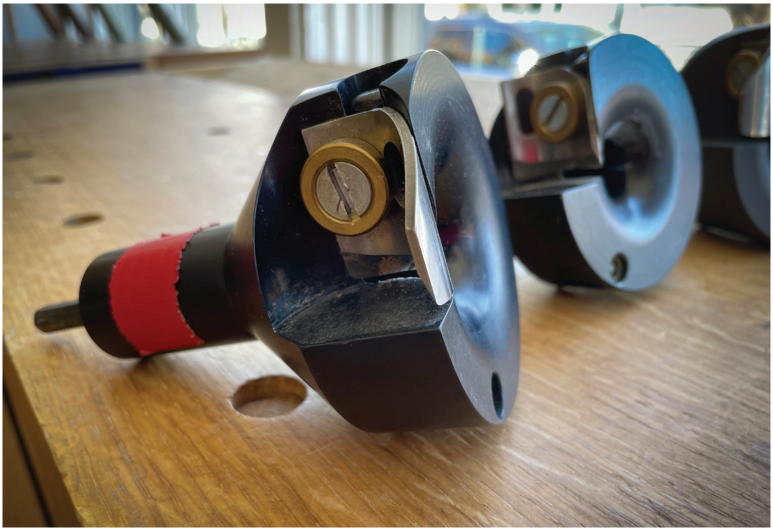
you well.

Chairmaking tools are like that. They can be hard to find. They can be particular – almost odd. Eventually you will find what you want, and they will sing in your hands. Promise.

TENON CUTTERS & ROUNDING PLANES

Tenon cutters cut cylindrical tenons of a particular size. The 5/8", 3/4" and 1" sizes will make all the chairs in this book. There are vintage hollow augers out there that are adjustable (the A.A. Woods & Sons is one version I've used). But I prefer modern tenon cutters that are dedicated to a particular size tenon. These sorts of tools come in two flavors:

1. A wooden version you spin with your hands. These are sometimes called "rounding planes."
2. A metal version spun by a drill or a brace.



POWER TENON CUTTERS

These miraculous tools make a perfect tenon on the end of a leg or a stick. They work in a brace or electric drill. You need only three sizes for all the chairs in this book: 1", 3/4" and 5/8".

The advantage of type No. 1 is that you can also shape your sticks with it. The advantage of type No. 2 is that it is faster.

As you'll see later in this book, there are many ways to make tenons for chairs. You can cut them with a plane, a tenon cutter or a lathe. I prefer using tenon cutters because they are fast and pretty foolproof. They aren't cheap (but they're cheaper than a lathe and fit in a drawer).

FROE

Depending on how you want to process your wood, this tool could essential or unnecessary. I like a froe that comes to a fairly fine point on the blade. These are less likely to bounce off the wood when you strike them.

The tool takes immense abuse because it is struck and then used like a lever. So the joint between the steel and the handle needs to be robust. The froe developed by Drew Langsner for Lie-Nielsen Tool-works meets all these criteria and is widely available. You also can commission a blacksmith to make one. Unfortunately, most of the antique froes that show up here in Kentucky are so ragged out that their best use is on the wall at Cracker Barrel.

RANDOM-ORBIT SANDER

Many traditional chairmakers eschew abrasives. I do not. Abrasive rush, shagreen (sharkskin) and sandpaper all were in use in workshops since the 18th century.

Small random-orbit sanders are a great help when saddling a seat. After shaping the seat with a scorp and travisher, a random-orbit sander can quickly blend these two surfaces and create an ideal surface for final scraping. In some cases, I switch back and forth between the sander and the scraper to tweak the seat's appearance.

To be honest, I dislike using an electric sander because of the noise and vibration (the dust is sucked up by a vacuum). But it is so handy that I have made peace with it. Also, I don't use it much – usually about six or seven minutes during the seat-saddling process.

LASER & TRIPOD

When I teach a chairmaking class, lasers help guide beginners as they learn compound-angle joinery. After a few chairs, you get a feel for working without them.

After years of using red lasers (and struggling to see the beam in daylight), a fellow chairmaker recommended green lasers. They make a difference. Even in our storefront with full sun outside, a green laser is easy to see and follow.

The lasers I use are technically "laser levels" that shoot a vertical and horizontal laser. The laser we have is "self leveling," which is not helpful for chairmaking (the horizontal laser is always parallel to the floor, and the vertical is always perpendicular). Fortunately, you can switch that feature off and take the laser lines off 0° and 90°. Also handy is that the laser can be attached to a tripod, so you can work alone.

I'll show how to use the laser for drilling when discussing drilling the mortises for the sticks.

ROUNDING PLANES

Rounding planes are trickier to adjust than metal tenon cutters. But they can also shape your sticks.

A QUICK SPLIT

A froe and a mallet can quickly convert a board (or a log) into chair-sized parts with dead-straight grain.

FLUSH-CUT SAWS

After you wedge the through-tenons in your chair's seat and arms, you need to cut the tenons flush. You can do this with a chisel, a shallow gouge or a scorp. Or use a flush-cutting saw.

All the methods require skill and have risks. All the tools can mar the surrounding surface. I switch back and forth between using my scorp and flush-cutting saws for the most part.

BELT-DISC SANDER

If you need to make curved chair parts in a hurry (like for a class of 18 students), then motorized sanding is essential. A belt-disc sander makes short work of convex curves and straight lines. And if you add dust collection, they are quite safe.

These machines come in stationary and portable versions. Plastic-y or heavy metal. You get what you pay for. If you care deeply about your tools and machines, look for metal controls (instead of plastic), and heavy cast trunnions (instead of stamped steel).

OSCILLATING SPINDLE SANDER

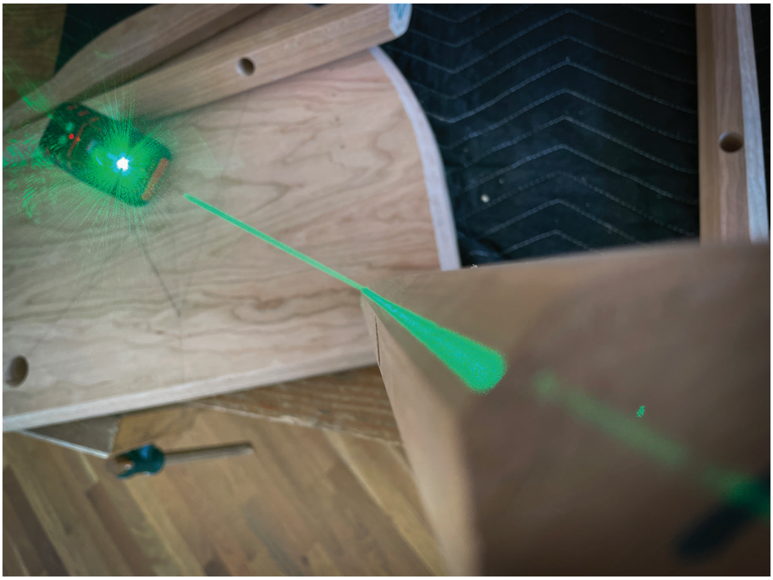
For concave curves, an oscillating spindle sander is the foil to the belt-disc sander. This machine comes with a variety of sanding sleeves in different diameters. Always use the largest diameter possible.

As with belt-disc sanders, these machines come in a wide variety of prices and quality levels. All the same advisories above apply to these machines. Look for metal over plastic, castings over stampings.

GLUE POT

We use hide glue when making chairs. It's reversible. Invisible to most traditional finishes. It cleans up with water (even when cured). The bottled version (liquid hide glue) has a long open time, which means you have more time to assemble your chair.

No matter what time of year it is, we warm our liquid hide glue in an electric glue pot to make it flow easily. If you can't afford a glue pot, use a slow cooker or a baby bottle warmer. Really, anything that heats the bottle to about 120° (F) will do the trick (including a cup of really hot tap water).



I SEE THE LIGHT

I resisted lasers until I started teaching chairmaking. They help students get the hang of the angles. I use them when making prototypes with unfamiliar angles.

DIAL CALIPERS

While this is a machinist's tool that measures things to the thousandth of an inch, it is a useful diagnostic tool. When your tenons are too tight, calipers can tell you exactly how big they are. It can help you find tenons that are out of round. It can measure the depth of mortises with insane precision. It can help you see things your eyes cannot.

THE FIRST STICK CHAIR?

An image from a Latin version of "Laws of Hywel Dda," a Welsh law book. This version dates from the late 12th or middle 13th century. Note the tapered legs and the sticks beneath the arm.

STICK CHAIRS & WINDSORS: A TINY HISTORY

When people see a stick chair for the first time, a typical response is to call it a "primitive Windsor." Unfortunately, every syllable of that expression is off base.

And that's OK. We live in a world where the term "Windsor" has expanded like a gas to mean almost any piece of furniture where stick-y components are mortised into a plank – Windsor table, Windsor stool, Windsor bench, Windsor printer stand.

It does make you wonder: Where did this furniture come from? A place called Windsor?

Perhaps.

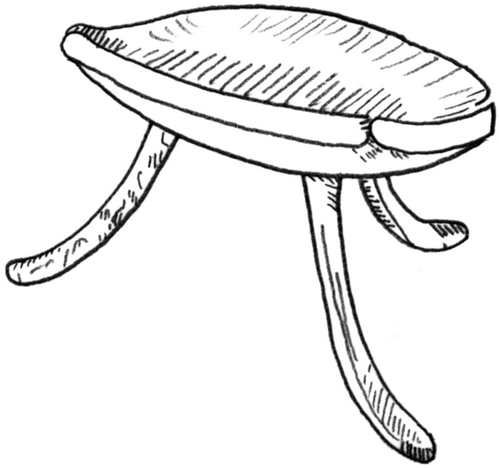
As furniture historians point out, the origin of the word "Windsor" to describe a class of chairs is complicated and has yet to be definitively settled.

So let's start at the beginning. Furniture that has its legs tenoned into a plank – what is sometimes called "staked furniture" – goes back to at least the ancient Egyptians. Three-legged staked stools with beautifully curved legs and a saddled seat have been found at Thebes (1400 BCE). And the National Museums of Scotland has a similar one from the same time period.

Staked furniture of all kinds appears in Western paintings and drawings through most of human history. Stools, benches and tables are the most common forms. So, the idea of putting sticks into a slab of wood is at least 3,400 years old.

What I'm interested in, of course, is this: When did people start making chairs this way?

The simple question is complicated by language. The term "stool" can sometimes mean "backstool," which is a stool with a backrest that is a solid board or an array of sticks. Some people consider a backstool a "side chair" and not a stool. So that word clouds the timeline. Old writings that mention "stools" might actually mean "backstools," and those might be chair-like.



EGYPTIAN STAKED STOOL

A low stool from Thebes, Egypt. Found at the tomb of Kha, 18th Dynasty. Note the curved legs and saddled seat.

The earliest stick chair – legs, seat, arms and backrest – that I know of is from a Welsh book of laws that dates from the late 12th century or the middle 13th century. The book is the "Laws of Hywel Dda"; the chairs are drawn in a particular copy that was written in Latin instead of Welsh (this copy is referred to as the "Peniarth MS 28").

The book is illustrated with images of important men sitting in chairs (one image is at the beginning of this chapter). Two of these appear to be armchairs. Both chairs have tapered legs below the seat. One has sticks under its arms, and the other has four shapes below the arm. The shapes could be cut-outs in a solid plank. Or the shapes could be objects holding up the arm.

John Brown, the chairmaker who coined the term "Welsh stick chairs" when he wrote the book of the same name, insisted that the word "Windsor" didn't apply to these sorts of chairs.

"Welsh Windsor chairs sounds to me like saying Welsh Scottish oatcakes, or Welsh Wexford glass" he wrote. "The chairs I am

STAKED FURNITURE EVERYWHERE

A staked bench from a Medieval book of health called "Tacuinum sanitatis." Italian, 15th century.

writing about are very definitely Welsh, and they are called stick chairs in Wales. They do, however, fulfil (sic) exactly the definition of what has come to be known, in Britain and the United States, as Windsor chairs. My judgement is to stay true to my original thoughts; only time will tell if I am mistaken."

So if early stick chairs aren't Windsors, where did Windsor chairs come from?

First, let's dispense with a myth about the origins of Windsor chairs that gets repeated in popular culture.

"The most popular meaning stems from the story which describes how George III was caught in a rainstorm near Windsor," writes Ivan G. Sparkes in "The English Country Chair" (1973). "Taking refuge in a cottage, His Highness sat on the best chair in the room and being well pleased with its comfort, required similar ones to be made for Windsor Castle. Unfortunately for this theory, the style existed and was so called long before the Georges came to the throne of England!"

Another (slightly more plausible) theory appears in "Popular Technology; or Professions and Trades. Hazen's Panorama" (1846) by Edward Hazen.

"The Windsor chair seems to have been first used for a rural seat in the grounds about Windsor castle, England; whence its name. It was originally constructed of round wood, with the bark on; but the chair-makers soon began to make them of turned wood, for the common purposes of house-keeping."

I do like that this theory hints that bark-on sticks played a part in the history of the Windsor and they were originally outdoor chairs. Many historical accounts of Windsors discuss how they were painted green and used in the garden. At some point they migrated inside.

In the last decade or so, historians have used probate inventories and paintings to present a clearer picture of the origin of the term. The best synopsis of the current thinking was published in 2010 in *Regional Furniture*, Vol. XXIV, by Robert F. Parrott.

The most interesting part of the evidence are two inventories taken two years apart of the same household, one in 1721 and the other in 1723. The first inventory was for the husband who died of a stroke; in the listing of the equipment for the garden are "Forty eight Forrest Chairs." (Other inventories use the spelling "forest.") Two years later there is another inventory, and in the section on garden equipment are listed 60 "Windsor" chairs. Presumably these are the same chairs, but the household had bought another dozen.

"Presumably therefore, the type of seat originally described as a 'Forrest' chair sometimes went under the alternative name of a 'Wind-

A SECOND WELSH CHAIR

Also from "Laws of Hywel Dda," this chair is slightly different. The structures under the arms might be cut-outs.

sor' chair," Parrott writes. "This, then, may be another reason why the early history of the Windsor has been so difficult to ascertain."

FOREST CHAIRS

We don't know exactly what these early chairs looked like, but we have some clues. Since the 1970s, several early chairs have shown up at auction houses, at the Victoria and Albert Museum and through some sleuthing. These chairs are far simpler than the typical later English Windsor and might be a stylistic link between stick chairs, Windsor chairs and American Windsor chairs.

These early chairs share many characteristics with stick chairs. There are no stretchers – the strut legs are simple turnings. There is no backsplat – a common feature on English Windsors. And the ornamentation is restrained compared to later English Windsors. There is a simple scratched groove around the seat and the comb. The front posts under the arm have a little shape. But that's about it for decoration.

As a maker of stick chairs, I think these are the prettiest English chairs I've ever seen. I am also struck by how much these early chairs resemble American comb-back Windsor chairs. It's rare to see an American Windsor chair with a backsplat. And the rake and splay of the legs looks far more American than English.

It makes me wonder – and this is conjecture – if these early Windsor chairs inspired American makers. Or perhaps these early English chairs were inspired by local vernacular chairs.

John Brown also had thoughts on this matter. He came to a slightly different conclusion.

"The oft repeated statement that American Windsors derive from the English chair could be in error," Brown wrote. "For historical reasons, and because of similarities in design, there seems to be a more direct link between the Welsh chair and the American Windsor. Perhaps the English version is the cousin, and the Welsh chair is the father!"

SO ABOUT THAT NAME, 'WINDSOR'

Once you know these chairs may have been called "Forest" chairs, you have to wonder, why did the name switch to "Windsor?" Was it because the chairs were made in Windsor?

William Sergeant found evidence of the earliest-known maker of Windsor chairs in a village in Lincolnshire, which he discussed in a 2018 article in *Regional Furniture*. That maker, Joseph Newton of Fenton, placed an ad for "New-fashioned" Windsor chairs in July 1725.

Newton's ad also mentions there are makers of these chairs in London. What's important to know is that Newton's shop was

IS THAT YOU, FORREST?

A very early English chair from a private collection in the United States. Could these early chairs, which have no backsplat, be the "Forest" chairs referred to in early 18th-century inventories?

nowhere near Windsor Castle (it's about 140 miles away).

Parrott and other historians have found connections between chairmaking activity near Windsor and where those articles went to London. But Parrott admits the link is still tenuous.

One possible theory for changing the name is that the term "Windsor" gave the form a royal flavor and is in line with the French naming furniture styles after kings (i.e. Louis XIV).

Or perhaps the name "Windsor" could have become popular first as an insult to the chairs, as Sparkes wrote in 1973.

"In the end I find myself agreeing with those writers who connect the origin of the name with the manufacture and sale of these chairs to the London dealers at the Windsor Market and along the main road from Windsor to London. For one can imagine the London chair dealers, used as they were to the finer mahogany and walnut products of the London workshops, referring in a derogatory way to the latest batch of beech chairs 'up from Windsor'."

Today the term "Windsor" gets applied to broad classes of furniture that have no connection to Windsor Castle. Or pieces that have nothing to do with the House of Windsor, which was founded in 1917, or the town of Windsor. It can be confusing.

At times I fantasize about a world that has switched back to the earlier and more evocative name for this distinctly English chair: Forest Chair.

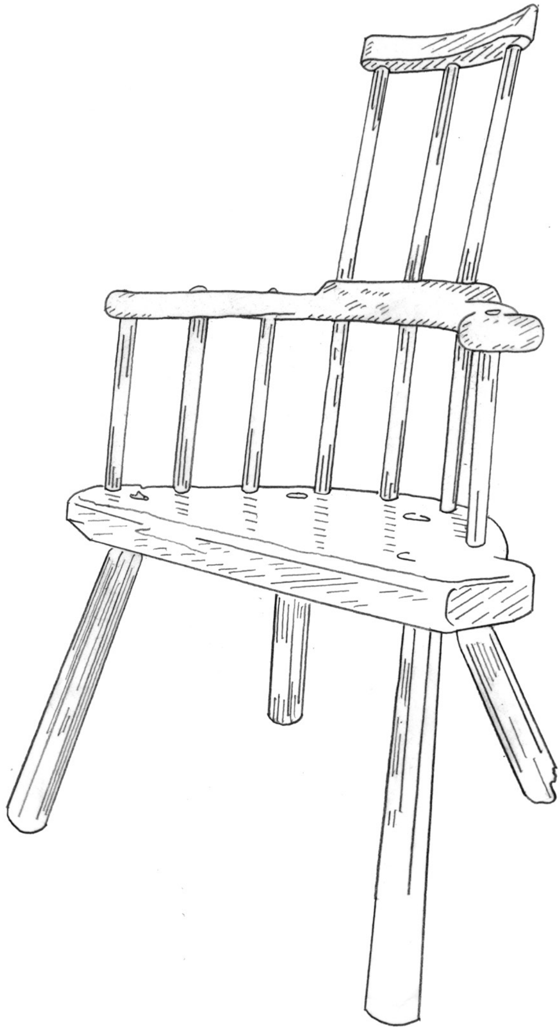
The term "Forest" is far more descriptive of how the chairs initially were used: as a seat for the outdoors. And, unlike the word "Windsor," the term "Forest" describes without a doubt where the chair came from.

And so, in this book – as a bit of a lark – I will refer to "Windsor" chairs as "Forest" chairs.

I am certain this will catch on everywhere – just like Esperanto.

BEAUTIFUL UNDERBELLY

The seat of these chairs is thick – about 2-3/8". But they have an illusion of lightness thanks to the shaping under the pommel and the rounding of the front and sides of the D-shaped seat.



AN UNUSUAL WELSH COMB-BACK

One of my favorite chairs, this comb-back has three sticks for the back, which is unusual. Most comb-back chairs have four sticks or more. This chair is on display at St Fagans.

THE STICKTIONARY

I used to work in a shop with a guy – let's call him Gary – who called almost every furniture component a "rail."

"Can you put hinges on that rail?" (It's a stile, Gary.)

"Attach the front rail (drawer blade) to the side rail (drawer runner)."

"Screw that bottom rail (toe kick) to the shelf rail (case bottom)."

Now, I'm not one of those pedants who corrects someone's grammar and word choice in conversation. Talking to someone is an imprecise and messy way to communicate.

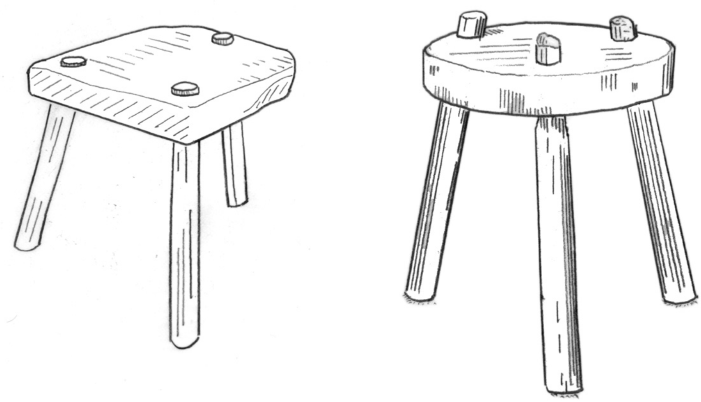
But knowing the right word for something is helpful when learning the craft of chairmaking, case construction or butt surgery. For example, the word "backstool" means different things to different people. In some books, backstool means a stool with a solid plank added as a primitive backrest. To others, a backstool is more like a side chair (basically a chair with back sticks and a comb – but no arms).

To be honest, I struggle with these terms myself. Is an armchair also a comb-back? Is a lowback a side chair, a backstool or an armchair?

This chapter is an attempt to bring some order to the world of stick chairs I've obsessed over since the 1990s. In this chapter, I deal only with stick chairs – a form where sticks are driven into a solid seat. I'm not trying to classify the different kinds of ladderbacks, turned chairs or chairs made predominantly with square mortise-and-tenon joints (sometimes called framed chairs). And Forest chairs have their own books and their own names.

For the most part, the names of these stools and chairs derive from descriptions of antiques in catalogs. Or from historical texts. But antique dealers aren't paragons of consistency, either. So don't take my word (or anyone else's) as gospel.

Now, before we can talk about chairs, we have to talk a bit about stools. There aren't many books about stools exclusively, and that always struck me as odd because stools are so important to the history



TWO LOW STOOLS

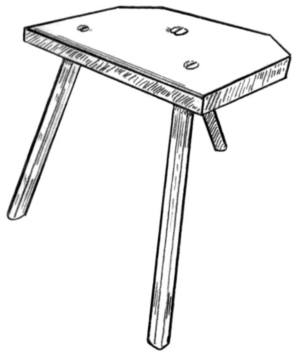
The stool at left is likely Welsh. The one on the right is Irish. The protruding tenons are a common problem on these hard-used household items.

of sitting. But to be fair, there aren't a lot of books about stumps and rocks, either, and they are just as important.

WHY DISCUSS STOOLS?

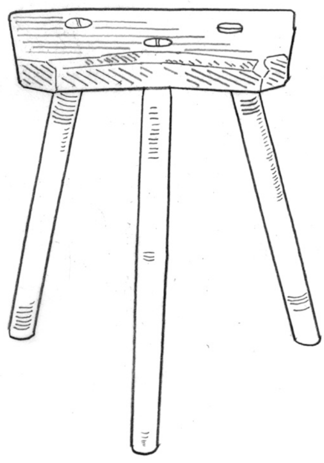
Stools aren't chairs, so it might seem a bit odd to bring them into a taxonomy of stick chairs. In truth, stools and stick chairs are so closely related that it is difficult to discuss one without understanding the other. Many times an old stool will be converted later in life to a backstool or a chair by adding sticks and arms above the seat. Other times, a chair will be transformed into a stool when the arms or sticks break. You just saw off everything above the seat, and you have fixed your broken chair.

Early stools tend to be low things (10" or lower) with three legs so they are stable on uneven floors. Why are they low? So the sitter can



A SEAT-HEIGHT STOOL

This stool, sold as a Welsh example, has a typical six-sided seat that is simple to make with only a handsaw.



A SHEFFIELD WORKSTOOL

These three-legged stools were found in Sheffield factories. The legs are rough but the form is appealing.

breathe easier. In many cultures, these low stools were used in buildings that had wood (or peat) heat and were – by design – poorly ventilated. Ventilation lets out both smoke (yay!) and heat (boo!). So in these structures, the air is always healthier by the floor. Some of these low stools earn evocative names, such as the Irish "creepie." I often picture people sitting on these stools and creeping or scooting closer to the fire inch by inch as the night wore on.

There are few rules for building stools. You take a chunk of wood that is big enough for a human butt and drive some legs into it. Many surviving old stools have the legs' tenons poking above the seat. This attests to the hard life that these stools led, and the flexibility of the human form to find comfort in difficult circumstances.

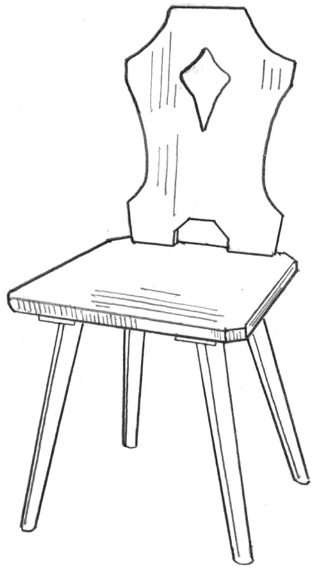
One of the common variants on the rude stool is the milking stool. Milking stools can be even lower – I have seen Shaker examples that are 6" tall. You can usually differentiate a creepie from a milking stool by the seat. Many milking stools have a decorative hole there to make the stool easy to carry around the farm. Even stranger: Some milking stools have only one leg, and the stool is strapped to the farmer's butt with a belt or rope.

In addition to the low stools, there are taller stools. These are similar in all respects to their shorter siblings but have longer legs (18"-30") and sometimes have stretchers. These taller stools are typically used for working at a bench or workstation.

BACKSTOOL

A stool that has a simple back – usually a solid plank – is often called a backstool. Like stools, backstools can be tall or short (a tall backstool might be a barstool, for example). The back is typically tenoned through the seat and fastened with wedges or pegs.

The most common form of backstool is a German/Swiss form. This surprisingly lightweight backstool features a thin seat with two battens on its underside that thicken the seat where the legs are attached. The back is typically a solid plank of wood that has been sawn into a pretty shape with piercings and carvings. The other defining characteristic of this Germanic/Swiss form is that the legs get thinner toward the floor. That's the opposite of what is typical with vernacular chairs.



A GERMANIC/SWISS BACKSTOOL

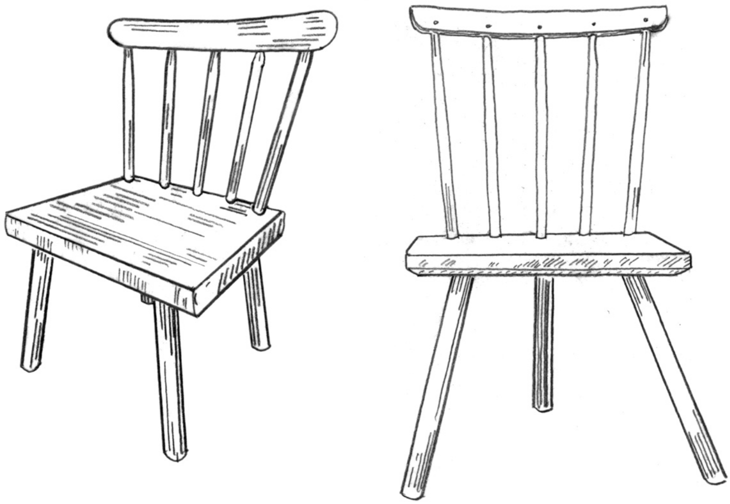
Note the battens beneath the seat. These thicken the thin seat to make the backstool more robust.

Is a backstool a chair? Some historical sources lump them in with stools; others think of them as a simplified chair. I say let the backstool be its own thing.

SIDE CHAIR (A BACKSTOOL WITH SPINDLES)

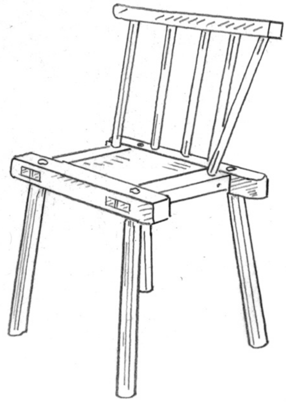
OK, here's where the language gets muddy. What most Americans call a side chair is a chair that has some sort of backrest but has no arms. A side chair's backrest can be anything – from a fluffy cushion to a bunch of thin wooden spindles topped with a backrest. Why is the term "side chair" confusing? Because (as mentioned above) some people call this form a backstool instead.

To add to the confusion, some of these side chairs/backstools don't have a seat that is a single slab of wood. Instead, the seat is a frame-and-panel construction that is skinned with thin wood. It can – at first



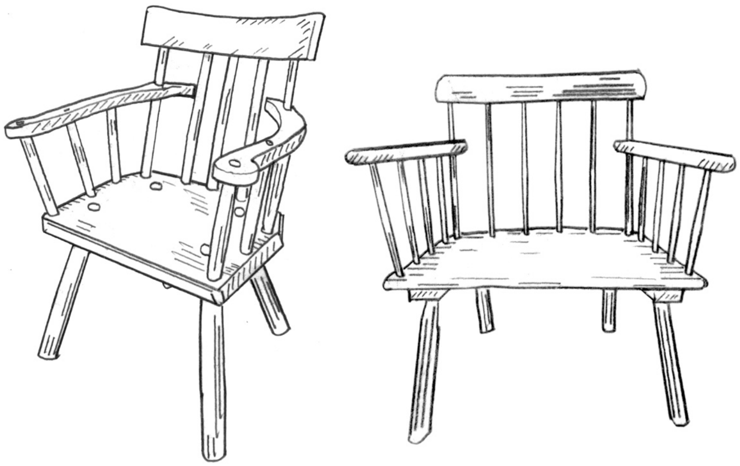
TWO SIDE CHAIRS

Typical side chairs are backstools that have a back made of multiple spindles with a backrest.



SIDE CHAIR WITH A DOOR SEAT

The frame-and-panel construction of the seat allowed the maker to use smaller bits of wood to create a seat.



TWO ARMCHAIRS

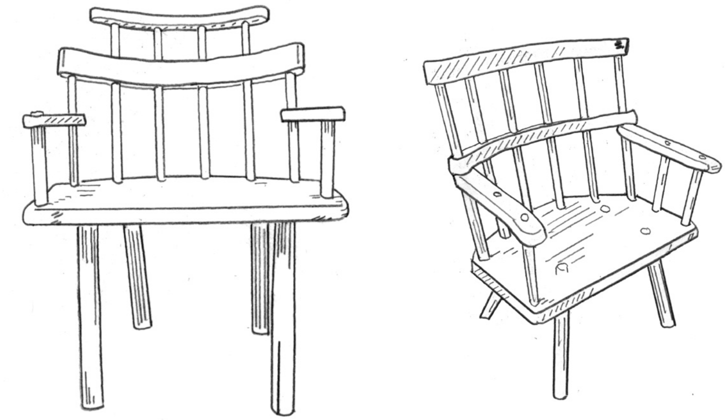
Note how the arms are linked to the back sticks. The one at left is Irish. The one at right is interesting because of its thin seat and battens.

glance – look like a slab seat. But it's not. The legs are tenoned into the thick frame members. These seats are occasionally called "door seats" because their construction resembles a door somewhat.

ARMCHAIR

"Armchair" is another weasel word in the chairmaking lexicon. On the one hand, it simply means any chair that has arms. But other sources (including me) use the term "armchair" to instead describe a chair with two separate arms that are linked in some way to the chair's backrest, usually via the chair's back spindles. Also important: an armchair's backrest is typically low enough to contact the sitter below the shoulder blades.

Some armchairs feature some additional bracing on the back sticks. Or they have a second baby backrest that sticks up above the main one. These additional bits of wood add comfort, strength or just decoration to the basic armchair form.



TWO ARMCHAIR VARIANTS

The chair at left has an additional backrest. The chair at right has an additional brace above the arms.

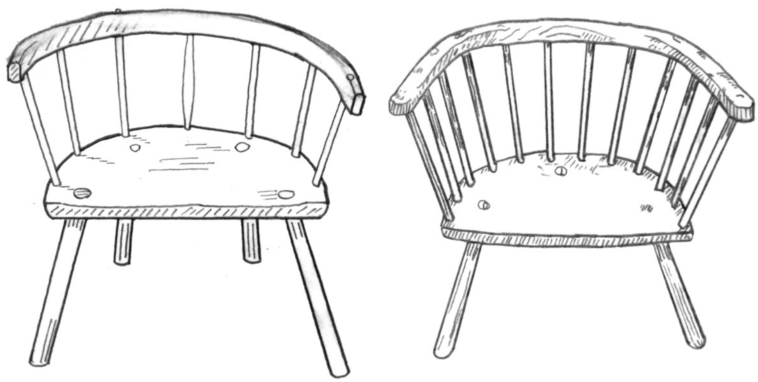
LOWBACK

Lowbacks have a curved armbow that surrounds the sitter on three sides. The armbow can be a single piece of wood – either bent by the maker or by nature. Or the armbow can be pieced together from multiple pieces of wood that are joined. Sometimes the armbow is thickened at the back with an additional piece, called a doubler or a shoe, which can provide additional support for the sitter's back.

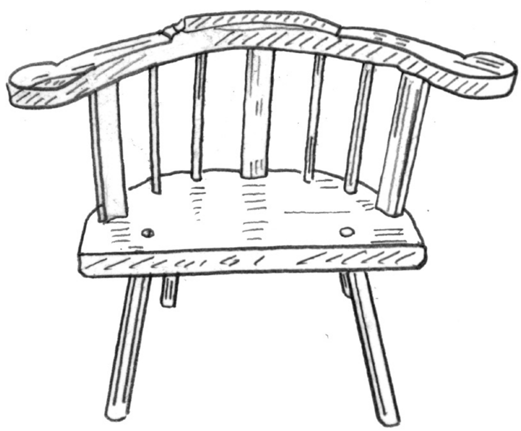
Some people call lowbacks "armchairs" because nothing in this world can be easy anymore.

The lowback form gets messed with a lot. One common hybrid version merges a lowback with a backstool. The chair has a curved arm – like a lowback – but it also has a single slab of wood as a backrest – like a backstool.

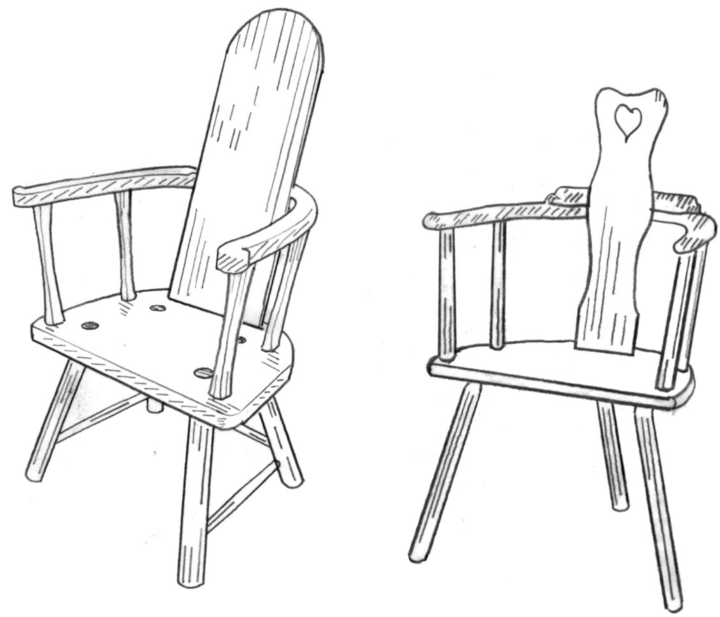
Sometimes a lowback's armbow doesn't have much curve because the armbow is a giant root that has a very gentle curve. Finally, just like with armchairs, sometimes lowbacks get some extra parts added on, either at birth or later in life. The most common "implant" is to add a little backrest above the arm.



TWO TYPICAL LOWBACKS
In lowback chairs, the arm sweeps all the way around the sitter, providing support for the back and arms.



ROOTBACK VARIANT
A common and early Welsh chair, the rootback features a naturally curved limb to support the back and arms.



LOWBACKS WITH BACKSPLAT
These lowbacks feature a backsplat – much like that on a backstool – to help support the shoulders of the sitter.

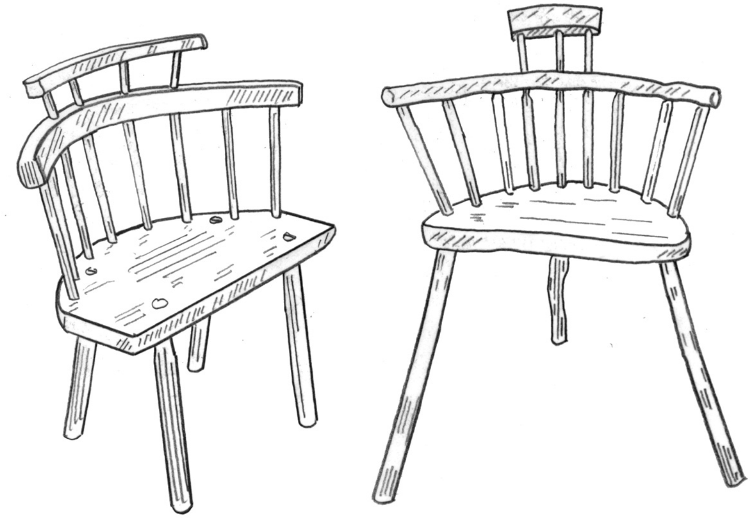
COMB-BACK

These common and comfortable chairs have arms and a tall back that is topped with a piece of wood called a comb or crest. With most comb-back chairs, the sitter rarely reclines against the comb, so the comb can be highly decorated. Or it can be a flat board or a gnarly stick.

Of course, just like with the other chair forms, there are a lot of possible variations and hybrids.

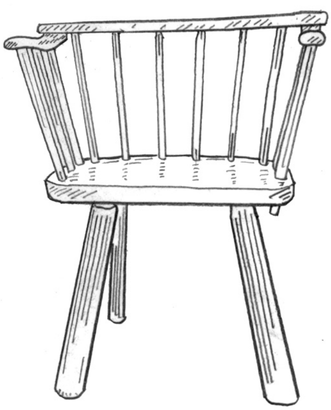
One of the most common variations is to add a tall slab of wood to the back, like a backstool. When this happens, the slab of wood is called a "splat" or a "backsplat" and is often festooned with curves, piercings and carvings. This form is common among English Forest chairs.

Another distinctive variation from Wales is the "lobster pot" comb-



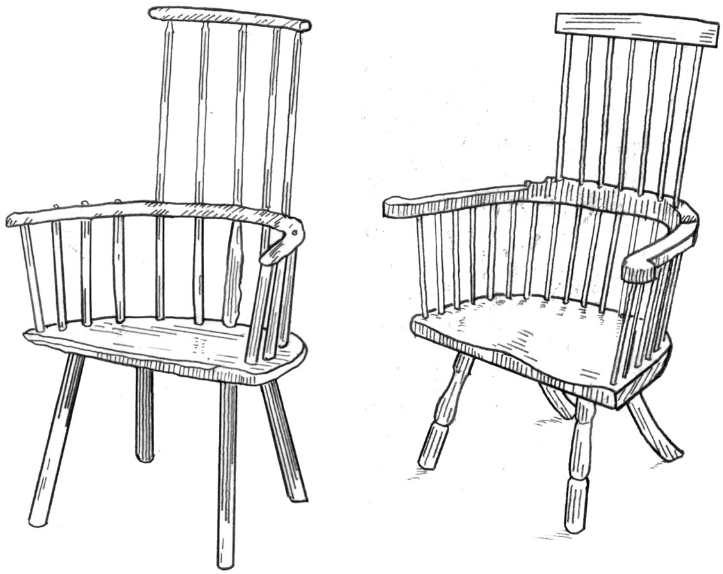
TWO LOWBACK VARIANTS

These lowback chairs have an additional backrest that is only slightly above the arm.



LOWBACK WITH LINKED ARMS

The arms of some lowbacks are stacked on top of one another instead of being joined together. Or is this an armchair?



TWO TYPICAL COMB-BACK CHAIRS
Their key feature is the comb or crest high above the arm.

back. In this sort of chair the back sticks are bent inward. The back looks a bit like a lobster trap (if you are both squinting and drinking).

Finally, comb-backs can be dressed up by adding a lot of extra parts for bracing or decoration. Sometimes the back will get extra tiers. Or the back will be made as a rectangular frame that surrounds the chair's back sticks.

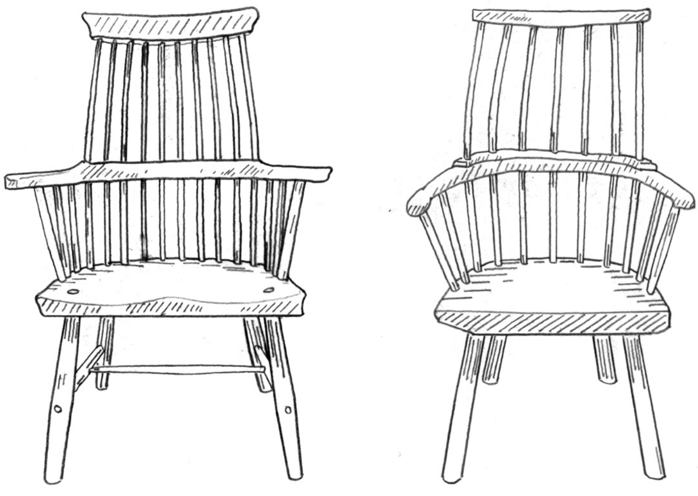
ESPECIALLY IRREGULAR CHAIRS

There are many chairs that don't fit into the above categories because they were made by creative or deranged individuals. Or perhaps the maker knew another craft (such as boatbuilding or cabinetmaking) and built a chair using the joints and techniques common to his or her trade.

Other irregular chairs include Forest chair forms that were crossbred with stick chairs. Imagine a sack-back chair that has been built

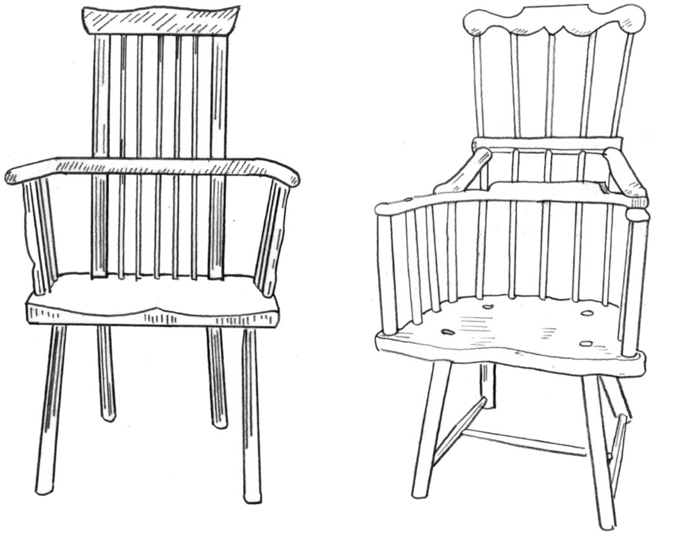
COMB-BACK WITH SPLAT

A common variant on the comb-back is to add a solid backsplat that links the seat, arm and comb.



LOBSTER POT COMB-BACKS

Note how the sticks above the arm tend to bend toward the centerline of the chair.

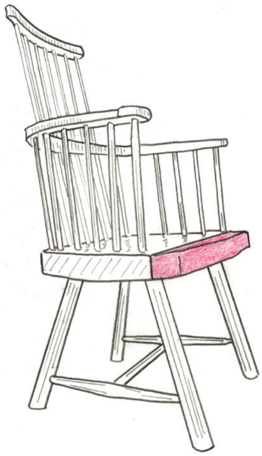


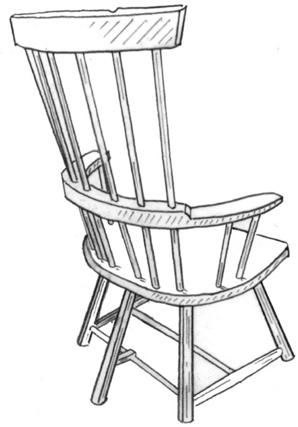
COMB-BACK VARIANTS

In one variant (left), the back (and possibly other parts of the chair) have been built with square mortise-and-tenon joints. Some comb-backs (right) can be quite complex, with added bracing elements between the arms, back and other members.

with a seat, legs or arms that would look more at home on a vernacular chair.

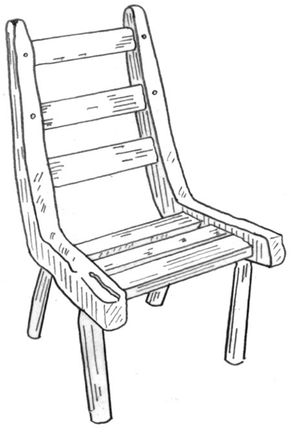
In fact, this category of misfit chairs is almost endless and could encompass an entire book – a book that I (and perhaps four other people) would enthusiastically purchase.





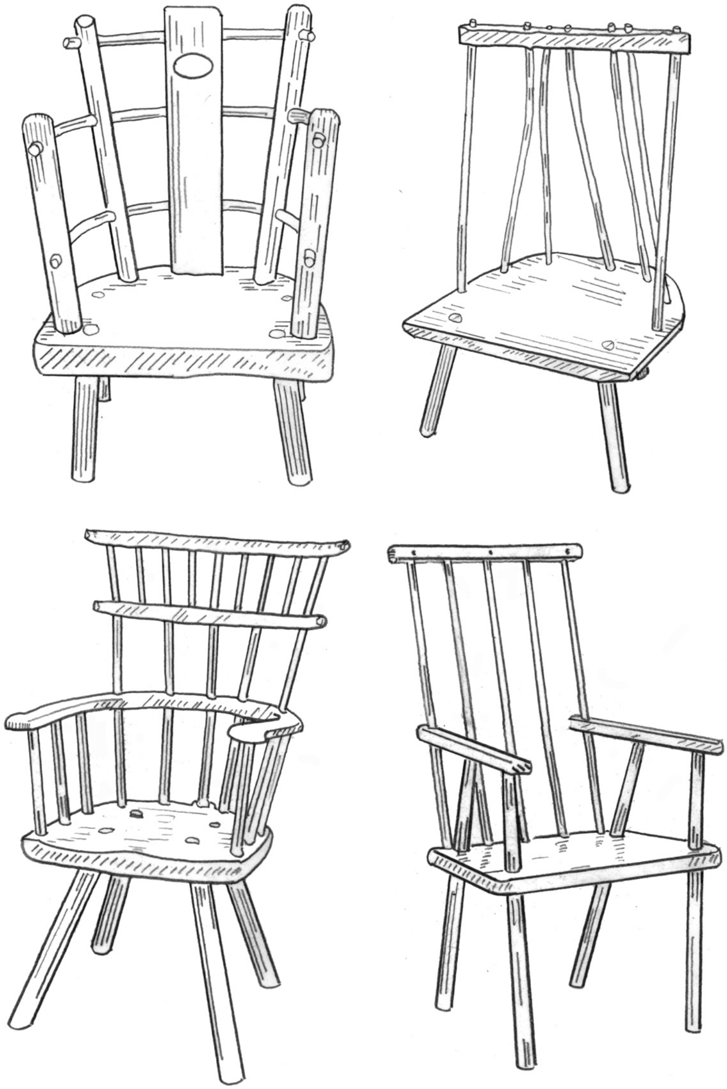
MORE VARIATIONS

This comb-back chair at left has had its seat extended at some point in its life. The extra part is colored red. At right, a fifth leg restrains chair from tipping backward. This extra leg appears on chairs with rear legs that don't have a lot of rake or splay.



SUTHERLAND CHAIR

Many vernacular chairs defy categorization, such as this example in "Irish Country Furniture: 1700-1950" by Claudia Kinmonth.



HIGHLY IRREGULAR BEAUTIES

One of the joys with vernacular chairs is that some of them defy classification (or logic).

FROM SOMEWHERE ELSE

Once you master the core techniques, then any chair you can think of is within your grasp. This backstool (or is it a lowback with a backsplat?) combines elements from at least four other designs.

NONE SHALL PASS

The notebook where I recorded what I learned at The Windsor Institute. It is off-limits for my work today.

THE RED BOOK OF CHAIRMAKING

With all the woodworking information available for free these days, it seems unlikely that there are still trade secrets amongst us.

But during 15 years of working with professional woodworkers to get their work published in a magazine, I had a lot of conversations that went like this:

"What kind of dye is that?" I'd ask.

"Red."

"What brand? And what is the name of the color?" I'd ask.

"Can't say."

There were also many techniques that were off-limits. The woodworker would say something like: "This is how I teach it, but it is not how I do it."

These encounters troubled me. I thought all the secrecy stuff had died off with the European guilds. I was wrong. In many ways, I sympathized with the professional. He or she was fighting a horde of amateurs who were willing to undercut their prices. Why should a professional offer aid or instruction to this amateur enemy?

On the other hand, as woodworker W. Patrick Edwards says, "To die with a secret is a sin." How will the craft progress if we don't share what we know?

As I plunged deep into chairmaking in the early 2000s, I found myself stymied by some operations relating to compound geometry. The techniques published in the books seemed entirely too awkward compared to what I knew about pre-industrial woodworking. There had to be a simpler way to do these difficult operations.

I took some chairmaking classes. These helped, but I felt like either:

1. The teacher was also finding his way in the dark.
2. They didn't want to tell me how they really did it.

In 2010, I took a Windsor chairmaking course with Mike Dunbar at The Windsor Institute, along with my father and John Hoffman, my business partner. Dunbar, now retired from the school, had built a chairmakers' terrarium – a perfect ecosystem. You started with the class on making a sack-back chair. Then you moved on to other chair forms. If you wanted to make chairs for a living, you could receive training on business, sales and marketing from Mike's spouse, Susanna. Plus, the Dunbars, their employees and affiliates supplied students with tools, patterns and wood.

It was an impressive operation. Mike and his assistants were there at every step to help you move forward on your chair. The lectures were funny. The workshop itself was gorgeous.

There was one problem, however. The class materials. At the top of the handouts for the class was this warning:

Our students are authorized to use these materials for the making of chairs for personal use and for the making of chairs for sale. We do not authorize the dissemination, reproduction, or publication of these materials in any form and strictly prohibit the use of the materials in the teaching of chairmaking to others.

Again, I felt that same old conflict. There is the urge to protect what you know. But that same urge has caused a lot of knowledge to be stockpiled in the cemeteries.

During my week at The Windsor Institute, I filled a red notebook with all the details of constructing a sack-back chair. I also kept all the handouts from the class in a green folder.

However, I never consult them. I'm almost afraid to read them because they might give me some ideas for making chairs that I am not allowed to pass on to others.

OK, wait a minute. I'll be right back.

Good news, everyone. I went through the class materials and notes, and I didn't find anything that was universally mind-blowing. Most of the juicy bits in my notes related to how to build that specific sack-back chair. Whew. I'm glad I don't build sack backs.

Giving away knowledge has always been a part of my personality. I don't like secrets. While it would be easy to assign that trait to my time

SACK BACK IN PROGRESS

My father (left) sights John Hoffman as he drills the initial mortise for a leg in a sack-back chair at The Windsor Institute.

as a newspaper journalist, I know it goes back much further. In fact, I remember the moment I became this way.

In 1977 I was in fourth grade at the local Lutheran school. That year, some of the kids in the higher grades were permitted to dissect sharks for biology class. So, one day when we were called for an assembly in the school's common area, I hoped (against hope) we were going to see some shark guts or something cool.

Instead, there was some old guy in a suit standing in the center of the room, holding a regular piece of paper. We all sat down on the carpet around him, legs crossed. Waiting for the boring session about a dull piece of paper to begin.

He began.

"Let's say we live in a world where 'corners' are the most valuable thing in the whole world. Can you imagine that?"

"Yeah, but I can also imagine some crazy dissected shark fetuses."

"How many corners does this sheet of paper have? Yes? You? Why yes, you are correct! This sheet of paper has four corners!"

"You know what has more corners? Shark teeth. Rows and rows of flesh-ripping corners."

"Now, what if a friend of yours came up to you and was really, really sad. Sad that she didn't have a single corner in the whole world."

"So, my friend is a circle?"

"What would you do? You don't want to give up one of your corners. Because then you'd have fewer corners. But you feel really bad for your friend. And so, you decide to give her one of your corners."

Then the guy holds up the sheet of paper. He rips off one of the corners and gives it to a kid in the front row. Suddenly I'm transfixed.

"Oh look, I gave up one of my precious corners. But now I have five corners instead of four. That's strange, don't you think?

"Then, another friend asks for a corner because he has none.

"Another one? How can I lose yet another corner?

"But I decide again to give up one of my precious corners."

Rip. He hands a corner of paper to me.

"And look. Now I have six corners instead of five!"

The guy continues to rip corners off the sheet of paper and hand them out, increasing the number of corners with every rip.

No one had ever explained generosity to me in those terms before.

And though I was only 9 years old (and I still haven't seen a dissected shark), I felt like a different person from that day forward. Giving stuff away – money, time, possessions, corners, knowledge – always results in getting something greater back in return. The more I give away, the more I receive.

To this day, however, I am able to sympathize with people who hoard their knowledge out of caution or fear. When you are in a shrinking profession such as woodworking, giving up your hard-won know-how seems like suicide.

But here's what I've found. If the stuff you know is really good – truly excellent – you could end up like Garrett Hack, Christian Becksvoort or David Charlesworth. Amateurs and professionals will pay to learn what you know through classes. Publishers will pay for you to write it down. You might have a tip or trick named after you.

Or you can remain that bitter crank in his shop up on the hill. Perhaps you know how to make buttons for attaching tables to their tabletops in one amazing swish on the table saw. But you aren't performing that trick for just anybody.

It's a great trick. One that could change the way everyone works in their shop in the entire world. Right?

There's only one way to find out.

NOW TEAR A CORNER OFF THIS PAGE

The following chapters detail how I build stick chairs. I've tried to include every "corner" that I've acquired since I first started building these chairs. Also, I've tried to give credit to the people who taught me the trick or the operation.

I'm sure I've forgotten a few good tricks and the names of some chairmaking friends who have shared their knowledge along the way. If so, I apologize.

My hope is that you will refine these operations and make them simpler, easier and foolproof. And when someone asks you how you make your sticks or your arms or your legs, you'll be willing to rip off one of your own corners and give it away.

A SOLID SEAT

In many vernacular chairs, the grain runs from left to right – opposite of what is typical in Forest chairs.

MAKE & SHAPE THE SEAT

I usually begin building a chair with the seat. Much of the chair's joinery enters the seat. And the seat's shape can determine how the rest of the chair will look. So, I prefer to get the seat sorted before I make the arms and other curvy parts.

Of course, another option is to work from published plans, in which case you can start almost anywhere on the chair.

This seat-first approach isn't universal. Many Welsh chairs instead take their shapes and overall design cues from the natural bends in the armbow, a fact figured out by chairmaker Chris Williams and conservator Emyr Davies at St Fagans National Museum of History.

But when I'm building a vernacular chair using flat boards, my first step is to look at my store of thick stock and search for the best seat.

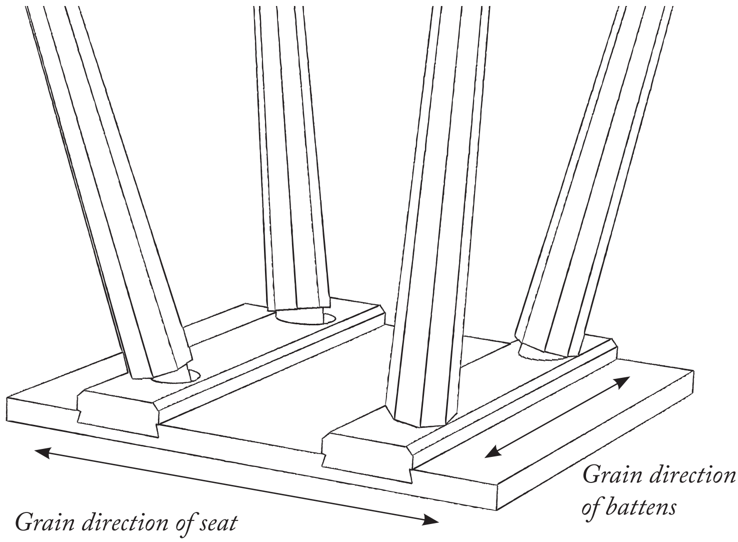
THICKNESS, WIDTH & LENGTH

Most chair seats begin with wood cut roughly to 2" thick. After planing, it might end up at 1-3/4" or 1-5/8" thick.

Once you get your seat stock planed up, then it's a matter of deciding the seat's depth (measured front-to-back) and the width (left-to-right). Most of my chair seats are 16" deep and 20" wide. Those numbers are flexible. You can make the seat as shallow as 13" (front-to-back) and get away with it. But I wouldn't make it deeper than 16", as the front edge of that seat will likely pinch off blood flow behind the sitter's knees.

You can make the seat as wide as 25" without things looking throne-ish our couch-ish. But dropping much below 20" wide is not advised for the modern American gams.

One common question from first-time chairmakers is what they should do if they cannot find thick stock for the seat. Should they glue up two 3/4"-thick boards like a sandwich to make the seat? The answer is in the drawing on the next page, a solution from the Alpine chairs.



A SOLUTION FOR THIN SEATS

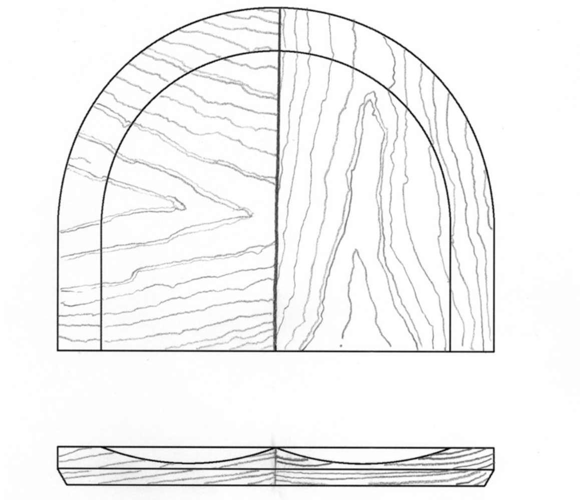
In Germanic countries, you will find many stools and backstools with a thin seat that is reinforced with battens. This makes a lightweight and strong chair.

WOOD SELECTION

You can use almost any species for the seat. I prefer wood that is difficult to split. Tulip poplar, white pine, yellow pine, American sycamore, soft maple, beech and the elms are ideal North American woods for seats. The domestic diffuse-porous and semi-diffuse porous species, such as walnut and cherry, are also good for seats. They'll split, but it will take some effort.

The ring-porous species – ash, hickory and oak – are kinda OK for seats if you are careful. When you drive the legs into the seat, you can split the seat if you knock the legs in with too much gusto.

Bottom line: If the wood looks so gnarled that it would be difficult to split with an ax, then it's probably good seat material (so said the late great John Brown). And if you are unsure if a certain piece of wood will work for a seat, there's a test you can perform that's explained in



EITHER WAY

The grain in a seat can run left-to-right or front-to-back. Both approaches are common in the historical record.

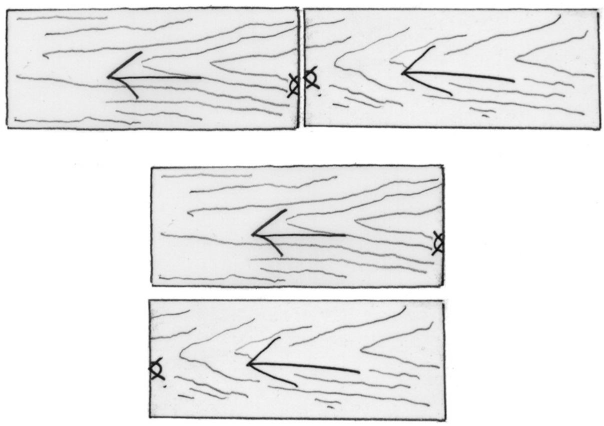
the earlier chapter on wood.

Also, here's a tip on selecting seat boards: Quartersawn stock is far easier to saddle than flat- or rift-sawn wood. Even oak and hickory are a pleasure to saddle when they are quartersawn.

Of course, make sure the wood for the seat is sound. Look for checks (especially in white oak). If there are discolored areas, stab them with a pocketknife to ensure they aren't rotten. If there are knots with splits, keep those splits away from the joints for the legs and sticks.

GRAIN DIRECTION

The grain in your seat can run from left-to-right or front-to-back. If you look at a lot of vernacular chairs, the makers didn't have rules about which way it should go. Likely they decided which way the grain should run based on the width of stock on hand and where the wood's defects were.



A SOUND SEAT STRATEGY

With a two-board seat, I find the seats look best if they were connected to each other in the tree. The arrows represent the grain direction in the boards.

In antique stick chairs, the wood for the seat is typically the lowest-quality stock in the entire chair. While that might seem odd, it makes sense when you study the wood market in Great Britain, its colonies and Europe. Seats require thick and wide pieces of wood, which have always been harder to find than the thinner pieces needed for sticks and legs. In fact, thick wood could be so precious there are accounts of people poaching wood from royal or government lands. And being punished for it.

Given a choice, I run the grain from left-to-right in my seats. This makes it easier to find the wood I need. Here's how that thinking works: Assume the seat is 16" deep and 20" wide. If the grain in the seat runs left-to-right, then you need to find one board that is 16" wide, or two boards that are a tad more than 8" wide.

If, on the other hand, the grain in the seat runs front-to-back, then you need to find one board that is 20" wide, or two boards that are a bit more than 10" wide.

GLUED-UP SEAT

Because wide stock can be difficult to find, the majority of my chairs have seats that are glued up. Here's how I make a seat that is durable and looks good.

At the lumberyard, find the 8/4 stock and hunt for boards that are about 9" wide. Those are ideal for seats. Two 9"-wide boards that are 22" long will end up making a nice 16"-deep x 20"-long seat after trimming. The seam will be down the middle of the seat, far away from the leg joints.

If you have to make your seat from three (or more) narrower boards, arrange the boards so the legs don't pass through the seams in the seat. While a good glue joint can be stronger than the surrounding wood, it also can be weaker if you don't use enough glue, your glue is old or (most likely) your glue joint isn't perfect.

If you plan to paint your chair, there's a lot less fussing with composing the grain of the seat. If your grain is going to show, the two seat boards should come from the same plank. I prefer to have the two boards separated by one saw kerf. That way the color and grain of the seat will likely be consistent.

Also important: It is desirable to have the grain direction running in the same direction throughout the seat. This allows you to easily plane the seat flat and to scoop out the seat. So mark the grain direction on both seat boards as you try different arrangements.

Some texts make a fuss about alternating the heart side and bark side when gluing up a panel or seat. Ignore it. The most important goal when gluing up a seat is to make it strong and beautiful. The second goal is to have the heart side of the boards face up (and the bark side of the boards face the floor). Third is that the grain should run the same direction throughout the seat.

Make the edge joint for the seat board with a jointer plane or an electric jointer. Then you have an important decision to make: Should you add loose tenons to the joint or not?

I prefer to add loose tenons, which I peg from the underside of the seat. While the loose tenons won't make the glue joint stronger, they will make the chair as a whole more durable. If the glue joint gives way someday, the tenons and pegs will keep the two seat pieces from falling apart. In fact, if the chair has stretchers, there's a chance the chair's owner won't notice that the seat's glue joint has failed. The pegs through the tenons, the undercarriage and the sticks above will keep the seat boards close to one another.

To make the mortises for the loose tenon, I use a mortising machine. I use three tenons, each tenon is 12mm thick by 100mm long (about 1/2" x 4"). One tenon is centered on the length of the boards. The other two are about 3-1/2" from each end of the seat blank. Before I owned this machine, I cut the mortises by hand. The joints don't have to be pretty.

Glue up the seat. While I prefer liquid hide glue, this is one joint on the chair where I'm OK with PVA. Unlike the rest of the joints, this one won't ever have to come apart for a repair.

After the glue is dry, peg all the tenons from the underside of the seat. You can use small pegs, bamboo skewers or chopsticks. I use tapered wooden pegs that you can purchase with a matching tapered drill bit (one brand is Kakuri). I first drill the blind hole, put a drop of glue in the hole and drive the peg in. I put four pegs in each tenon.

SINGLE-BOARD SEATS

Single-board seats are the best. When I visit the lumberyard, I always look for stock that is 16"+ wide so I can make seats from a single board. These seats look the best, and they have no glue joints to hide or reinforce. The best place to find single-board seats are at yards that cut their own slabs for large-scale work – conference tables and the like.

For them, 16"-wide boards aren't special. They want stuff that is 24" or wider. Also, they want boards that are 8' or longer. Chairmakers, on the other hand, can get by with boards that are only 24" long.

One local sawmill always has a pile of discounted "shorts" that I dig through. These are usually about 20" wide and 4' long – too short for a dining table but great for a pair of chair seats. The yard is happy to be rid of them, so they aren't as expensive as buying a huge slab and cutting it into chair-sized pieces.

DIFFERENT SHAPES OF SEATS

I don't settle on a seat shape until the seat is glued up. Many times, I alter the shape of the seat to avoid defects in the wood. This can be

SEAT INSURANCE

If the glue in your seat ever fails, the tenons and their pegs will help keep the chair in service. It is a construction that goes back to early Roman and Greek times.

PEG THE TENONS

You can use bamboo skewers to peg the loose tenons in the seat. Wooden pegs are a more traditional choice.

as simple as making the seat 1/2" narrower. Or changing the radius of a curve to avoid a split. Sometimes I shift the seat pattern to encompass the defect, instead of cutting through the middle of a knot or sap pocket.

Vernacular seats come in many shapes, from a 16" x 20" rectangle to a tri-corner hat. Most seats are built using simple kindergarten shapes that have been stuck together. For example, the common D-shape seat is just a half-circle stuck to a rectangle.

All the seat shapes shown in the illustrations on the following pages are ones I've seen in the wild. There are many more shapes out there to discover. Every one of these shapes can be altered. The 90° corners can be rounded or clipped. The front edge of the seat does not need to be a straight line; it can bulge out about 1/2".

Another common alteration is to add a rectangular extension at the back of the seat to accommodate extra sticks to reinforce the backrest. This extension can be added to almost any seat shape. (Depending on the grain direction of the seat, these extensions might be joined to the

STEER CLEAR OF SPLITS

The defects in my seat blank can change the shape of the seat. Here I shifted the pattern forward to avoid a split. I had to change the shape of the front of the seat as a result.

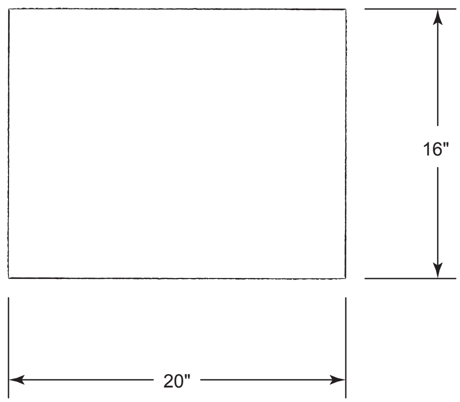
seat with a tenon or two.)

With these basic shapes (plus others you might find on your own) it is possible and desirable to never build the same chair twice.

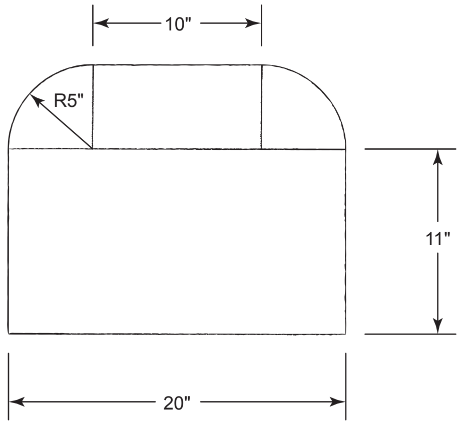
When I use a seat shape for the first time, I draw it full size on butcher's paper. I use a simple compass, a yardstick drilled with holes and drafting squares. Plus a good gum eraser.

Once I get a seat shape I am happy with, I draw it out on thin plywood, usually 5mm underlayment left over from the crates I build to ship furniture to customers. I cut these patterns out and keep them around. They help lay out the locations of the legs and sticks and can answer a lot of questions as I build the chair. I usually record all the details of the chair on the pattern.

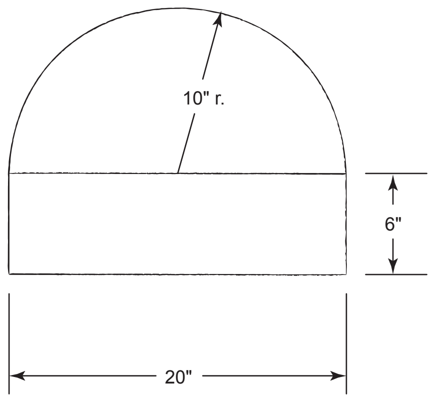
These patterns and notes are a useful snapshot for future chairs. Though I rarely build the same chair twice, I often take a seat or arm shape from a past chair and alter it. My patterns are like long-distance love letters. While I can't have the object of my affection (an old chair)



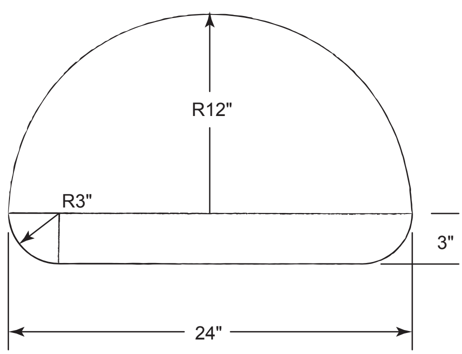
Simple rectangle



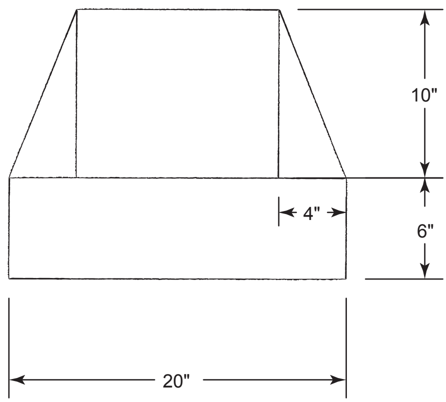
Square back or rounded rectangle



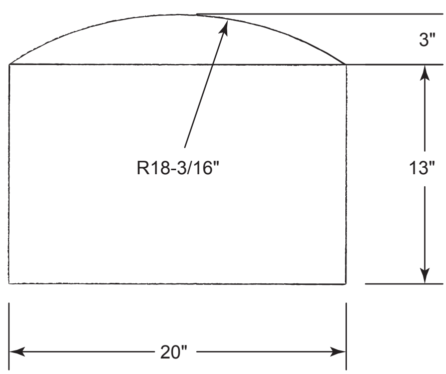
Traditional D-shape



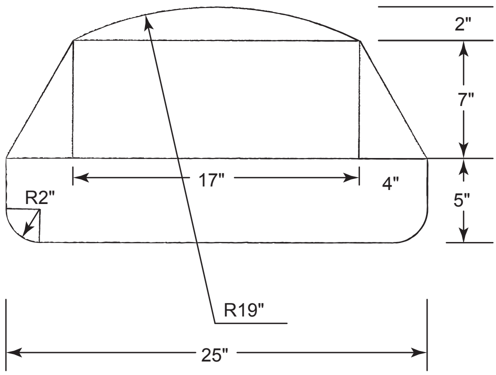
Half-circle with rounded corners



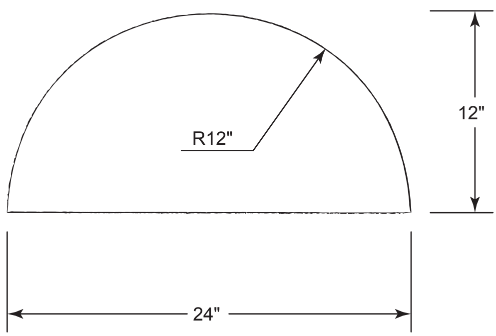
Clipped corners



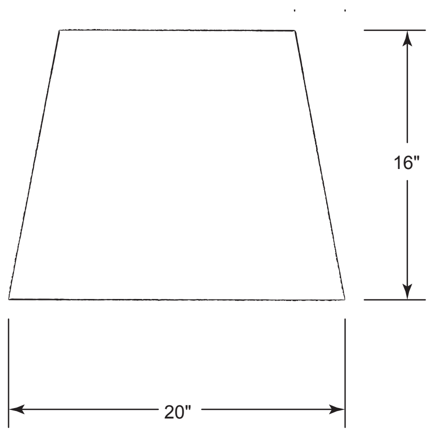
Rectangle and arc



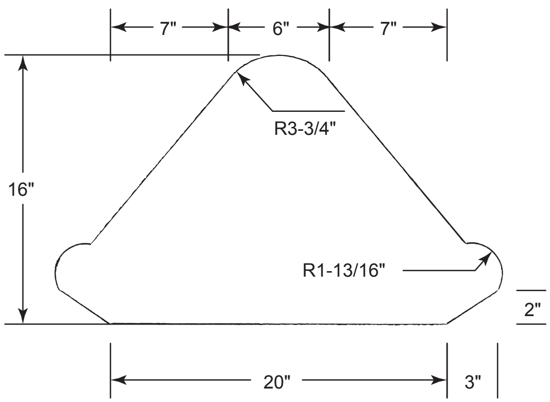
Irish Gibson



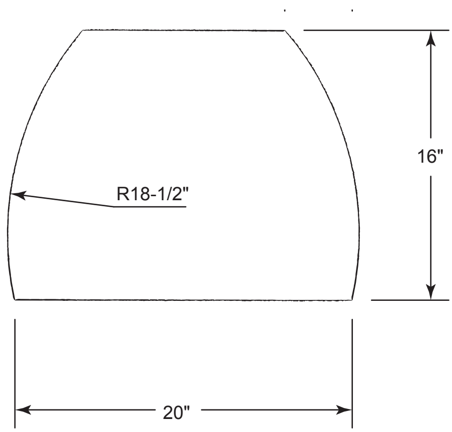
Half circle



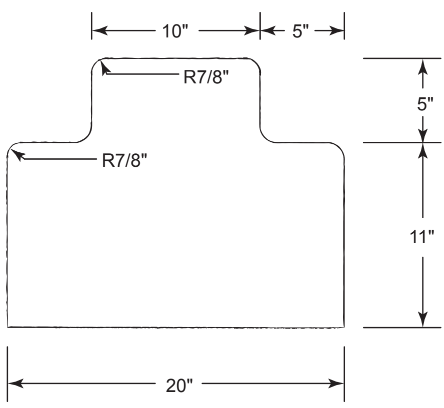
Trapezoid



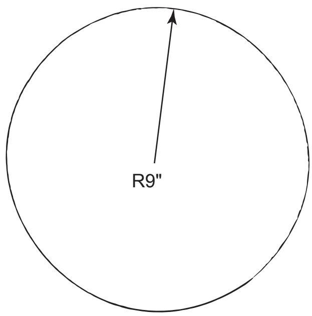
Welsh triangular with round extensions



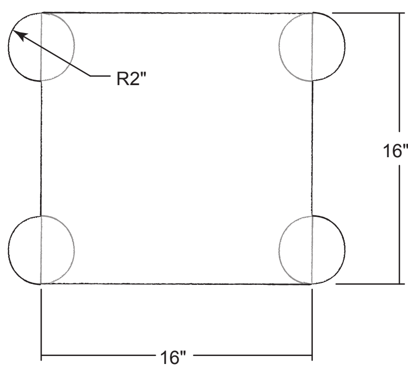
Bulging rectangle



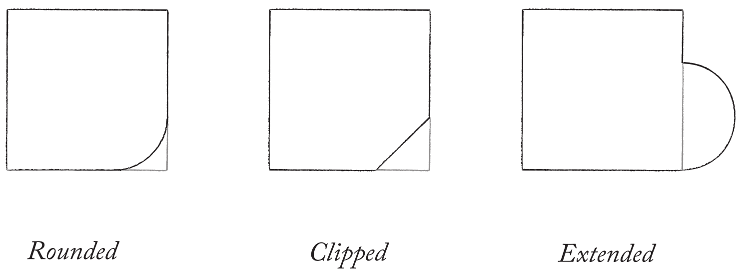
Rectangular with an extension for back sticks



Circle



Square with round extensions



ENDLESS VARIANTS

You can create new seat shapes by changing the corners. Three common variations are shown above.

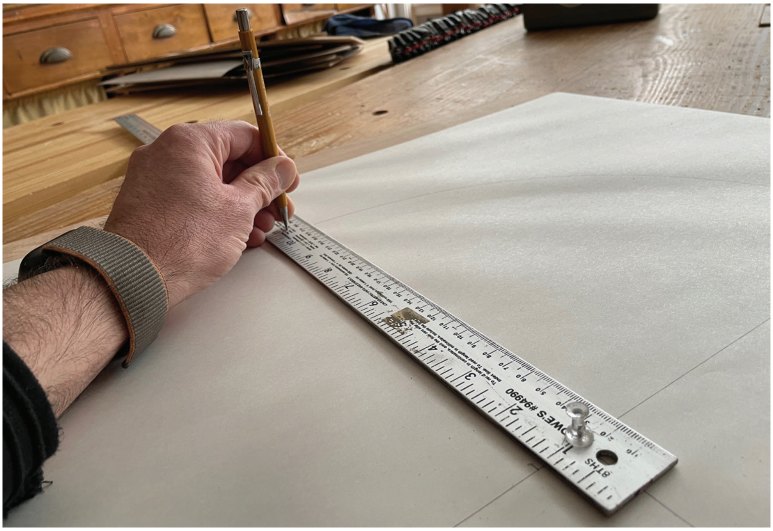
with me, the pattern reminds me of what I adored about it.

Patterns are also important because photographs are lying jerks. The foreshortening and parallax that crops up in photos of a chair will fool you. I remember seeing chairmaker John Brown's patterns for his settee. The seat's shape looked nothing like I thought it should, and I've seen dozens of photos of John Brown's settees.

So make patterns and keep them around. This is not a new idea. Many traditional shops, such as the Dominy workshop on display at Winterthur Museum & Gardens, relied on patterns.

After you draw the seat shape on the wood, cut it out. I prefer the band saw for this. Some chairmakers leave the seat rectangular as they cut the joinery and shape the saddle. The corners of the rectangle are great places to clamp the seat blank so you work on it. This is an excellent approach if you are building a known chair design that has all its elements realized.

I don't do this because I want to see the seat's finished shape at every stage of construction. Because no two chairs are identical, I always study how the arms, seat and legs interact. This interaction leads me to change the number and spacing of the sticks. And oftentimes alter the size and shape of the comb.



CODGER CAD 1.0

Manual drafting tools help you visualize things at full size. Start on paper, then draw the seat shape on thin plywood.

A DESIGN LIBRARY

I refer back to my patterns (and the notes on them) over and over. They help me create new shapes that are graceful. Patterns are not a modern invention. Many pre-industrial shops relied upon them.

In other words, there are no awkward surprises for me when my chair comes together.

BEVEL THE UNDERSIDE

Many vernacular chairs have a bevel on the underside of the seat, called an underbevel. The bevel makes the seat look lighter. A 2"-thick seat without a bevel makes the chair look bottom-heavy. (And sometimes that is exactly the look you want.)

This bevel is usually one-third to one-half the thickness of the seat and is somewhere between 35° to 45° off 90°. Shallower bevels don't trick the eye into thinking the seat is thinner.

The bevel can be sharp and crisp, or it can be rounded over like a river stone. You'll find both approaches on old chairs. I like my bevel to match other design aspects of the chair. If the chair has rounded

MARK & CUT THE BEVEL

Use your pencil gauge to mark the underbevel all the way around the seat blank. Tilt your band saw's table and cut the underbevel.

WHERE BEVELS COME FROM

When you work with slabs from the mill you will find that Mother Nature sometimes likes to start the bevel for you. I suspect this is how the underbevel developed into a standard feature.

hands, I'll round over the bevel on the seat, too.

There are lots of ways to cut the bevel. I use the band saw. Set the machine's table for the desired slope (say 45°). Draw the height of the bevel on the edges of the seat. Place the seat flat on the table (face up) and make the cut. Saw clear of the line so you can work up to it with hand tools. If you're a first-timer, practice on scrap first.

For many years I cut the bevel with a drawknife. To do this, draw the limits of the bevel on the edge and underside of the seat. Clamp the seat in your vise and peel off the waste. When you get good with a drawknife, you won't have to clean up the drawknife cuts.

You can also do the rough work with a jack plane or a block plane with a wide-open throat. It takes practice to follow the seat's curves.

CLEAN UP THE SEAT'S EDGES

The rough-sawn edges of the seat can be cleaned up with rasps, a spokeshave and block plane (or a smoothing plane). Use planes for the straight sections of the seat; use the spokeshave or rasp for the curved edges. This is a job I prefer to do with hand tools.

When I have 10 seats to clean up, however, I use a stationary belt sander loaded with #80-grit paper. Then I remove those scratches

DRAWKNIFE DOES THE JOB

If you don't have a band saw, a drawknife makes fast work of the underbevel.

with a spokeshave and plane. In the end, the seats look the same.

With the seat at its final shape, I move on to laying out and cutting the joinery for the legs.

TROUBLESHOOTING SEATS

The most common problem with seats is checking or full-on splits. Some of these splits occur during construction; others happen years later after the chair has been used and abused. The historical repair technique is still a good one: a metal plate across the split. Some people opt for a wooden butterfly instead, but I have no problems using metal. If the plate is on a show surface, I ask a blacksmith to make a metal bit. If it's under the seat or arm, I use mending plates from the hardware store. I strip the zinc off the mending plates (using citric acid or vinegar) and screw them in place.

I have seen old chairs with rusty metal plates that have held just fine. Install them with care, and you might get just as lucky.

EFFECTIVE REPAIRS

If the metal plate is visible (left), I'll hire a blacksmith to make the plate. If it can go on the underside of the seat, I'll use a hardware store mending plate.

GUIDED BY (MOSTLY) EYE

I embrace human variation when making stick chairs. I never intentionally make a leg look wonky. But the slight differences in angles add up to a better chair.

LEG-TO-SEAT JOINERY

There are many ways to drill the mortises in the seat for the legs. If you watch historical films of chairmakers, they seem to be guided by nothing more than experience. They know the angles in their bones and simply do the work.

Many modern chairmakers, on the other hand, use technology to help them teach the craft. Lasers, drilling guides and metal bushings are all part of the tool kit.

I fall between these extremes. Because I build stick chairs every week, I'm not after space-age perfection. I think stick chairs look better with the slight variations that come from drilling and reaming the mortises freehand. But I also don't want a chair to look like a drunk uncle who has fallen down the stairs.

Likewise, my approach to the geometry in a stick chair seeks a practical middle path. While I use trigonometric principles to deal with compound joinery, I have found a visual technique that avoids math and numbers altogether.

Lastly, I have tried to devise a way to teach this stuff so that a first-timer can build a nice chair. You won't have to drill 100 holes before you stick the landing.

RAKE & SPLAY

When we study chairs, we use words to describe the angles of the legs. When you look at the side of a chair, you are looking at the rake of the legs. The legs can rake forward or backward. Front legs rake forward (usually). Back legs rake backward.

When you look at the front (or back) of a chair, you are observing the splay of the legs. In general, legs splay out from the seat.

You can use rake and splay to drill the mortises. This is how I learned to drill compound angles in the early 2000s. Set one bevel for rake (say 6°) and a second bevel for splay (say 4°). Place both bevels on the seat by the mortise. Set the drill bit so it's aligned with both bevels. Drill.

RAKE & SPLAY

The concepts of rake and splay are ideal for talking about chairs. But they aren't ideal for drilling the mortises.

It's a bit like obeying two strict bosses – tricky, but do-able.

Some of the chairmaking books I read back then discussed a different way to drill that used "sightlines" and "resultant angles." Drew Langsner's book "The Chairmaker's Workshop" offered the best explanation of the technique. After learning that method, I embraced it. And I've found ways to make it simpler for my non-math-oriented brain.

SIGHTLINES & RESULTANTS

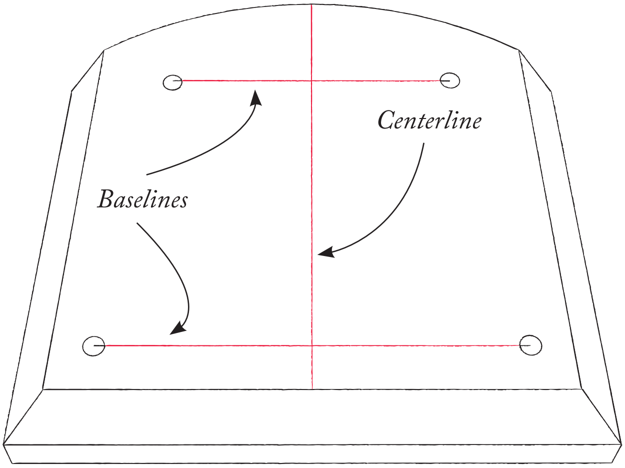
The goal of this method is to remove one of the two bevels from the equation. With some simple layout, you can drill and ream the leg mortises by following only one bevel.

Many chair plans provide sightlines and resultant angles for you to use (this book does, too). So first I'll show you how to lay out sightlines and resultants from a chair plan. And use them to drill the mortises. After you know how to use them, then I'll show you how to devise your own sightlines and resultants (with no math).

If you have any trepidation, remember this: The last time I took a

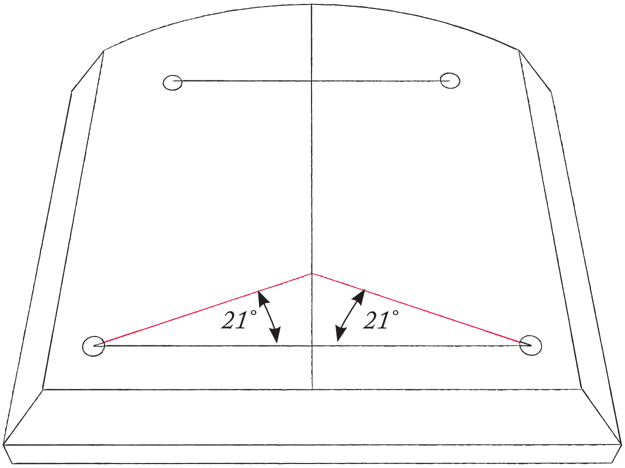
TWO BOSSES

One way to drill compound angles is to use two bevels. One set for rake and the other set for splay. Obey both as you drill.



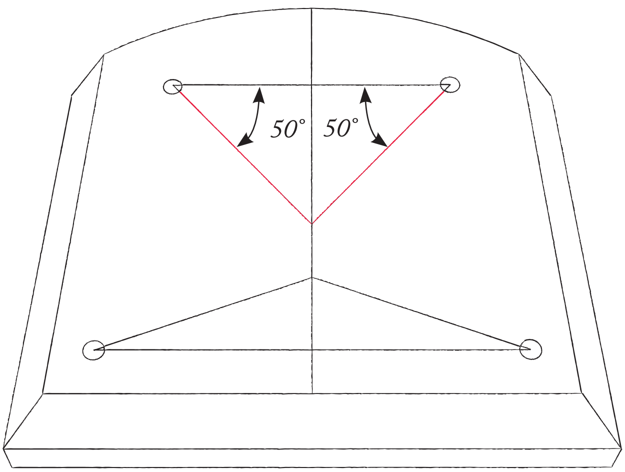
BASELINES & CENTERLINE

Lay out the locations of your leg mortises. Connect the front legs. Then the back legs. A centerline is always helpful.



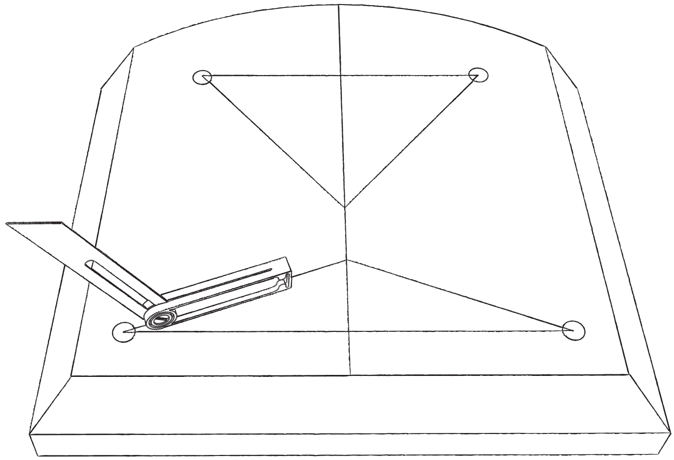
FRONT LEG SIGHTLINES

The sightlines are a certain number of degrees off the baseline. Here, they are 21°. Note how the centerline confirms the layout.



REAR LEG SIGHTLINES

Repeat the process for the rear leg sightlines. Here they are 50° off the baseline.



ADD THE RESULTANT

The resultant is 16°. Set a bevel to 16° off 90° and place it on the sightline. Follow the blade of the bevel when you drill.

standardized intelligence test, my math skills were in the 13th percentile (i.e. 87 percent of the population is better at math than I am). So, if I can do this with ease, you absolutely can.

Take a look at the drawings of the underside of a seat. The leg locations are laid out. Draw a line connecting the front legs. Then draw a second line connecting the rear legs. These are called "baselines." I also draw a centerline through the seat blank, which makes life easier, as you'll see shortly.

The sightline is a line that is XX° off your baselines. So, if the plans say the sightline is 21° for the front legs, then you put your protractor on the baseline and use it to draw a line 21° off your baseline. Do the same with the other front leg (use the centerline to assist you).

If the sightline for the rear legs is 50°, repeat the process for the back legs, drawing these lines 50° off the baseline between the back legs. Your seat layout is complete for drilling.

Now we turn to the resultant angle. Let's say the plans call out a 16° resultant angle for the front legs. Set your sliding bevel to 16° off 90°. Place the bevel on the sightline for the front legs by one of the

FOLLOW THE BEVEL

The sliding bevel is the guiding star. Keep the bit parallel and aligned with its blade.

mortises. You are ready to drill that mortise. Take a drill bit and drill it aligned with the blade of the sliding bevel. Drill the mortises in the seat.

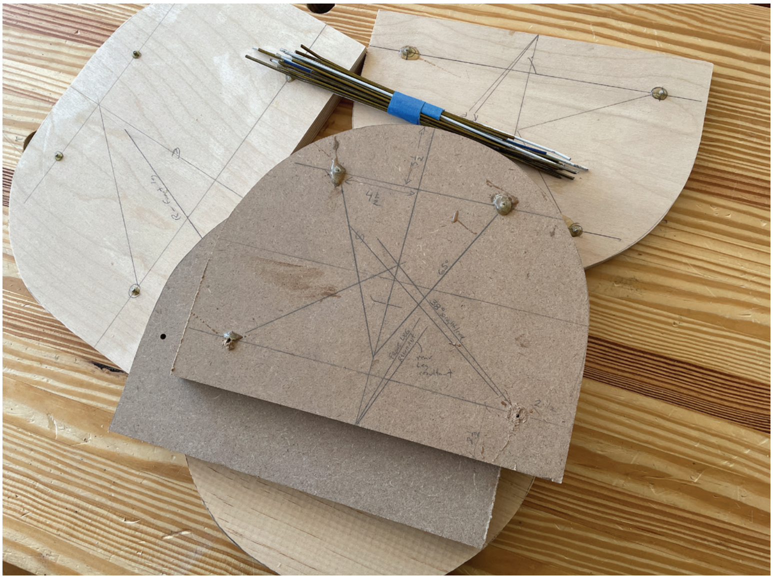
Let's say the resultant angle for the back legs is 26°. Set a sliding bevel for 26°, put it on the sightline for the rear leg and drill a rear leg mortise aligned with the blade of the sliding bevel.

We'll discuss how to drill the mortises in a bit. What's important here is to understand how the sightlines and resultants are used.

CREATE YOUR OWN SIGHTLINES & RESULTANTS

After you make a few chairs, you should try some different leg angles. You might want to copy the legs in an old chair. Or give your chair a different stance. Perhaps you'd like to try some nearly vertical front legs, like English Forest chairs. Or maybe you want to experiment with radical rake and splay for the rear legs.

There are a couple ways to do this. If you know the rake and splay that you want for your legs, you can use trigonometry to convert that



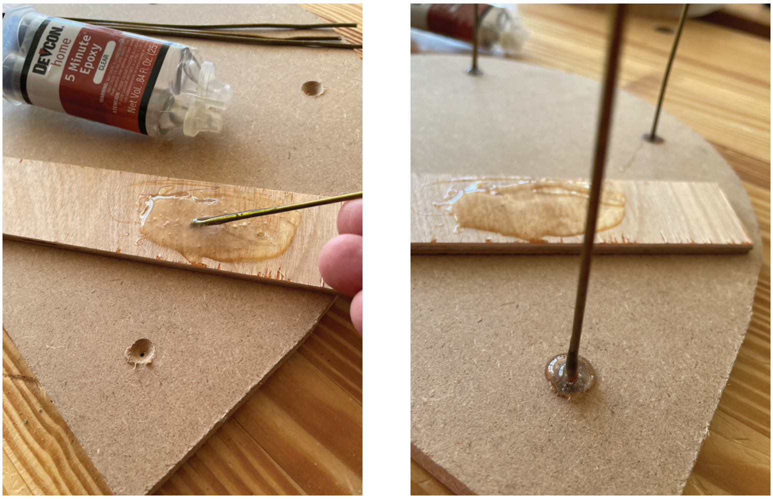
GROW YOUR OWN CHAIRS
Half-scale models made from scraps allow you to quickly determine the sightlines and resultants without math.

to sightlines and resultants. There are equations, tables and calculators out there to guide you on that math path. Or you can do it visually and without numbers.

The first step with this method is to make a half-scale model of your chair seat. Take a piece of plywood or pine and saw out the seat in half-scale. Drill holes for the mortises and epoxy in snipped-off lengths of wire hangers as legs.

After the epoxy dries, use needlenose pliers to bend the legs. You can use a protractor to dial in the rake and splay by the numbers. Or you can simply bend the legs until it looks like a chair you want to build. Which is how I usually work.

Don't worry about having too much rake or splay. Most people are too conservative with rake and splay (because they've seen a lot of conservative chairs). If anything, most people put too little rake on the chair's back legs, which makes the chair tippy when you lean back.



PRETTY-GOOD JOINERY

Drill a countersink for the wire legs. It will fill with epoxy and help hold the legs firm while bending them.

Once you have your model made and your legs bent, you can figure out the sightlines and resultants. It's easy to do. First you need to know this one True Fact: As you move around a chair, there are two positions where a leg appears vertical to both your eye and to a try square.

The photos at right show this.

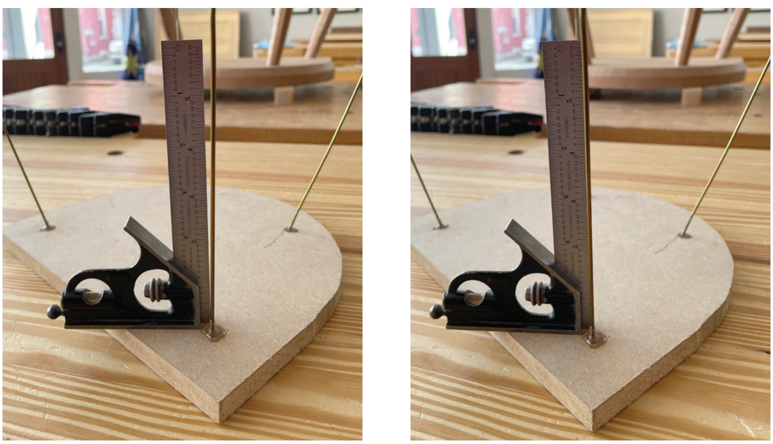
At the moment when the leg appears vertical, freeze your position. If you could shoot a laser line out of your eye and burn it on the chair seat, 1) that would be very cool and you should join the circus and 2) that is your sightline.

It's easy to mark the sightline on the seat. Place a ruler on the seat that lines up with both the leg and the blade of the square as shown on the next page. Trace the edge of the ruler. That is your sightline. You can measure it off the baseline if you need to know its number expressed in degrees.

The hard part is over. Place a sliding bevel on the sightline you just drew. Tilt the tool's blade until it is parallel to the wire hanger leg. Lock the sliding bevel. That is the resultant. You can use a protractor

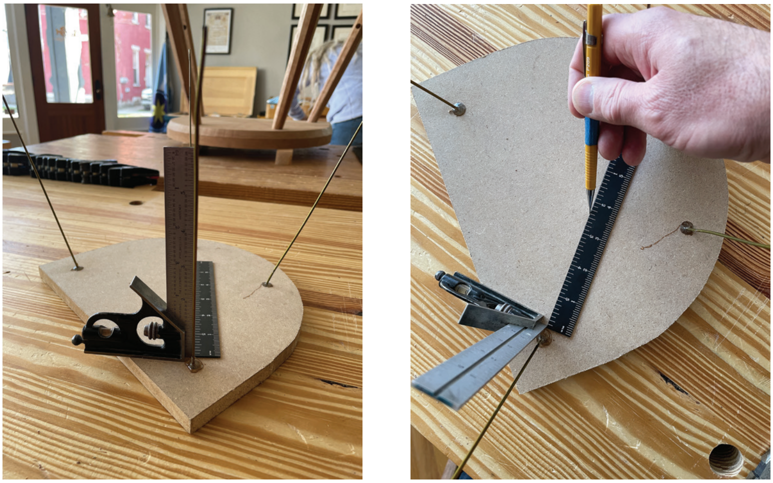
MORE SPLAY

A school protractor and needlenose pliers let you dial in the exact rake and splay.



USE YOUR ILLUSION

There are two points where the square appears 90° to the bent leg. Those positions reveal your sightline.



GET THE RULER IN LINE

Put a ruler on the model and line it up with the leg and the blade of the square. Now you can draw the sightline on the model.

to give numbers to these lines (for example, sightline: 23° and resultant: 16°). Or you can use your sliding bevel to record the sightline as a lines on a board – no numbers necessary.

We'll get into a deeper discussion of chair design later in the book.

LEG MORTISES

About 100 percent of the vernacular chairs I've encountered have cylindrical mortises for the legs and matching cylindrical tenons. If you want to build vernacular chairs using the original joints, cylindrical mortises are the way to go. End of story.

Cylindrical joints are strong; I've seen chairs last 300 years with this joint. You don't need a lot of tools to make the it. You can use a thick tenon (such as 1" in diameter), which is ideal for legs that don't have stretchers (aka "strut" legs). And making cylindrical mortises is fast.

One downside here is that you get only one chance to hit the correct angle for the mortise in the seat. If you drill the mortise off by 2°, you either have to live with the error, or plug the hole and redrill (I have seen this approach in old chairs).

THE RESULT

Set a sliding bevel on the sightline and show it to the wire leg. That is the resultant. Now you know everything you need to drill the mortises in the seat.

DO YOU NEED A BACKING BOARD?

When I drill the mortises for my legs, I always use a backing piece of wood to prevent spelching on the exit hole. This is likely overkill if you are going to saddle the seat. Any spelching (aka blow-out) will likely be removed by the saddling process. But I still use a backing board (usually a thin piece of ply). Why? I have created some Olympic spelching in my day. And sacrificing a piece of scrap plywood is a small price to pay for the occasional seat with deep spelching.

DRILL A CYLINDRICAL MORTISE

A typical leg mortise for a cylindrical tenon is 1" in diameter, though I have seen them as large as 1-1/2". Most electric drills and human

ABSORB THE DRILL

Brace the drill against your body in every way possible. This (and a little practice) is what creates accurate mortises.

arms can power a 1" auger through oak without too much trouble.

You might be surprised how much more difficult 1-1/2" is than 1". If you are going big, I recommend you use an old-fashioned T-auger or one of the Scotch-eye augers intended for bushcraft.

Drilling a cylindrical mortise requires focus and a little trickery. You get one shot to get it right. Most augers have a lead screw. Put the lead screw where the mortise should go. Vertical is fine – you want to just start the lead screw in the wood so it doesn't scoot. Turn the drill a few rotations so the lead screw pierces the wood about 1/8".

Now tilt the auger to the correct resultant angle and put the bevel up close to the flutes of the auger. Tape the sliding bevel to the sightline if you like. Now slowly rotate the auger until the cutting spurs along its rim contact the wood. The auger will jump out of position when its spurs hit the wood. Let them cut, then reposition the auger in line with the sliding bevel.

Here's the trickery I mentioned earlier. After teaching hundreds of students to make 1" mortises under pressure, I've found the following advice to be helpful: Brace the drill against your body as best you can.

Brace it ridiculously. Here's what I do: I bring the drill against my body. I don't care how weird or uncomfortable it is. Bracing the drill keeps it from going astray.

Then I trap the drill between my body and my arm. This is even more awkward. But if I can keep the drill from lurching around, then my mortise will be true.

So I put my wrist against the battery to trap the drill against my body.

If you are using a cordless drill, set it on its lowest speed. Turn off the drill's clutch. After that, pull the trigger slowly to bring it up to half-speed. Slow and steady. Watch the blade of your sliding bevel and the auger bit. Make small adjustments while the drill is running.

Drill until you bore through the seat. Be ready to accept your errors.

ONE MORE TRICK

If this is your first chair, a laser can help you drill the mortises for the legs. Turn on the laser and lock its self-leveling mechanism. Place it on the seat so it shoots a laser along the sightline on your seat.

Now put your drill in position. As you line up the auger bit with the sliding bevel, line up the drill with the laser as well. Almost all drills

IF YOU HAVE A LASER...
You can use it to help guide your drilling. Here I put it on the sightline on the underside of my seat.

have a center seam that you can line up with the laser. This little trick helps you keep things in line with the sightline so you can focus more on keeping the drill bit parallel to the sliding bevel.

HEY, LASER BOY!
Again, lasers are overkill for stick chairs, but they can be excellent training wheels. Here you can see how the laser lines up with the center seam of the drill.

LEGS BY HAND

While there are many machine methods to make legs, I prefer to make them by hand. It's safer and the legs look better.

TAPER & TENON THE LEGS

Like the seat, the legs of the chair are cut from thick, 8/4 stock. So, it makes sense to rough out the chair's legs soon after you select the pieces for the seat.

Unlike the seat, the grain of the legs must be arrow-straight. Plus, the wood must be dry and free of defects. If the legs shrink after assembly, they will fall out of their mortises. Finally, the joinery between the legs and the seat has to be outstanding.

The good news is that there are many paths to create a great set of legs. The first tip is this: If you need four legs, always rough out five or six. Unpleasant surprises happen. And if you do end up with some spare legs that are perfect, you can put them aside for the future.

THICKNESS, WIDTH & LENGTH

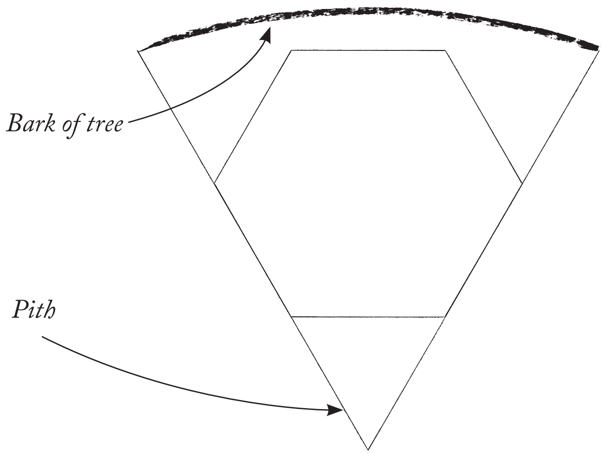
Legs range in size from 1-1/2" square at the dainty end to nearly 2" square. Thicker legs are stronger, but they also can make the chair look bottom-heavy. A happy medium is 1-3/4" square.

The legs' shape plays an important part in how the chair's undercarriage looks overall. For example, 1-1/2" legs that are round cylinders can appear thicker than 1-3/4" legs that are octagonal and taper from the floor to the seat. So, when designing a chair, it's important to test the legs in the seat and look at the chair from all angles.

You might be shocked by what you see. My earliest chairs had legs that were 1-3/4" tapered octagons. I didn't, however, make their octagons equilateral (which is where all the facets are the same width). Instead, half of my facets were 1" wide (near the floor), and the small facets were just under 1/2" wide. When I look at photos of these chairs now, the legs look like tree trunks holding up a dinner plate of a seat.

The seat height also plays a part in how the undercarriage appears. Chairs with a low seat (15") can handle thicker legs. Taller chairs (18") look better with thinner (or thinner-looking) legs.

As I pick through my stock for legs, I look for straight grain. When



SPLITS YIELD SIX SIDES

Hexagonal legs are easily cut from splits from small trees. Split off the pith and the remaining corners, and you are almost there.

I find it, I cut my leg blanks to 22" or 23" long, even if my legs will be shorter in the end. The extra length allows me to trim away defects, some of which can appear when adding the joinery or tapering them. After roughing out a bunch of legs, I square them up using handplanes or machinery. The next step is to make them octagonal.

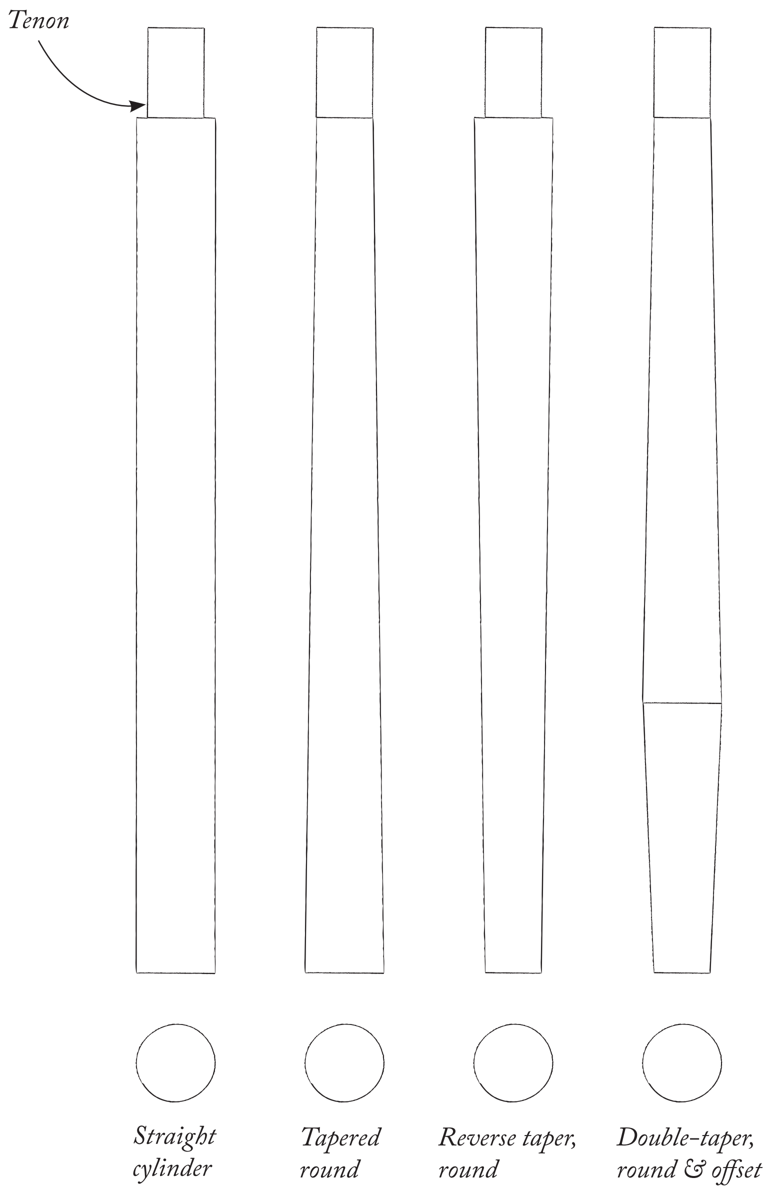
There are wide variety of leg shapes. The following pages show some common ones that appear on stick chairs that have been shaved. I don't turn legs for my chairs, though those appear in the historical record.

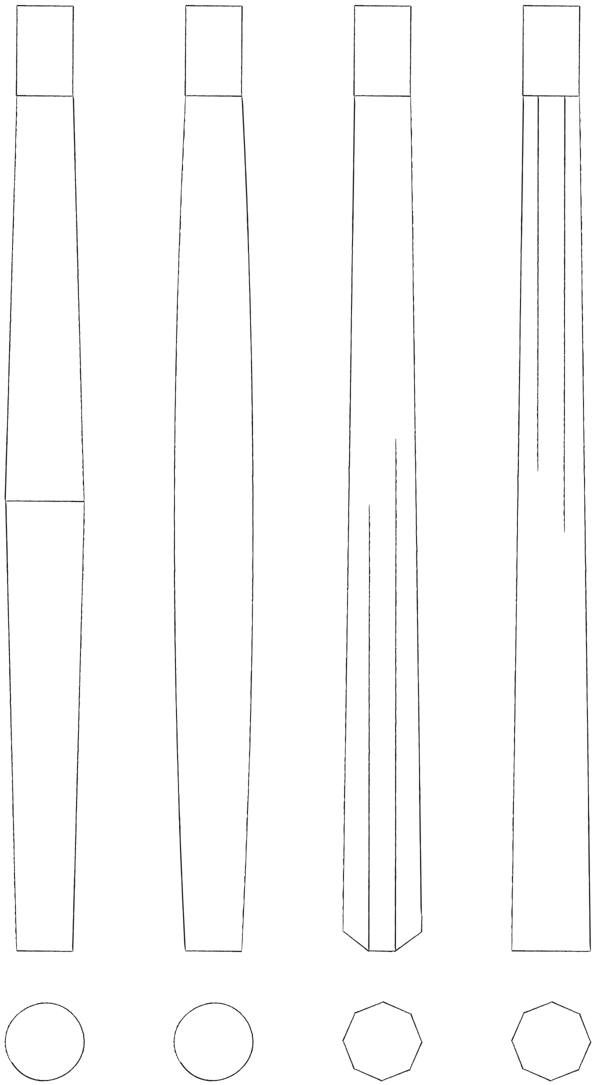
MARKING OUT OCTAGONS

Many vernacular chairs have hexagonal or octagonal legs. Hexagonal legs can be rived from triangular firewood splits (thanks to Welsh craftsman Gareth Irwin for showing me how this works). Or they can made from rectangular stock. If, on the other hand, you start with square stock, then it's easy to make it octagonal.

Marking out an equilateral octagon inside a square shape is easy. All you have to do is set a combination square from one corner to the

TAPER & TENON THE LEGS





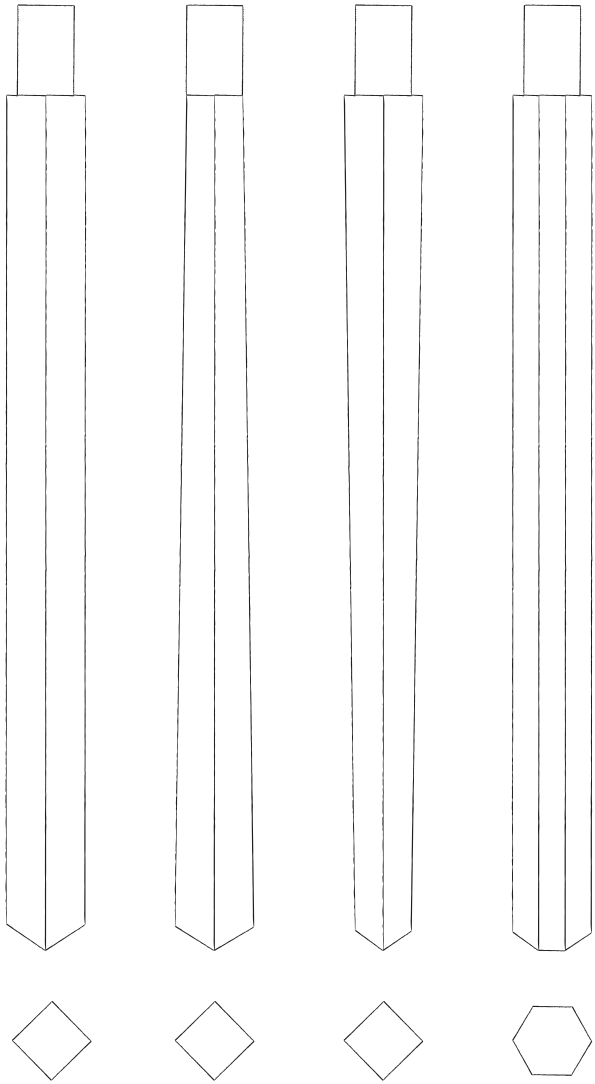
Double-taper, centered

Round with entasis

Octagonal, round at top

Octagonal, round at foot

TAPER & TENON THE LEGS

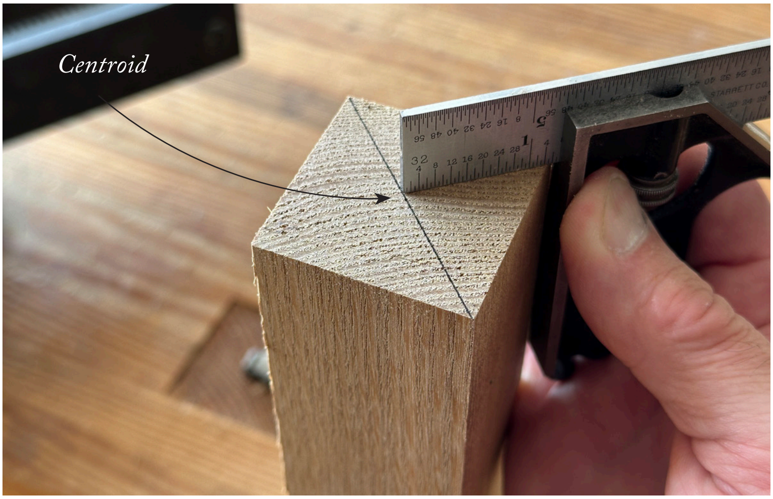


Square, straight

Square, tapered

Reverse taper, & square

Hexagon, straight



ONE LINE; ONE SETTING

Draw a diagonal line that joins two corners. Place your combination square against one of the other corners and touch the blade to the line. That is the setting you need to lay out the octagon.

"centroid" of the square. You get the centroid by drawing one diagonal joining two corners of the square. Then you can lay out the entire octagon. Here's how.

1. Join two corners of the square diagonally.
2. Set the stock of a combination square against one of the other corners and extend the blade until it touches the diagonal line.
3. Now use this setting to mark the octagon along the faces of the leg. Then plane down the corners until you reach your lines.

PLANING OCTAGONS

For years I used a planing cradle to convert square stock to octagonal stock. A planing cradle has two 45° angles butted against one another. When you drop the square stock into the cradle, the corner you need to plane faces up. Plane down to the pencil lines with a jack plane, then rotate the stick 90°. Repeat.

These days I simply use my carver's vise to hold the legs as I plane them to octagons. The vise's jaws grip the corners of the square leg as

EASY OCTAGONS

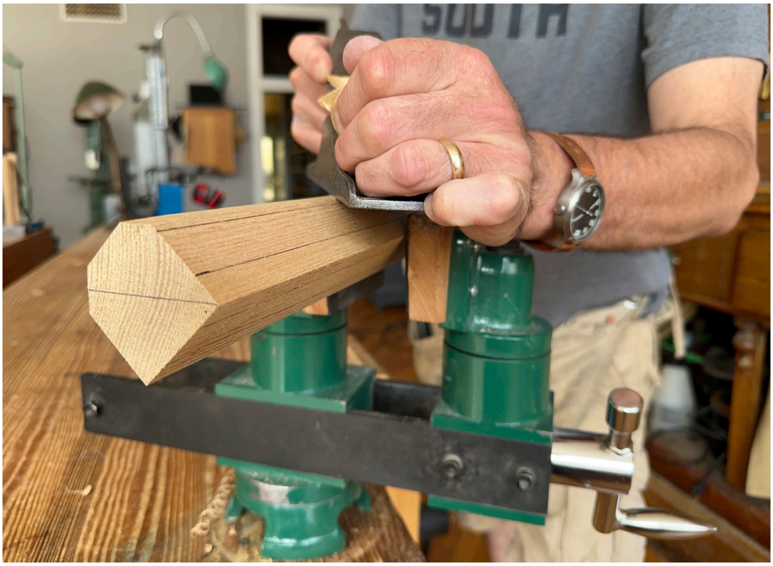
One setting with a combination square allows you to lay out the octagon on the long edges of your stick.

I plane down to my pencil lines. I prefer the vise to the planing cradle for a couple reasons. One, I don't have to find my planing cradle. And two, when the leg is in the planing cradle it sometimes jumps about and is difficult to keep in place. The carver's vise holds it firm and at a good height. There are dozens of way to hold the leg.

OCTAGONS AT THE BAND SAW

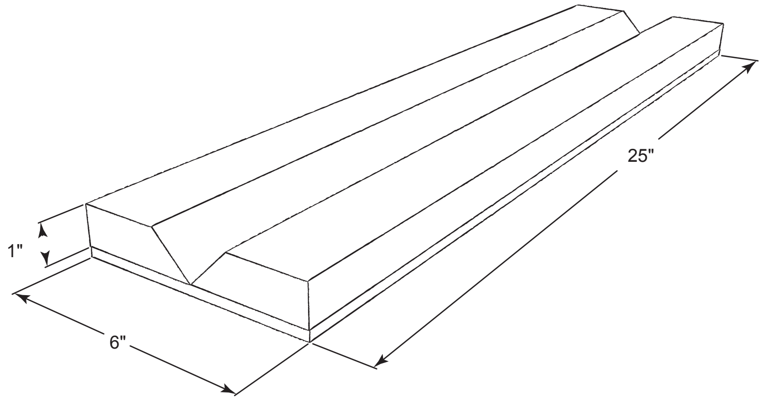
If you own a band saw you can make a simple jig that will transform square stock into octagons quickly and safely. The jig is like a planing cradle. It holds square stock at 45° to the blade so you can clip its corners and create an octagon.

The jig shown in the photos and illustrations on the following pages can be made from one piece of wood, or it can be built up from three pieces of wood, depending on what you have on hand. The jig as shown is designed to cut square legs (1-3/4"), stretchers (1-1/4") and sticks (3/4") into octagons.



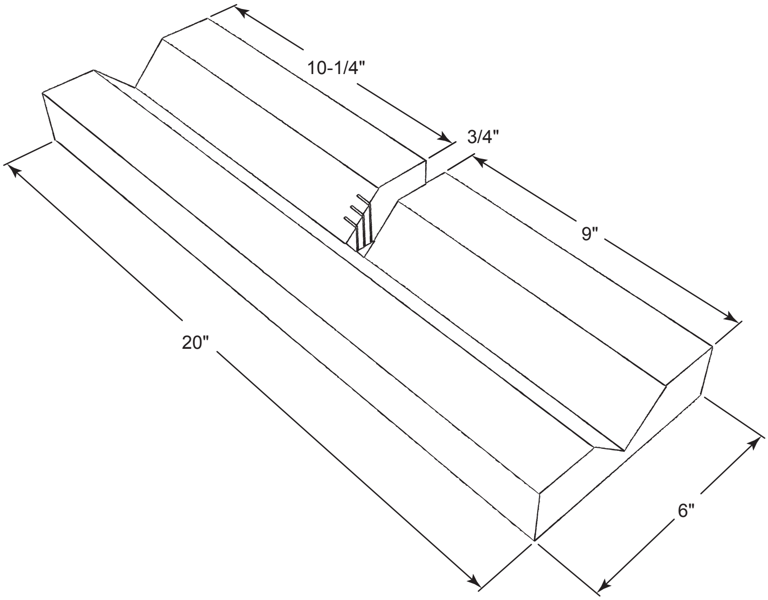
WITHOUT A PLANING CRADLE

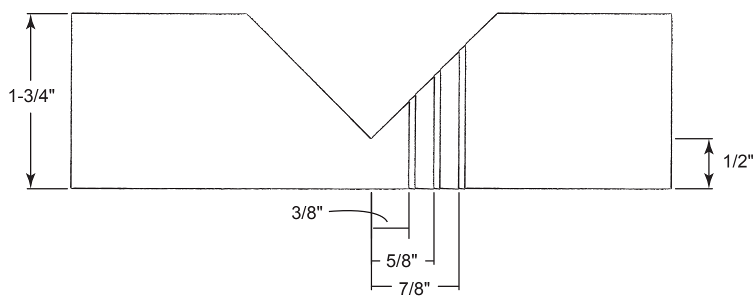
These days I octagonalize my legs in a carver's vise. It handles the operation with ease.



PLANING CRADLE

A simple planing cradle works with your workbench's planing stop (or a dog). It is helpful for making octagons and tapering legs.





OCTAGON JIG FOR THE BAND SAW

This simple jig can be made from one chunk of wood, or it can be built up from three pieces (like the planing cradle). This jig greatly speeds production of legs, stretchers and sticks. (Note: Some friends make just one cradle that works both at the bench and the band saw.)

SAFE & FAST

Many machine operations for making octagons put your fingers close to the blade. This jig has plenty of support on its infeed and outfeed so your fingers are protected.

It does this easily because there are notches in the jig for these three common stick sizes. You create these notches while building the jig.

First cut the 45° angles along the length of the jig (I used a table saw). Then cut the 3/4"-wide notch in the middle of the jig so the jig surrounds the blade of your band saw.

Take a piece of scrap leg stock and lay out an octagon on one end. Put it in the jig and line up the blade with your pencil marks on the leg's end grain.

Make shallow test cuts on the end grain. Then measure the length of the facets on your octagon. Adjust the jig and make more test cuts until the facets are equal (or look equal). Then, with the band saw running, push the jig into the blade and make a 1/2"-long cut into the jig. That notch in the jig will allow you to set the jig next time. Repeat the process with 1-1/4" stock (for stretchers) and 3/4" stock (for sticks).

NICK THE CORNERS

No matter what size chair part you have, a simple pencil layout can get you equilateral octagons in short order.

AUTO-OCTAGONS

Set your leg against the saw blade as shown. Bring the fence over and touch the corner of the leg blank. Lower the blade a bit, and you are ready to cut octagons.

OCTAGONS ON THE TABLE SAW

There are days when I need to make 200 squares things into octagonal things for a class. On those days, I use the table saw. It's faster than the band saw and a little more dangerous because you cannot use a blade cover.

Tilt the blade to 45°. To set the fence to cut an equilateral octagon, you can use a trick I learned from *Fine Woodworking* that is almost magic (in other words, it's geometry). Take your square stock and press one face against the saw blade with one corner of the stock touching the table saw's table. Slide the fence in until it touches a corner of the stock. Lock the fence.

The saw is now set to cut an equilateral octagon.

You'll want to lower the blade considerably before you turn on the saw. After that, it's just a matter of using push sticks and common safety protocols to keep your hands away from the blade and your stock under control.

SHAPING THE LEGS: ROUND

Once the legs are octagons, work them to their finished shape. You might turn them on the lathe, shave them round, taper them or do some combination of these operations. Or you might just leave them as straight-sided octagons.

Though you will occasionally find turnings in vernacular chairs, shaved components are more common. Shaved components could be made with simple tools that almost any farm or household would own.

According to those who study these chairs, some turnings in vernacular chairs might have been purchased from a turner. In many cases, only the front two arm posts of the chair are turned; the remaining sticks are shaved. Plus the turnings might be a different wood.

While I own a lathe and use it to make furniture components, I don't use it when building stick chairs. Turned legs and sticks look different than shaved legs and sticks.

If I want to make round components, I shave them at the bench. With one hand I press the work against a stop. With the other hand I shave the arrises of the leg with a jack or block plane. Rotate the stick, plane some more. I first learned this technique from John Brown in his book "Welsh Stick Chairs" and embraced it fully.

All you need is some sort of stop to restrain your work (it can be as humble as a nail in a picnic bench). Plus, a plane to do the cutting. This technique allows you to work without a shavehorse or a drawknife. I find it intuitive and liberating.

I have a low workbench with a stop for this work. But you can put a stop almost anywhere on a workbench or a sawbench to do the job.

Here are some important details that weren't in John Brown's book.

• Use a jack plane with a cambered cutting edge.

• Wield the jack or block plane one-handed. You don't need to use a lot of downward pressure, so one hand is enough to do the job.

• Relax the wrist that holds the plane and let the weight of the tool do the work.

• Always work the arrises (corners) of the legs, not the flats. The cutting action will be easier.

• If you get tear-out, don't worry too much. You can clean it up later.

Shave the legs until they are as round as possible with the jack. They

FINISH WITH A BLOCK PLANE

After the jack plane, finish up the legs with a block plane.

will be faceted, and you might have some torn grain.

A block plane with an adjustable mouth is the best tool to finish the job. Set the mouth as tight as possible so it will remove any tear-out. Work the arrises again. With a block plane you should be able to get the component looking round, with small flats that you can feel and that subtly reflect light.

Note that you don't have to make the legs fully round along their entire length. One of my favorite leg shapes is one that starts as octagonal at the floor and becomes round at the top.

Another favorite shape with round legs is to add some entasis. Basically, the leg bulges slightly in the middle of its length. To create entasis, first shave the leg round. Then taper the top half of the leg so it's 1/4" or 3/8" smaller in diameter. For example: If the leg is 1-1/2" in diameter, I'll typically taper it to 1-1/4" or 1-1/8" in diameter. After tapering the top of the leg, I turn it around and make the same taper at the foot.

TAPERING LEGS

ROUND & FACETED
A common leg shape among stick chairs has only part of the leg rounded off (either the top or bottom) with the remainder hexagonal or octagonal.

Tapered legs are worth the effort. Straight legs look lifeless in comparison (to my eye).

In chairs from the U.K., typical legs start thick at the floor and taper thinner toward the seat. This shape gives the chair solidity and roots it to the floor. I think each leg looks like a tree trunk rising from the forest floor.

In Germanic countries, chair legs often taper the other way. The legs are smallest at the floor and get thicker as they rise to the seat. This gives the chair a lightness and lift, even with heavy components.

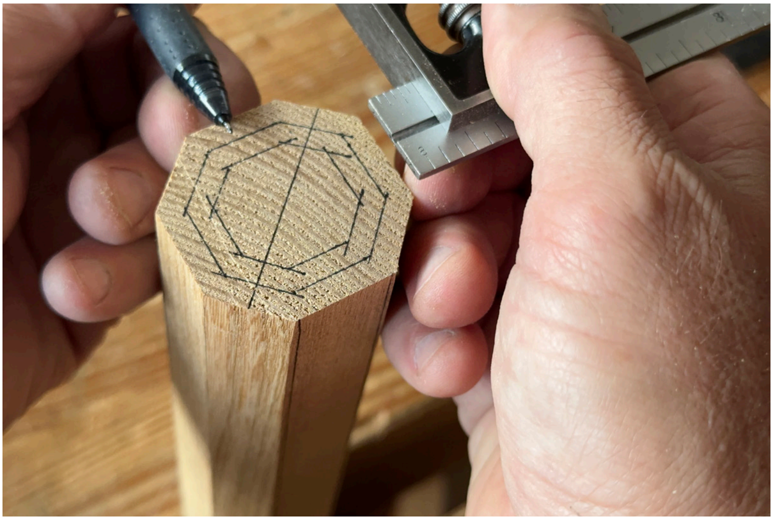
How much should the legs taper? When building a table leg, the rule of thumb is that the leg should taper to half its thickness and width. So, a table leg that is 2" x 2" at the top should be 1" x 1" at the floor. This taper happens over 25" or so.

In a chair leg, the taper happens over only 15" to 17". So, I like a less-extreme change. With a 1-3/4" x 1-3/4" leg, I like it to taper to 1" x 1" or maybe a shade more. This slower taper looks natural.

Making the tapers is easy with a jack plane, plus either a planing

LEGS WITH ENTASIS

The shaved legs on this Irish Gibson-style chair have a subtle bulge along their length. You have to look for it. But without it, the legs would look lifeless.



TAPERING LAYOUT

These are 1-3/4" legs that will taper to 1" at the top. I need to remove 3/8" from each facet. So I mark out the work in two stages.

cradle or a carver's vise.

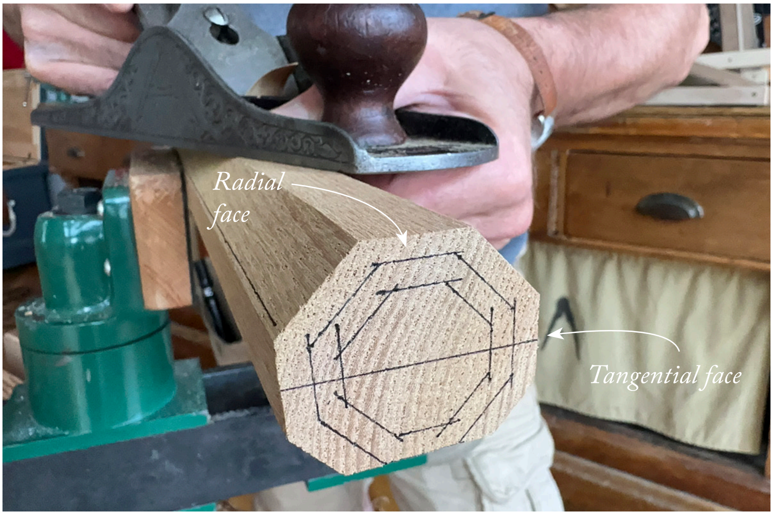
It begins with marking your target dimension on one end of the leg. This is simple math. If you have an eight-sided leg that is 1-3/4" square and you want to taper it to 1", then you need to remove 3/8" from each facet. Set your combination square to 3/8" and pencil in these target lines on the end grain.

You'll find that 3/8" is a lot of material to remove in one go. The facet will get really wide as you taper it – almost too wide. So I also pencil in lines that are 3/16" in from each facet. First I taper down to the 3/16" line all around the leg. Then I taper down to the second line all around the leg.

Put the leg in your carver's vise (or planing cradle). Fetch your jack plane and set it to make a heavy cut. My shavings are typically about .015" thick (about three sheets of photocopier paper). Wax the sole. If the leg is 22" long, I make sets of three tapering cuts on each facet. The first three cuts are at 7" from the end. The second set of three cuts are at 14", and the third cut is a full-length shaving on the facet to blend in

THE BASICS OF TAPERING

Mentally divide the length of the leg into three parts. The first stroke is short and one-third the length of the leg. The second stroke is two-thirds the length of the leg. The third stroke is the full length of the leg. Repeat, and the leg will begin to taper.



START WITH THE RADIAL FACE

Radial (quartersawn) grain is easier to plane that tangential or rift/bastard. So begin the taper on the radial faces. Then plane the bastard faces. Finally, taper the tangential (flatsawn) faces.

the bottom of the leg (without taking away too much material).

Planing the first facet of an octagon is the most arduous part of the job. So I recommend you begin planing on the leg's radial (aka quartersawn) face. The radial face is easier to plane than the tangential (flatsawn) face.

Also, make sure your handplane's cuts are parallel to the layout lines on the end of the leg. If your cuts are skewed, shift the jack plane sideways to correct it. The curved iron helps make these corrections.

Wax or oil the sole every few minutes to reduce the effort needed to taper the leg. Rotate the leg to the adjacent facet and repeat the process. If you are getting tear-out, plane the leg the other direction as you get close to the final strokes on a facet.

If that doesn't remove all the tear-out, don't be too concerned. Before you assemble the chair there's a "make pretty" stage where you will fix these cosmetic problems. After the legs are at their final shape, get ready to cut the tenons on their ends.

LEVEL A TAPERED LEG

Place a shim under the level that is a thick as what you removed from the tip of the leg (3/8" in this case).

ABSORB THE DRILL

Do everything to envelop the drill with your body while cutting tenons. If the drill wobbles, your tenons will be wonky.

MAKE THE TENONS ON THE LEGS

There are many methods to make the tenons on the legs, including a block plane, a dedicated tenon cutter or a lathe.

My favorite way to make straight tenons for legs is with a modern 1" tenon cutter. These aluminum tools chuck into a brace or an electric drill and make perfect tenons. (Some production shops even chuck them into a lathe.) With this tool you can fine-tune both the tenon's diameter and finished length.

Each size of tenon requires a dedicated tool, so it can get expensive. But these tools save lots of time. I own several. The sizes used in this book are 5/8" in diameter (for sticks), 3/4" (for sticks in armchairs) and 1" (for legs, large sticks and posts). Here are some tricks to using them.

• The leg, stretcher or stick should be level in your vise. This is easy to

OBSERVE THE ENTIRE STICK

Don't focus on the front rim of the tenon cutter. Instead, watch the entire stick and tenon cutter as you pull the trigger.

do with pieces that aren't tapered. To level a tapered leg or stretcher in your vise, put a shim under the bubble level at the tapered end. If you removed 3/8" from each facet of a leg, then the shim should be 3/8" thick.

• The drill should be set to a medium speed (clutch off). That means 700 to 1,000 rpm for a clean cut.

• Your body position and how you hold the drill is critical. The drill should be braced against your body as much as possible without it getting weird. I cannot stress this enough. Also, the workpiece should be at elbow-height. If it's lower or higher, your tenons will likely be angled up or down.

• Level the drill using the bubble level on the tenon cutter (or a bubble level taped to your drill).

• Aim the drill straight down the stick. Press forward so the tenon cutter is firm against the work. Pull the trigger with a smooth motion. Drill with confidence and keep control of the drill.

• After every two tenons, wipe out the blade and mouth of the tenon

MAKE A DEPTH STOP FOR A TENON CUTTER

Cut a full-length tenon with the tenon cutter. Measure the tenon you need and cut off the remainder. That serves as a plug that goes in the tenon cutter, acting as a stop. You can remove the plug with an awl. A little tape can help the stop stay put.

cutter with an oiled rag. Regular oiling will silence the tool's squeal.

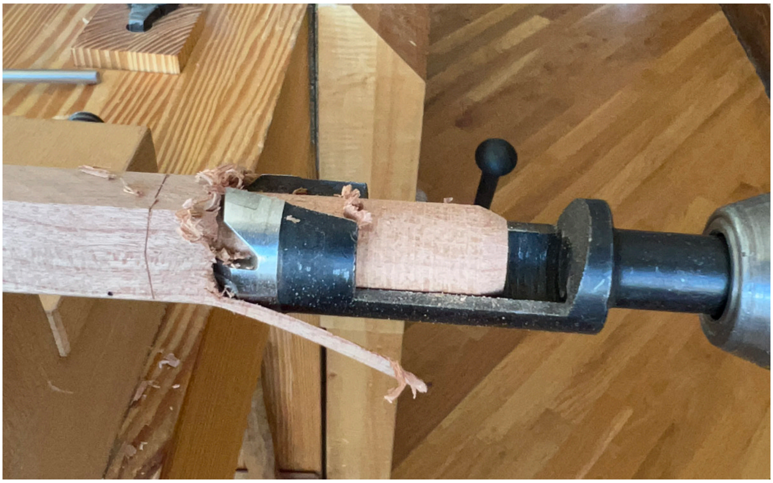
One more tip. It should be obvious, but it's not: Warm up on some scraps before you cut tenons for keeps.

If your tenons aren't perfect at first, here are some troubleshooting suggestions.

• If your tenon is angled up or down, adjust your next workpiece up or down in the vise until you find a position that works better.

• If your tenon is angled left or right, you are not keeping the drill in line with the work.

• If your tenon is off-centered but straight, you need more practice. But you might also need to move the workpiece up or down in the vise a bit.



CHEAPER TENONS

A plug cutter can make tenons. Just be sure to scribe the shoulder and chamfer the tip of the tenon so it can enter the cutter.

• If the tenon has spiral gouges on it, you aren't keeping the drill under control and the tenon cutter is lurching.

Once you get warmed up, you can use one of your warm-up tenons to set a depth stop for the tenon cutter. Measure the resulting tenon on your test scrap. Let's say it's 3-1/4" long. And let's say you want your tenons to be 2-1/4" long. Cut 1" off the sample tenon and stick it into the mouth of the tenon cutter. The scrap acts as a stop.

Also, while you are cutting test tenons, check the diameter of the tenon and make sure it's the right size for your chair. If you aren't sure, make a sample mortise with your auger or spade bit and check the fit of the sample tenon.

Some woodworkers use plug/tenon cutters to make cylindrical leg tenons. These are available in a wide variety of sizes up to 3" diameter. You can use them like a tenon cutter if you first taper the tip of the stick so it will enter the mouth of the plug cutter. After that, it's all about keeping the cutter straight and level. Another tool that will do this is a rounding plane.

A REVERSE TAPER

Turn a taper into a cylinder by planing a reverse taper. Make your strokes as shown in the photo until you have a cylinder. Then plane the cylinder down to the correct diameter.

STRAIGHT TENONS WITH PLANES

Before I owned tenon cutters, I planed my tenons to cylinders with a block plane, which is how John Brown did it. First I scribed my target tenon size on the end of the work using a compass or a template.

Press the tip of the leg against a stop in your vise to hold it still. Then you need to plane a "reverse taper" to turn the tapered tip of the leg into a cylinder that is 1" in diameter and about 2-1/4" long.

I cut this reverse taper over about 9" of the leg. I take a short stroke with the plane that begins 9" from the tip and ends 6" from the tip. (Don't forget to skew the tool quite a bit during the cut.) Lift the plane to stop the cut. Then take a second stroke 9" from the end of the leg to 3". Then take a third stroke from 9" to the end of the leg. Rotate the leg a bit, and repeat these three stokes.

Keep working the leg like this until you reach the target on the end

TEST THE TENON

After planing the tenon round, test it in a sample mortise drilled into a scrap from the seat.

of the leg. Then begin testing the tenon in a sample mortise that is drilled in the same species of wood that you are using in your seat.

Drive the tenon in (this will compress it). Observe where there is too much wood left. Remove it with your block plane. Repeat this process until the tenon goes all the way through the sample mortise.

STRAIGHT TENONS WITH A BEDAN TOOL

When there are mountains of tenons to make, I might use my lathe and a bedan sizing tool to make tenons for the legs. The bedan tool is an attachment for a parting tool. It essentially acts as a stop for the parting tool, forbidding it to cut too deep.

You set the bedan tool so the distance from the parting tool to the bedan tool equals the tenon diameter you want. There is some trial and error. To reduce the error, I usually place the auger bit I plan to use between the parting tool and bedan tool and start there.

BEDAN SIZING TOOL

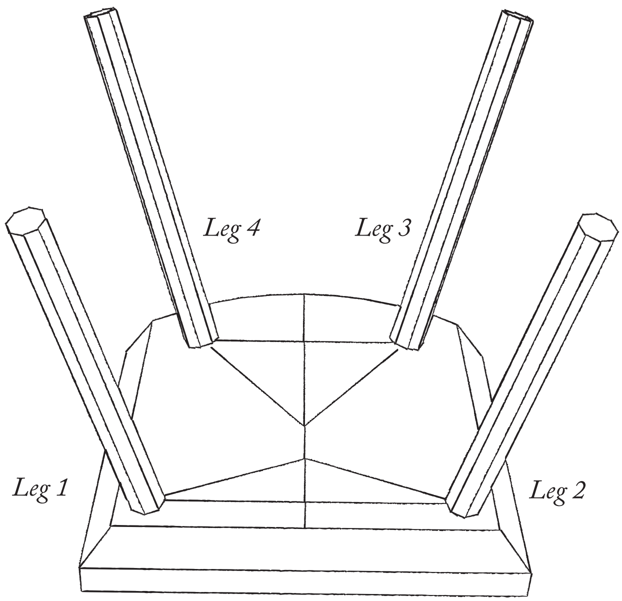
Set the bedan sizing tool using the auger bit as a guide. Rough out the tenon on the lathe. Then use the bedan tool and a parting tool to create the tenon.

I rough out the tenon with a roughing gouge and get it close to size, usually 1/16" oversized. Then I switch to the bedan tool. I pivot it over the tenon and it removes a section of waste. I shift the tool to the side and continue removing waste until the entire tenon is done.

THE DOUBLE-CHECK

After you have tenoned the legs, you can designate a leg for each hole. I have a pattern I have used since my first chair. I number the holes in the seat the same way: 1-2-3-4. I drive the legs in and mark them 1-2-3-4 on the foot of the legs with a marker.

I also rotate the legs in their mortises so they are in the proper orientation when the chair is finished. If you have strut legs (no stretchers) you can position the legs any way you like. I usually put a flat facing the front of the chair. (And, because I am really fussy, I choose the flat that exhibits quartersawn grain to face front.)



NUMBER YOUR PARTS

I have labeled my legs the same way since my first chair. You could also use a traditional cabinetmaker's triangle. Pick a system and stick with it.

If you will add stretchers, you need to rotate the front legs and back legs so that they have flats facing one another. I do this with a yardstick. By pressing the yardstick against the flats of a front leg and back leg, I can rotate them until their flats are in line. Then I knock them into their mortises with a mallet.

Once the legs are in position, I mark the legs so I can return them to this position. The simplest method is to pencil a tick mark on the leg (and mark its number again) where the sightline on the seat touches the leg. This tick mark can also serve as a reminder as to when to stop sawing when you kerf the legs for wedges. Don't remove the legs just yet. You need to mark their tenons so you can saw a kerf down each leg.

FACET-TO-FACET

If your chair will have stretchers, then the facets between the front and back legs need to face one another. Align them with the help of a straightedge.

ANOTHER BACKSTOP

When my legs are in final position, I make a tick mark where the leg intersects the sightline. Note I have also numbered the leg.

KERFING FOR WEDGES (OR NOT)

I usually saw a kerf down each leg tenon before final assembly of the chair's undercarriage. These kerfs make it easier to wedge the tenons during assembly.

First mark where the kerf should go. With the legs still in the seat, mark a line through each tenon that is perpendicular to the grain of the seat. After marking the tenons, remove the legs from the seat. (Many people struggle to pull the legs out. Use an offcut from a 3/4" or 5/8" stick to knock the tenons out from the topside of the seat.)

Saw the kerfs so they are two-thirds the length of the tenon. You don't want the kerf to show below the seat. If it does, the assembly process will close the kerf and make the tenon difficult to wedge. I use a tenon saw to make the kerfs, but if the tenon is really tight in its mortise, I'll use a handsaw or a band saw (these saws make wider kerfs).

ABOUT WONKY LEGS

If one (or more) of your legs are wonky, do not get worked up. It happens. After the chair is assembled, there are so many parts and angles in the chair that a wonky leg is difficult to see. Chairs are a casserole of angles. So sometimes you can't taste the weird mustard inside.

Many old chairs (perhaps most old chairs) have legs that are all different angles. And you don't notice this until you try to measure their rake and splay.

I think there are two solutions to wonky legs. One, invest in some drilling jigs. Or take my approach: Embrace the wonk.

DER HINDERPLUGGEN

Here you can see the kerf in the leg's tenon is correctly oriented perpendicular to the grain of the seat. The 5/8" dowel with orange tape is "der hinderpluggen" (a fake German word). We use this to help knock out sticky tenons. Why the tape? So we don't throw it away by accident.

REINFORCEMENT FOR THE EYE

Stretchers aren't always necessary. And they aren't an evolutionary improvement. But at the very least they do make a chair more durable.

MAKE THE STRETCHERS

About half the chairs I build don't have stretchers. Structurally, they don't always require them, but my customers (and sometimes my designs) demand them.

When to use stretchers and why is one of the most frequent questions I get about chairmaking. My answer to the question is simple: It's complicated.

I cannot speak for other forms of furniture, but most stick chairs do not need stretchers to survive the long haul. If you have straight-grained legs that are firmly joined to a thick seat, the chair will be fine unless it encounters a catastrophic downward force named Eugene.

Omitting stretchers can save you some construction time. While stretchers aren't especially difficult to make, they add at least four joints to a chair. Another advantage to omitting stretchers: A chair that has "strut legs" – no stretchers – is easier to repair. If a leg becomes loose or it cracks, you simply remove the leg, make the repair and re-insert the leg into its mortise.

If all the above is true, why do stretchers exist?

A strut-leg chair demands straight-grained legs, a fairly thick seat and good joinery. If you can't guarantee all those things are present, then you should add stretchers to the chair to reinforce the undercarriage. Stretchers restrain the legs from moving, so the undercarriage as a whole is likely stronger.

But adding these stretchers will add to the construction time when building a chair. And when a stretcher chair needs repair, it's more complicated than fixing a strut-leg chair. You have to loosen multiple joints to mend things.

From the customer's point of view, however, stretchers are expected, like dovetailed drawers or a glass-smooth finish. Chairs that lack stretchers are seen as lacking – despite the fact that those stretchers might be shoring up an inferior undercarriage.

In my shop, stretchers are sometimes a design decision. They add interest and visual weight below the seat. They allow you to repeat or reinforce design details you have used elsewhere on the chair. And they can be a place for a sitter to rest her feet.

DIFFERENT ARRANGEMENTS OF STRETCHERS

There are several ways to configure stretchers on a chair. And their arrangement and placement is an important design decision. In general, stretchers that are low to the ground give the chair a more primitive feel. Stretchers that are up high by the seat look modern.

Why is this? I suspect that low stretchers provide more reinforcement to the legs than high stretchers. So, an earlier builder would opt for the stronger approach. It's similar to the way that early carpenters overbuilt buildings (until engineering equations came along).

Stretchers can be parallel to the floor or parallel to the bottom of the seat. It's a subtle difference, but stretchers that are parallel to the floor look a little more elegant and finished.

The following are the various stretcher arrangements common to stick chairs.

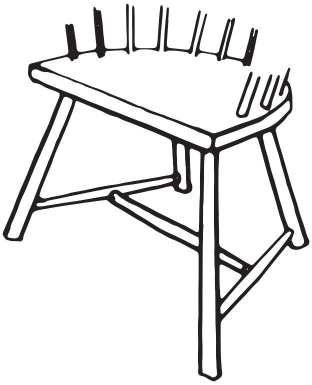
• The H-stretcher is the most common arrangement. It is durable and easy to execute. Some chairs have two (or more) medial stretchers. Additional medial stretchers add strength and create a shelf for a hat or a purse.

• Some chairs feature only two side stretchers that go between the front legs and the back legs. There is no medial stretcher that joins the side stretchers. This makes the chair look early and a bit mysterious. I've built a few chairs using this stretcher arrangement, and it's remarkable how stable this arrangement is.

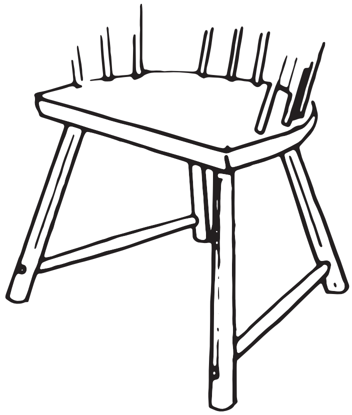
• Occasionally a chair will have an H-stretcher plus an additional stretcher between the rear legs.

• Box stretchers are also common. The stretcher at the front can be a nice place to put your feet, but it will experience a lot of abuse. So make it using the strongest, straightest stock possible. Some variants will omit the front stretcher or raise it to the point where you cannot easily rest your feet on it. One uncommon variant is a box stretcher with additional side stretchers, which make the undercarriage look a bit like a ladderback chair.

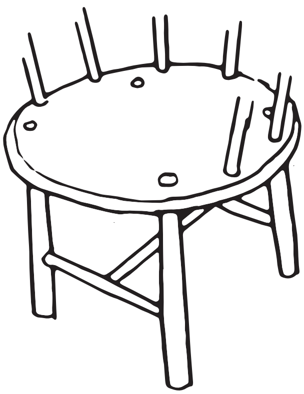
• The typical box- or H-stretcher arrangement can be rotated 90°



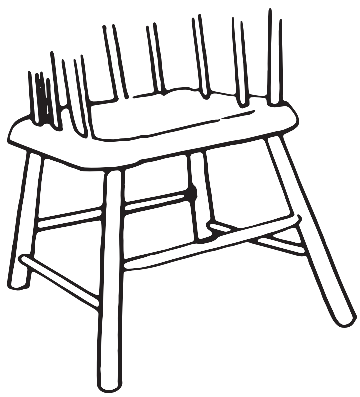
H-stretcher



Side stretchers

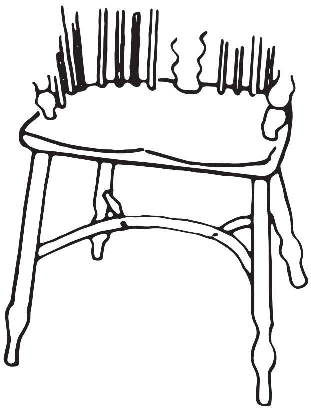


H-stretcher rotated 90° (rare)

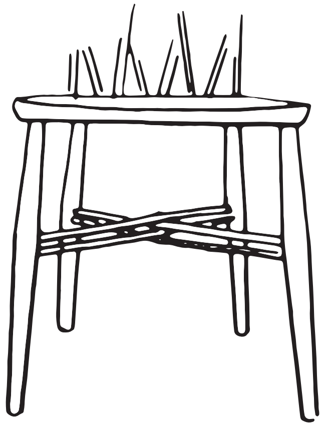


Box stretchers

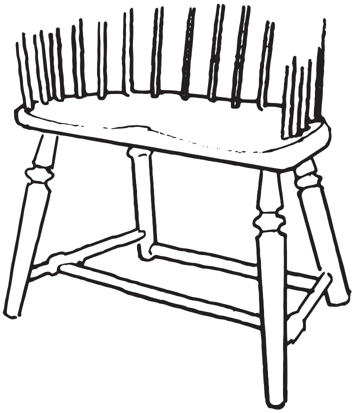
STRETCHER PATTERNS



Crinoline stretcher



X-stretcher (rare)



H-stretcher with additional back stretcher (rare)

STRETCHER PATTERNS

(CONTINUED from previous page)

STRETCHERS IN THE WILD

As always, the best way to learn about stretchers is to look at old chairs. Look how low these box stretchers are. It gives the chair a solid and old feel (not a bad thing).

from what is typical. This is fairly rare and looks odd. (Don't forget, odd can be good.)

• A crinoline stretcher is one of the fancier forms and is found mostly on high-style chairs (i.e. not folk chairs). It features a bent C-shape (which resembles a hooped petticoat) that connects the front legs. Two smaller, straight stretchers connect the rear legs to the curve.

• X-stretchers join the legs diagonally. This is probably the least-common stretcher arrangement in stick chairs.

STRETCHER JOINERY: THROUGH OR BLIND?

The tenons on stretchers can be either through-tenons or blind tenons. Each approach has advantages and disadvantages.

Through-tenons add visual appeal (if the chair is unpainted) and provide more gluing surface than a blind joint. Also, through joints are wedged, which provides even more durability. The joints also are

THROUGH-TENONS

A wedged through-tenon is visually appealing, and the tenon is unlikely to come loose anytime soon.

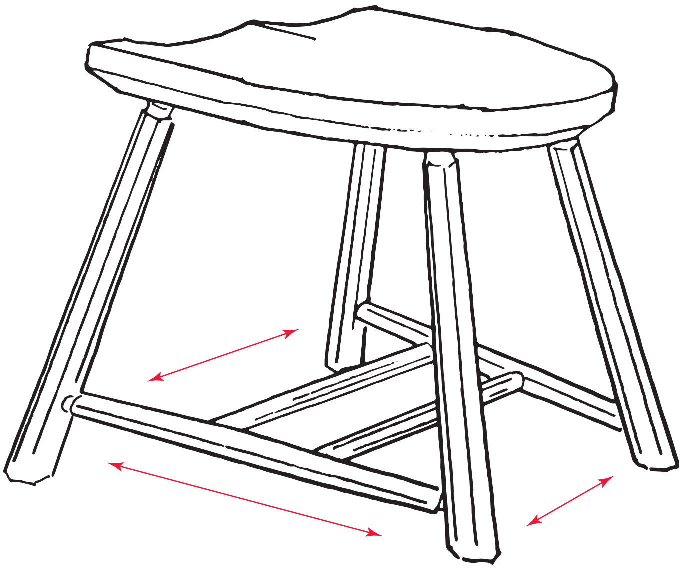
somewhat easier to repair. You heat the joint to make the glue elastic then pry out the wedge. Then the joints comes apart easily.

The downside to through-tenons is they are more complex to execute. To make the mortise, you need to drill most of the way through the leg until the lead screw of your bit pokes out the other side (some modern bits allow you to drill straight through without a backing board). Then you need to come around to the other side of the joint and finish boring the hole. Assembly time requires more wedges and more joints to juggle as well.

Blind tenons are simpler to make. But they aren't as appealing to people who like expressed joinery. They don't have as much gluing surface as through-tenons, and they aren't usually reinforced with wedges. Repairs are more involved.

If you build your chairs with good joints, then I consider the decision on using through-tenons or blind to be mostly aesthetic.

You can make the tenons on your stretchers using planes, a lathe or a tenon cutter. These methods are covered in the chapter on legs.



PUSHING OUT

When properly installed, stretchers put the undercarriage in tension, making it less likely to come apart.

TYPICAL DIMENSIONS

Stretchers are typically 7/8" to 1-3/8" in diameter. Usually the medial stretcher is a bit thinner than the side stretchers. For example, when the side stretchers are 1-1/4" in diameter, the medial stretcher might be 1" in diameter.

I have found that the size of the joints in the stretchers usually mirrors the joinery for the chair's sticks. So, if the sticks have 5/8"-diameter tenons, then the side stretchers have that as well. Sometimes the medial stretcher uses a slightly smaller tenon than the side stretchers. So, for example, if the side stretchers have 5/8" tenons, the medial stretcher will have 1/2"-diameter tenons. If you do this, you will need a 1/2" tenon cutter – or make those tenons with a plane.

The stretchers don't have to be round or equilateral. They can be oval

RECTANGULAR STRETCHERS

Look close and you will see these side stretchers are taller than they are wide. This shape allows me to use a 5/8" tenon for the medial stretcher instead of a 1/2" tenon.

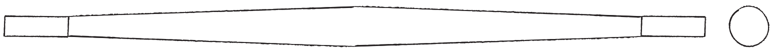
or rectangular in shape. One of my favorite stretcher shapes is 7/8" thick x 1-1/4" wide. I double-taper the stretchers down to their tenons. Then I drill the mortise for the medial stretcher through the 1-1/4" faces. This approach puts some more wood around the mortise for the medial stretcher – strengthening the joint.

As far as tenon length goes, for blind joints make them 1" to 1-1/4" long, depending on the thickness of your legs. For through-tenons, make them over-long – usually 2-1/4" is long enough – so they can be wedged and cut flush after assembly.

STRETCHERS TO ADD TENSION

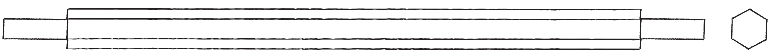
Some chairmakers make their stretchers a tad over-long – 1/8" over-long is typical – to introduce tension to the undercarriage. Tension is a force that tries to elongate a body, so over-long stretchers try to push the legs apart.

Round cylinder



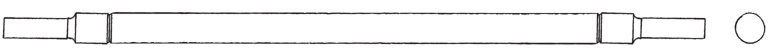
Round, double-taper

Round, bulbous

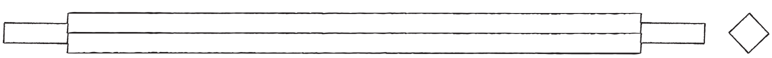


Hexagonal or octagonal

Hexagonal or octagonal, double-taper



Round cylinder with incised grooves



Square

SHAVED STRETCHER SHAPES

Is this necessary? I cannot say. In general, I find that my undercarriages offer enough tension/resistance because I drill everything freehand. So adding tension on purpose seems unnecessary. But when I cut my stretchers to size, I'll usually round up the dimension to the nearest eighth (22-7/16" becomes 22-1/2", for example). This simplifies my math and likely adds a tad of tension as well.

DIFFERENT SHAPES OF STRETCHERS

If you dig into any book on Forest chairs, you will find an astonishing number of patterns for the chairs' legs and stretchers. Stick chairs, on the other hand, have a limited palette. And thank goodness.

To my eye, the turnings on Forest chairs can look like slick brown tumors strung on a thick wire. The bulbous shapes are supposed to impress you – "Gads, Biffy, this chair must be pricey. Just look at all the whoop-de-doos."

Money can't buy taste. If it did, all the vinyl-clad McMansions would be built like Estonian peasant huts instead.

Most vernacular stretchers are made without a lathe – just handplanes, spokeshaves and scrapers. So they follow these basic patterns:

• A straight-sided round or oval cylinder.

• A faceted cylinder that is typically four-, six- or eight-sided.

• Round with a bulbous center. This common stretcher shape swells in its center. These stretchers look turned but are made with planes.

• Double-tapered stretchers. These can be round or oval, faceted or smooth. They are thicker in the middle than at the ends and are easily made with planes.

Sometimes stretchers have a couple incised rings. But that's about all the whoop-de-doos you'll find on commonplace chairs.

Once you have a plan for where your stretchers will go and what they might look like, you can lay out and drill the mortises in the legs.

DRILL MORTISES FOR THE STRETCHERS

Drilling the mortises for the stretchers seems daunting. It requires compound-angled joinery that intersects legs that are raked and splayed at compound angles.

But once you know the trick, drilling these joints takes just a few minutes and (in my book) is one of the easier aspects of chairmaking as

MARKED FOR MORTISING
A simple block of 4x4 allows you to mark the location of the stretchers. Then poke a starting hole with an awl. Just eyeball it.

a whole. The technique is called "direct drilling," and I learned it from chairmaker Don Weber.

Let's start with a common stretcher configuration: an H-stretcher that is in a typical position (11" below the seat). After you know how to lay that out, then the variants (low, high and parallel to the floor) will be simpler to explain.

There are fancy ways to lay out stretchers, but I always go back to a dirt-simple method that uses a chunk of scrap 4x4. If your stretchers will be 11" off the seat, cut the 4x4 to 11". Now take a carpenter's pencil and plane it down to half its thickness. I call this the "half pencil." (You could also use a chisel to mark the line.)

With the seat upside down on your benchtop, place the 11"-long 4x4 on the seat. Slide it over to one of the legs and use the half pencil to scribe a line on the facet that will receive a mortise. Repeat this for the other three legs. Take an awl and – by eye – poke the midpoint of each of the four lines. The layout for the stretchers is complete.

ALL THE GUIDANCE YOU NEED

Use the block that marked the stretchers to drill the mortises. Sure, you can fetch your laser. Or not. Note the line drawn on my drill. That helps.

HOW TO LAY OUT THE VARIANTS

Making the stretchers higher or lower is easy. Just cut a shorter or longer 4x4. For ultra-low stretchers, there needs to be some forethought. You don't want the stretchers to drag the ground (or do you?).

To make the stretchers parallel to the floor, you must take an additional step. Drive the legs into the seat, then cut them to their final lengths. (To do this, skip to the chapter on leveling the legs.) While I usually level the legs after assembly, there's no harm in doing it now.

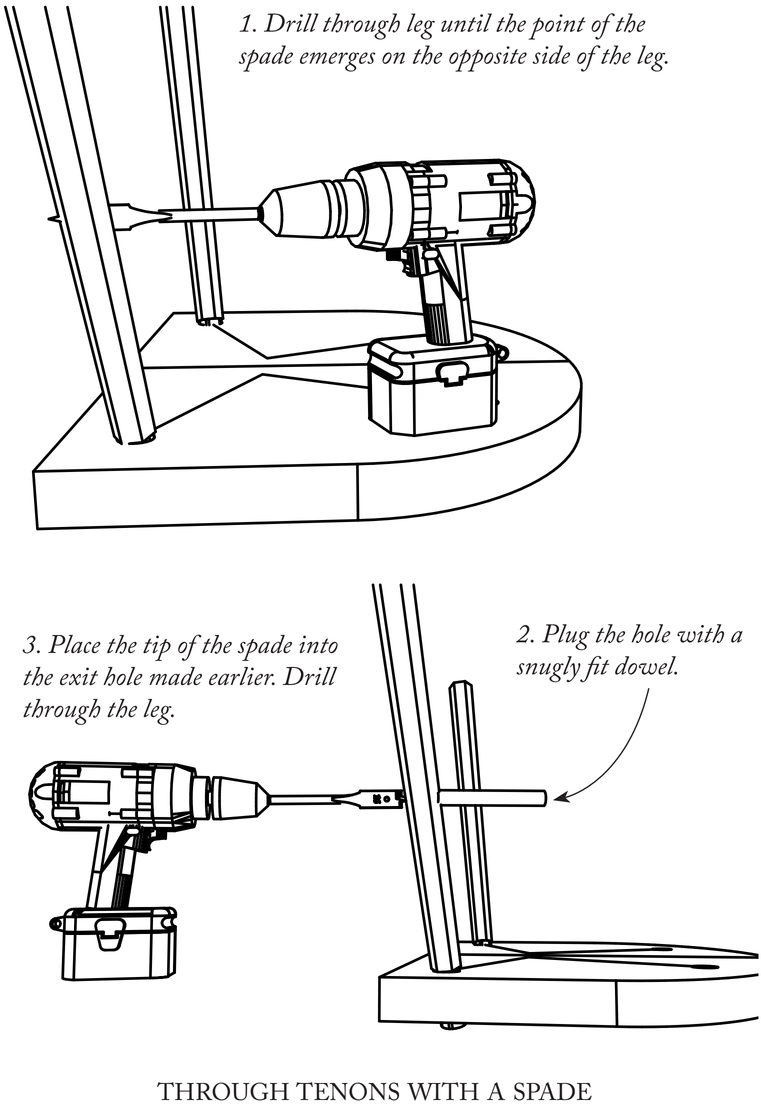
After you cut down the legs, set the chair's legs on your workbench. Decide how high the stretchers will be off the floor. Let's say 4". Cut a 4x4 to 4". Put the 4x4 on your benchtop and use it to mark the facets for the stretchers – again using the half pencil. Use an awl to mark the midpoint of the four lines.

AN INTRODUCTION TO DIRECT DRILLING

The term "direct drilling" is an apt name for this method. You simply take a drill, put the tip where the mortise will go and drill the mor-

THE EASY WAY IN

If your drill's chuck is parallel to the bottom of the battery (most are), you can use that to guide you as you drill the mortises for the stretchers. This drill holds a bit 9" above the battery – perfect for stretchers. Place a 2"-thick block of wood under the battery to place the stretchers 11" below the seat.



THROUGH TENONS WITH A SPADE

To make a clean through-mortise with a spade, drill through the leg until the tip of the spade emerges on the exit side. Temporarily plug the hole with a dowel. Then drill the other side of the mortise with the spade.

tise by eye. The trick, is, of course, to hold the drill in the correct place.

I use a 5/8" spade bit (or a fancy bit that leaves a clean exit hole) for this operation. If the mortise is going to be blind, I wrap tape on the shaft of the bit to remind me to stop drilling.

Place the drill in position with the tip of the bit on your awl mark. Hold the drill in line between the leg you are drilling and the leg in front of you. That gets the drill in the correct position left-to-right. There are many ways to get the drill positioned correctly up-and-down. You could:

1. Place the 4x4 block that you used to mark the stretchers adjacent to the drill and use that to guide you. Honestly, this offers enough guidance for me.

2. Place a block of wood under the battery of the drill to hold the bit at the desired height. Make sure your drill's chuck is parallel to the bottom of the battery before you do this.

3. Have a friend hold a laser level so its beam stretches between the two mortises (if you don't have a friend, mount the laser on a tripod). Use this to guide you.

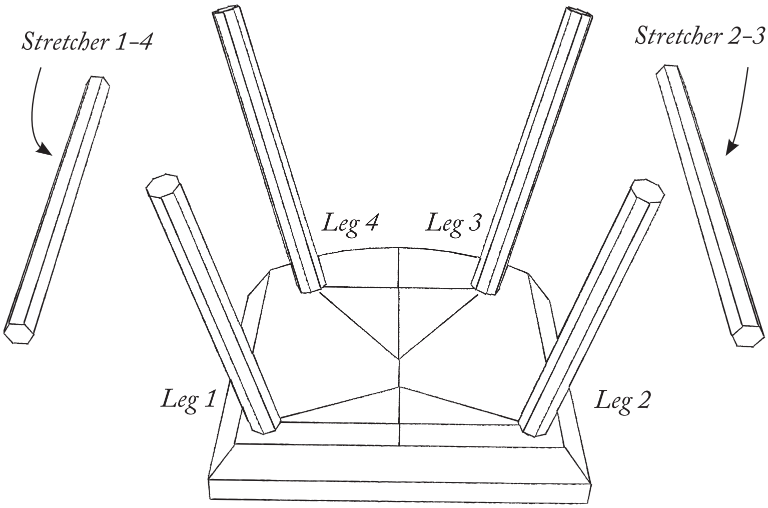
4. Just go for it. Eyeball the mortise in the leg in front of you. Start drilling slowly and make an adjustment as soon as the bit is fully engaged in the leg.

Once you start drilling, the next step is to stop in the right place. If the mortise is blind, stop drilling when the tape reaches the rim of the mortise. If the mortise will pass through the leg and you are using one of the fancy bits (such as the Star M F-type) designed to leave a clean exit hole, you can drill straight through the leg to make your through mortise.

If you are drilling a through-mortise with a spade bit, then stop drilling when you can feel the lead tip of the bit just start to emerge on the far side. You will not injure yourself doing this if you drill with light pressure. But if you are bearing down on the drill as if to bodily pass a cheese pizza, then you deserve the nick you'll get. And your chair's leg will almost certainly be chewed up as a result.

Remove the drill bit. Now fetch a piece of 5/8" dowel that is about 4" long. Check its fit in the blind (for now) mortise. If it's loose, wrap tape around it to tighten things up. Press the dowel firmly into the mortise until it bottoms out.

Now move around to the other side of the mortise and place the tip



NUMBER YOUR PARTS

I have labeled my legs and stretchers the same way since my first chair. You could also use a traditional cabinetmaker's triangle. Pick a system and stick with it.

of your bit in the tiny hole left by the bit's tip. Hold the dowel with your off-hand and align the drill so it is in line with the dowel. You can do this several ways.

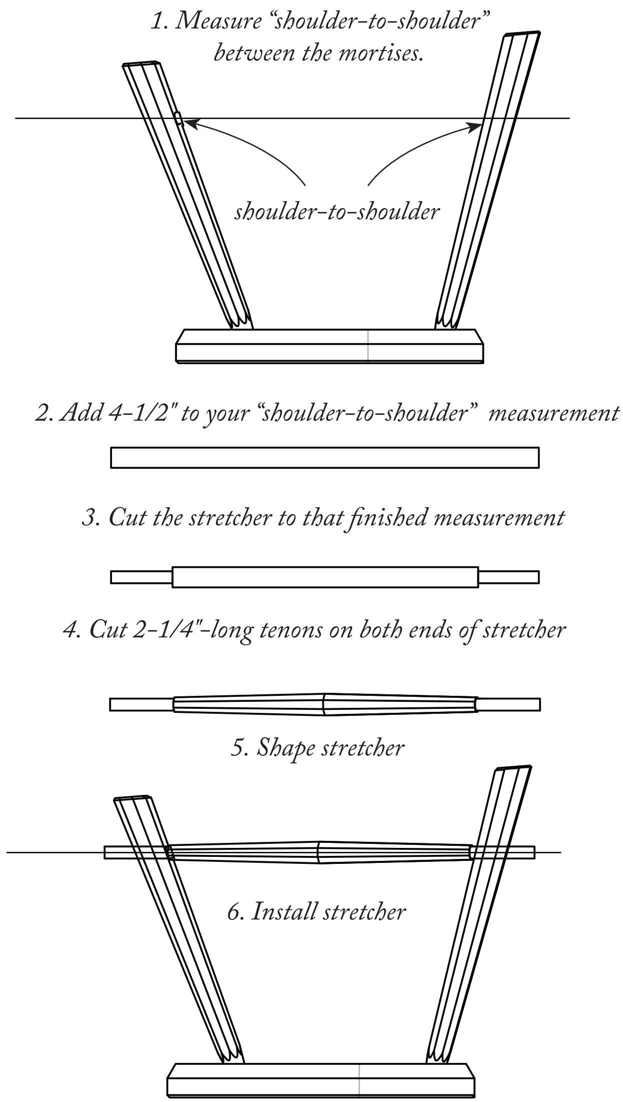
1. Have a friend tell you when the drill is in line with the dowel.
2. Use a laser.
3. Swing your head and shoulders around the chair so you can see the dowel and your drill. This usually is enough to keep me on target.

Drill out the end of the mortise. It should take only a few seconds. Now drill the mortises in all the legs that need them.

MEASURE FOR STRETCHERS

No matter what sort of stretcher joinery you are using, it pays to write down all the information about the stretchers and their tenon lengths as you go. I write my measurements and math on the underside of the seat. That way, if I ruin a stretcher, I can go right back to the

MAKE THE STRETCHERS



MEASURE FOR STRETCHERS

The key to fitting your stretchers is to first find the "shoulder-to -shoulder measurement," then add the tenon lengths to that.

measurements I wrote on the seat.

Each stretcher gets a name, and that name derives from the legs it connects. If my stretchers run front to back, then I have a 1-4 stretcher (connecting the front leg labeled No. 1 and the rear leg labeled No. 4) and a 2-3 stretcher (connecting the front leg labeled No. 2 and the rear leg labeled No. 3). With box stretchers, I'll have four stretchers labeled, 1-2, 2-3, 3-4 and 4-1.

Before we talk about measuring stretchers, we have to talk about tenons. Here's an important point about all the tenons in this book. They all start off as 2-1/4" long. Yup. The tenons for the legs, stretchers and sticks are all 2-1/4" long. Why? Well 2-1/4" is the longest tenon I need for any of my chairs. So if I cut that tenon length on all my legs, stretchers and sticks, then I can use any of my parts in any of my chairs. All I have to do is trim the tenon to the necessary finished length.

Also – and this is probably more important – I can keep all my tenon cutters set to make a 2-1/4"-long tenon. I don't have to measure or think or make adjustments to the tenon cutters' depth stops. I can just go.

Finally, this approach can simplify a lot of the math and remove a lot of the thinking. Why? Because instead of making a stretcher that is 22-5/8" long with an 1-1/4" tenon on one end, and a 1-5/16" tenon on the other end, I can do this:

1. Measure the space between the tenons – what I call the "tenon-shoulder-to-tenon-shoulder" measurement. Or the "shoulder to shoulder" measurement for short.
2. Add 4-1/2" to the shoulder-to-shoulder measurement. That's the raw stretcher length.
3. Cut 5/8" x 2-1/4"-long tenons on both ends of the raw stretchers.
4. Trim each tenon to fit its mortise perfectly.

This might sound like more work, but it's not. I've done it both ways and taught it both ways. Students (and me) make far fewer mistakes when all the tenons are cut to the same length.

MEASURE FOR THROUGH-TENONS

If your tenons pass through the legs, you need one piece of skinny scrap for each stretcher. The scrap needs to be smaller than the

MEASURE SHOULDER-TO-SHOULDER

Place a piece of scrap between the mortises. Mark the two shoulder locations on the scrap. Measure between the marks to get shoulder-to shoulder.

through-mortises. (I use the off-fall from octagonalizing the legs on the band saw.) Thread it through the through-mortises for the stretcher. Mark the shoulder-to-shoulder length of the stretcher between the legs. Be sure to mark the scrap on the face that faces the seat. This is the smaller dimension between the two mortises.

Remove the scrap and measure between your marks. That is the shoulder-to-shoulder measurement. Add 4-1/2" to that dimension. That is the raw length of your stretcher. Cut a stretcher to that length, then put 5/8" x 2-1/4" tenons on both ends of the stretcher. Then do a dry-assembly of the legs and the stretcher. The tenons will poke out from the legs. That's OK. You will trim them during the assembly process. Rotate the stretcher so it is positioned correctly between the legs. Then mark the ends of the tenons for a kerf. The kerf should be perpendicular to the grain of the leg (that is, parallel to the floor).

Now follow the same process for the other two legs.

Mark all the through-tenons with the number you gave to each leg. So the tenon through the No. 1 leg should be marked No. 1 etc. This will reduce confusion at assembly time.

HOW TO MEASURE BLIND MORTISES

Measuring the side stretchers for blind mortises is similar to the process you used for the through-mortises. First take one of the skinny scraps and snap it in half.

Pinch the scraps together so they make one long, adjustable stick. Slide the ends of the adjustable stick into the blind mortises until they bottom out in the ends of the mortises.

With a pencil, make a couple tick marks that pass across both scraps. These marks let you remove the scraps and rejoin them using the ticks so you know the entire length of the stretcher. Then use your pencil to mark the shoulder-to-shoulder measurement between the legs.

Remove the scraps and reassemble them using the tick marks. Now you can measure the shoulder-to-shoulder dimension between the legs. Add 4-1/2" to that (which is your stretcher's raw length). Cut a stretcher to that length, add 5/8" x 2-1/4" tenons to both ends. Then trim the tenons so they completely fill each blind mortise in the legs.

Just like with the through-mortise stretchers, label all your stretchers so you can match the tenons with the correct legs when the glue comes out.

MEASURE BLIND MORTISES

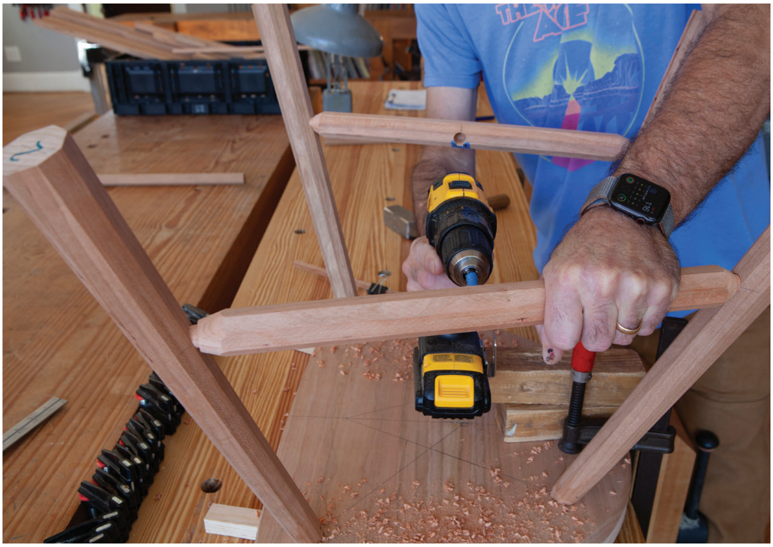
For blind mortises, use two scraps. Bottom them out in the mortises and make a tick mark across both scraps. Then mark the shoulders on the scraps. Remove the scraps, reassemble them and measure shoulder-to-shoulder.

MEDIAL STRETCHERS

If your chair has medial stretchers – stretchers that run from side stretcher to side stretcher – then you need to first make and dry-fit the side stretchers. Then you can drill the mortises for the medial stretchers using the same methods as for the side stretchers. Use pieces of skinny scrap to record the shoulder-to-shoulder length of the medial stretcher. Then add 4-1/2" to that. Cut the medial stretcher to length. Tenon both ends as before. Just like with the side stretchers, the mortises for the medial stretchers can be blind or through.

SHAPING STRETCHERS

Like shaping legs, shaping stretchers is all a matter of what you want. You can shave them round, double-taper them or even leave them octagonal. Begin shaping them with a jack plane, then finish with the block plane.



MEDIAL STRETCHERS ARE EASY
After you install the side stretchers, follow the same steps to install the medial stretcher(s).

KERF THE STRETCHERS

After the stretchers are shaped, cut the kerfs in the stretchers' tenons. The kerfs should go down about two-thirds the length of each tenon.

STANDARD STRETCHERS
The stretchers on this chair are about 9" from the underside of the seat. That's a fairly standard place to put them.

SIMPLE ARMS

Arms that are not connected into an armbow are easier to make and somewhat easier to assemble.

ARMS & HANDS

The arms can be the simplest part of a chair. If you're fortunate, you might find a branch in the woods that grew into the shape of a perfect arm. Or the arms can be as basic as two straight boards: one for the right hand and one for the left.

If you like, you can make a C-shaped arm that wraps around the sitter by gluing three or four bits together – one for the sitter's right hand, two for the spine and one for the left hand.

On the other hand, a chair's arms can have involved joinery – mitered scarf joints or curved half-laps (for starters).

And if that's not enough of a challenge, try steambending, where there's a significant risk of chucking a lot of failed pieces into the trash – plus daydrinking.

With dozens of methods available, deciding how to make the arms of a chair can be daunting. So, let's begin with some basic principles.

THE GOAL OF THE ARM

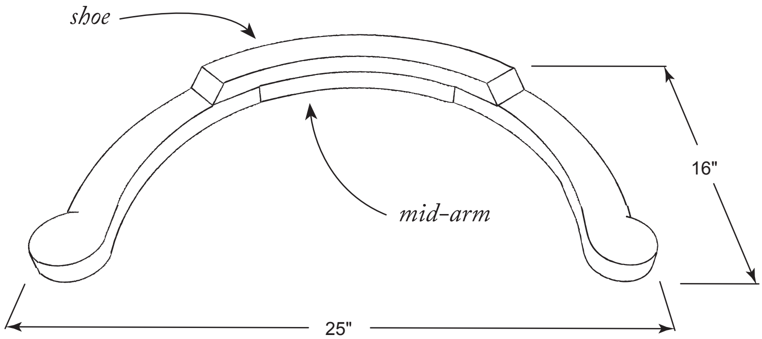
The mechanical goal of the arm on a good stick chair is simple: Avoid short grain as much as possible. If you plan to build your chair with two separate, disconnected arm pieces, things are simple. You can easily find two sticks to do the job and avoid weak short grain.

The troubles begin when you want your chair to have what's called an "armbow" – a curved arm that wraps around the sitter from her right hand to the left. How in heaven's name do you avoid short grain with a C-shaped arm? There are several strategies:

• Find a curved branch that looks like a 90° bend. Saw it through its thickness (called "resawing") to make two identical curves. Then join the two 90° curves to make an arm that curves 180°. Or get really lucky and find a curved branch that is perfectly C-shaped.

• Take a straight stick and use steam to bend it into a 180° curve.

• Saw up a bunch of thin (1/8"-thick) pieces of veneer. Apply glue to their faces like spreading butter on bread. Bend them over a curved



TYPICAL PIECED ARMBOW

The-four-piece armbow is strong and can be made easily with boards from the lumberyard.

"form" that represents the arm's final shape. Let the glue dry. This process is called "bent lamination."

• Purchase "cold-bend hardwood," which is flexible when wet. You bend it over a form (similar to steambending but without the steam). When it dries, it keeps its shape.

• Create a "pieced armbow." This is where you use three or four chunks of wood that are sawn to a curved shape. You glue them up in a way that reduces short grain, sometimes adding a piece called a "shoe" to the top to cover and strengthen areas of short grain.

TYPICAL DIMENSIONS

Arms vary quite a bit. A steambent arm might be 1" thick and 1-1/4" wide. A pieced armbow might be 1" thick and 2-1/2" wide. A curved branch or root can be a whopping 2" thick and 4" wide.

The arm has to be strong enough that it won't crack during assembly or in service. And this challenge is made more difficult by all the holes you drill in the arms for sticks. Make the arm too bulky, however, and it might look ugly. It's a balancing act.

In the world of stick chairs, a typical arm is about 1" thick, give or take. In a strong material, such as elm, I'll accept 7/8" thick. For

MIGHT BE AN ARM

An osage orange crook that I plan to slice down the middle in hopes of getting an arm. There's a little rot in there, so I'm not hopeful.

width, I like 1-1/4" wide for arms that I've bent. And about 1-3/4" to 2" wide for pieced armbows.

If the arm has a shoe, I usually shoot for 5/8" to 1" thick for that component. Thinner shoes are easier to clamp down without gaps.

When assembled, the armbow is oversized compared to the seat. If the seat is 20" wide, then the armbow might be 23" to 26" wide overall. The depth of the armbow varies according to the design of the chair. If the back of the chair leans a lot, you might have to make the armbow deeper (or not, depending on where you want its hands to end up). Sometimes the hands hang over the front edge of the seat. Sometimes they are in line with the front edge of the seat. Sometimes they are a few inches back. Here's a good starting point: My armbows are typically about 16" deep, and that works for most designs.

All that said, don't be afraid to stray from these guidelines when copying an old chair.

ARMS IN THE HEDGE

Among stick chairs from Wales, it's common to find a chair where the arm's shape was determined by the tree. A tree branch grew in a graceful curve, and it was harvested by a cunning chairmaker. I first learned about this from chairmaker Chris Williams and Emyr Davies, a conservator at St Fagans. They planted the following idea into my brain: "Chairmaking begins with a walk in the woods."

That is, you can find a chair's arms in the branches, and the chair's design begins there.

During my visits to the Welsh forests, these words became real. I looked at the branches of these craggy Welsh trees and saw the arms of chairs waving at me. Curved branches are common in trees that are part of the intertwined ecosystem of hedgerows and sunken lanes.

When I returned to the United States, I went to the forest to look for arms, but above me I found only legs, sticks and stretchers – straight stuff. Of course, naturally bent wood is out there in American forests and towns, but it's not nearly as common as it is in Wales, where the landscape nurtures these curves.

If you do find curved material for arms, harvesting it, sawing it, drying it and shaping can be a challenge. Naturally bent wood can possess significant internal stresses. And you need to saw away the pith to avoid serious checking. The reward, however, is an armbow with no short grain.

There are two typical ways to use the curve of a branch in an arm.

• With a branch that possesses a shallow curve, use the curve as-is, like in a root-back Welsh chair. These arms act more like a backrest. Sometimes they have a shoe (aka doubler) that is carved from the solid arm. Sometimes a shoe is applied.

• With a branch that bends 90°, saw it through its thickness and join the two pieces into an armbow. The joint can be a scarf or a half-lap.

While I have looked for arms during many walks in the woods, most of my success has come from "walks by the stream." Trees that grow adjacent to a stream can have roots that bend from the bank then plunge down. Sometimes erosion can expose these bent roots. They are ideal for arms. (Thanks to chairmaker John Porritt for showing this trick to me.)

ROOT-BACK CHAIR

A gorgeous root-back chair on display at St Fagans. Note the shape of the seat – a fairly shallow arc, which matches the shallow curve of the massive arm.

SCARFED ARMBOW

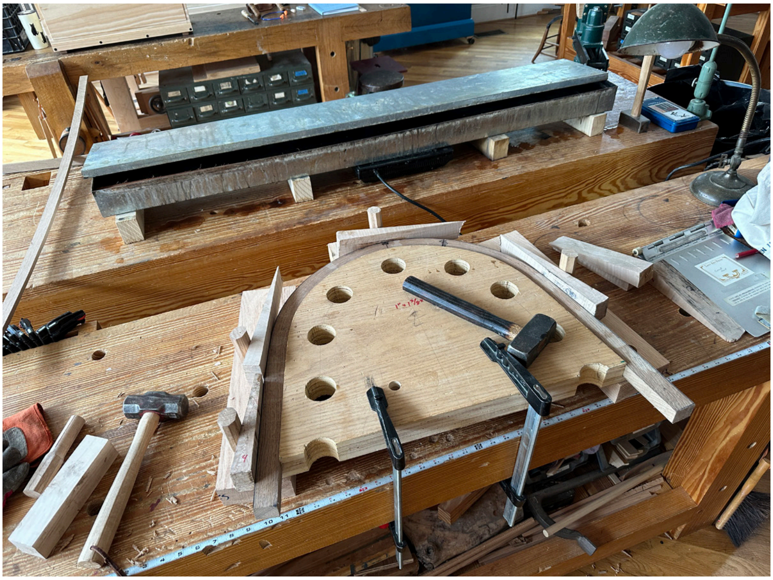
This Welsh beauty has an armbow made from two curved branches that have been joined with a scarf joint. The two back sticks that pierce the joint reinforce it. Photo courtesy of Tim Bowen Antiques in Ferryside, Wales.

HOT & TRICKY

I love steambending, but it does require some special equipment and there is a risk that the arm will split during the bending process or while drying. Using air-dried or green, rived wood greatly reduces the failure rate.

STEAMBENT ARMS

Steambending is challenging and time-consuming, and there's always the risk of failure. Despite this, I have loved it since I bent my first comb in 2003. You need a steambox or large metal tray, a way to make steam/heat (I use a wallpaper steamer or a hotplate), a steel bending strap and a form. The biggest challenge, however, is getting the right wood. The grain must be dead-straight along its length, or it is likely to split while being bent. Air-dried or green wood bends the easiest – it still has lots of moisture in it, which helps carry the heat into the stick. If the wood has been kiln-dried, it probably needs to be rehydrated before bending. Cut the stick to shape, then soak it in



A HOT SOAK

A metal tray and a hotplate is another way I heat up arms and combs for bending.

water for a week or two.

But even when you do everything right, sometimes steambending goes wrong.

After steaming the stick for an hour or so, you bend the stick around the form, secure it with clamps and let the stick dry. You can let it air-dry for a week, or you can build a primitive kiln using some insulating board, duct tape and a light bulb. You want the bulb to heat the kiln to 115°-125° (F). After a day in the kiln, the arm will be dry enough to keep its shape.

People have written entire books about steambending. The chapter on the comb-back with a bent arm goes into detail on this technique.

BENT LAMINATIONS

I'm not a fan of using bent laminations in stick chairs. Laminations look wrong to me. Basically, making a bent lamination involves sawing multiple thin strips of wood from a board in sequence. You apply

COLD-BENDING

Another way to bend arms is to use "cold-bend hardwood," which is flexible when wet. Clamp it to a form. When it dries, it keeps its shape.

glue to their faces, bend the wet mess over a form and let the glue dry. Then you machine the glue-encrusted part to shape.

I am happy to make bent laminations for contemporary pieces, but in a vernacular stick chair, I opt for something else because it looks like fancy plywood.

COLD-BEND HARDWOOD

Surprisingly, the easiest way to bend an armbow or comb is using a high-tech material called "cold-bend hardwood" or "comp wood" ("comp" is short for compression). This material has been heated with steam and compressed along its length. When it arrives in your shop, it is wrapped in plastic and is pretty wet (about 25 percent moisture). It also is flexible. You cut it with a band saw and bend it around a form.

HALF-LAP ARMBOW

This chair was inspired by a chair on display at St Fagans in Wales. The arm is joined by a half-lap. There is no shoe. I had to pick the arm stock with care to avoid as much short grain as possible.

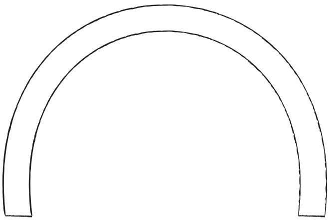
SEPARATE ARMS

If your arms aren't connected it's much easier to avoid short grain. You might need the grain to curve a little, so look for your arms near knots in your boards.

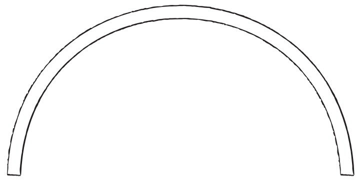
It's like steambending without the steam, strap or failure. I've had only one failure in 12 years of working with it.

What's the downside? It's expensive. A stick of comp wood that will get me three armbows might cost $200. When I sell a chair for $1,800, a $70 armbow isn't all that big a deal. If fact, it might be cheaper than steambending because there is almost zero risk of failure when bending an arm. However, if you are a hobbyist, your time is your own and you can make these decisions without worrying about the clock.

After you bend the comp wood, clamp it to the form. Then let it air-dry for a week, or put it in the kiln overnight. When its moisture drops below 15 percent, take it out of the form. I have found it quickly

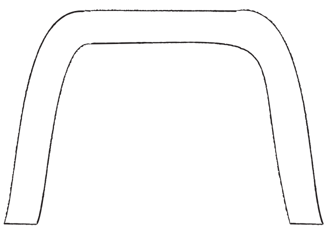


D-shape arm

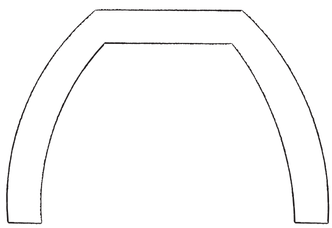


C-shape arm

Arc segment

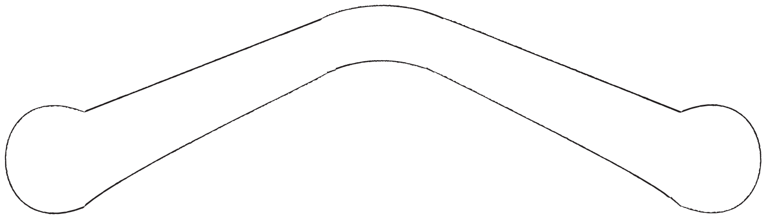


Square back

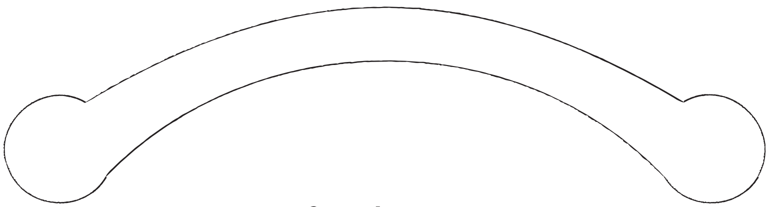


Square back,
rounded arms

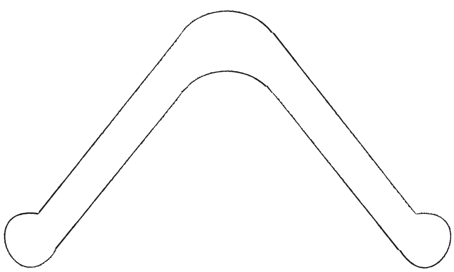
COMMON ARMBOW SHAPES



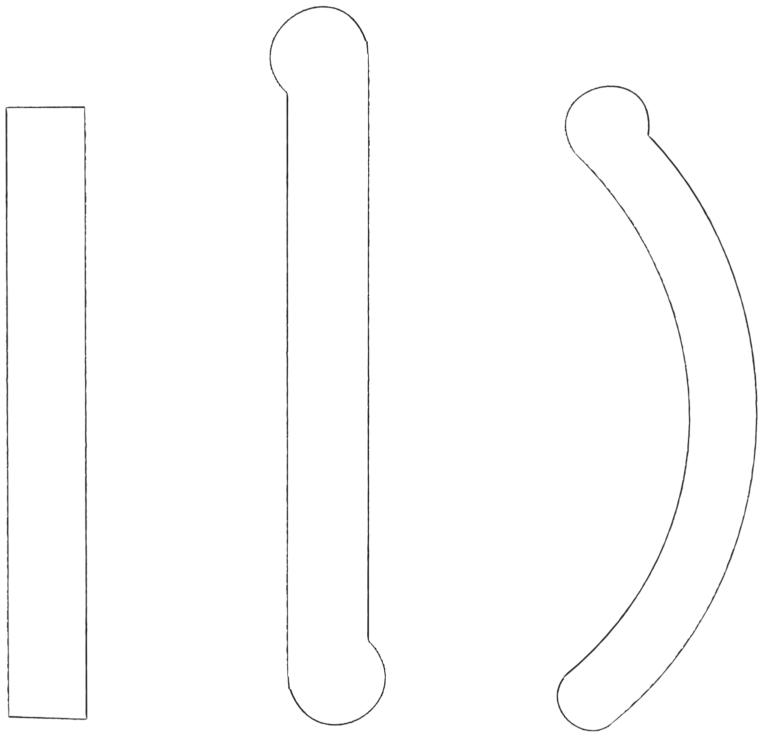
Triangular root arm



Curved root arm



Triangular branch arm (rare)



SIMPLE ARMS

The arms can be as simple as a board (left), or have hands or curves. The curved arm at right is simple enough to cut from a solid piece (no bending necessary).

acclimates to your shop's equilibrium moisture content.

Comp wood is indistinguishable from wood that has been steam-bent, so it looks fine in a stick chair. I go into detail on using comp wood in the chapter on the comb-back with a bent arm.

PIECED ARMBOWS

My favorite way to make an armbow is the easiest method overall. A pieced armbow is made from three or four bits of wood that are sawn

MINIMIZE WOOD MOVEMENT

The arms are joined to the mid-arm with pocket screws. Then covered with a shoe or backrest. This four-piece construction greatly reduces wood-movement problems.

and glued to avoid short grain. A pieced armbow allows you to use flat boards from the lumberyard (or sticks from your backyard) and, with a bit of cleverness in selecting the grain, create a sturdy armbow.

The joinery can be as simple as butt joints and glue, or as showy as mitered lap joints or long scarf joints.

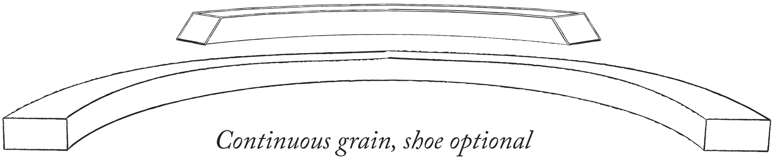
Making a pieced armbow begins with choosing the shape of the arm, choosing the joinery, then making patterns for the parts.

ARM SHAPES

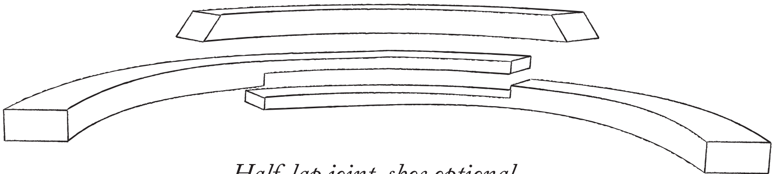
Like seat shapes, most armbow shapes are simple geometric forms – mostly arcs and rectangles. A few arms look triangular, but those are rare. About 80 percent of all the armbows I've seen on comb-back chairs have either a D-shape or a square back. Both shapes look good and are comfortable.

I prefer the D-shape because I like its long curves. The square back, on the other hand, is roomier. If you or your sitter is on the stocky side, a square back (or one of its variants) might be the right choice.

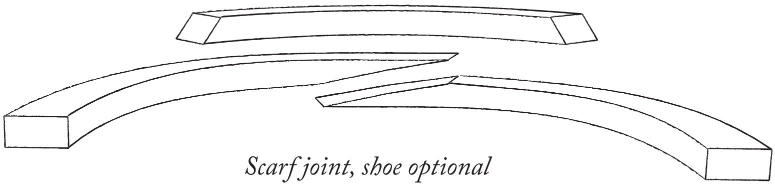
Some chairs have a simple C-shape (a half-circle) or just a partial



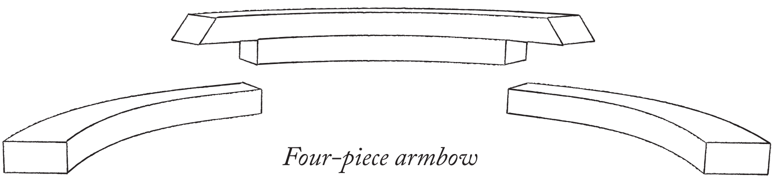
Continuous grain, shoe optional



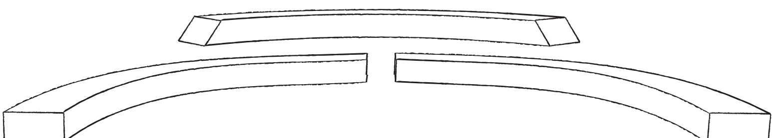
Half-lap joint, shoe optional



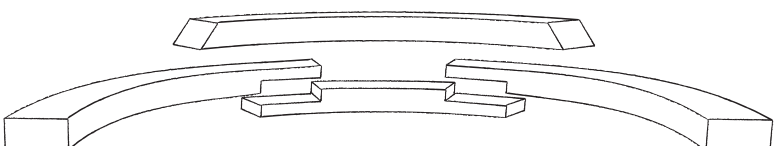
Scarf joint, shoe optional



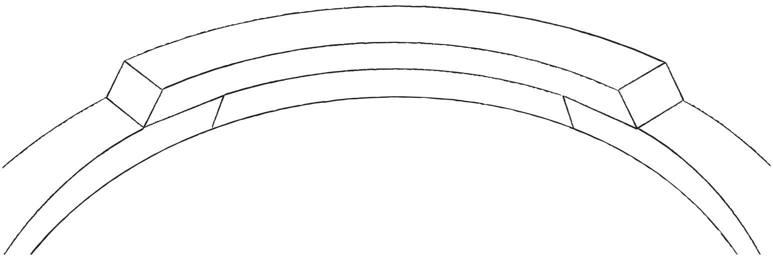
Four-piece armbow



Three-piece armbow with butt joint



Four-piece with half-lap



ARMBOW MITER

Mitering the ends of your armbow components makes the joint a little trickier to make, but it helps keep the pieces together if the glue ever fails.

arc. These arms don't wrap around the sitter. They act as more of a backrest than a place to put your arms (unless you spread your elbows out at your sides). These shapes are quite attractive, especially on the earlier root-back chairs, where the arm is a massive chunk of wood.

A few of my favorite antique chairs have the odd triangular back. This back is almost always the result of the chairmaker using a natural 90° branch. These arms look dramatic, but they aren't comfortable without a pillow.

PICK THE JOINERY

The simplest pieced armbow is two arm shapes butt-jointed together (sometimes with dowels or screws to join them) with a shoe glued on top. This works (I used this form for many years), but I prefer a slightly more complex arm that uses four components: two short arm pieces, a short "mid-arm" between them and a shoe on top. When I teach chairmaking, this is the armbow we start with.

When made well, this butt-joint armbow is durable but isn't flashy. Making it is straightforward: Plane the ends of the joints between the arms and mid-arm simultaneously until they are true. Then drill a couple pocket holes in each of the arm pieces. Apply glue and screws to pull the arms against the mid-arm.

A QUICK CLAMP

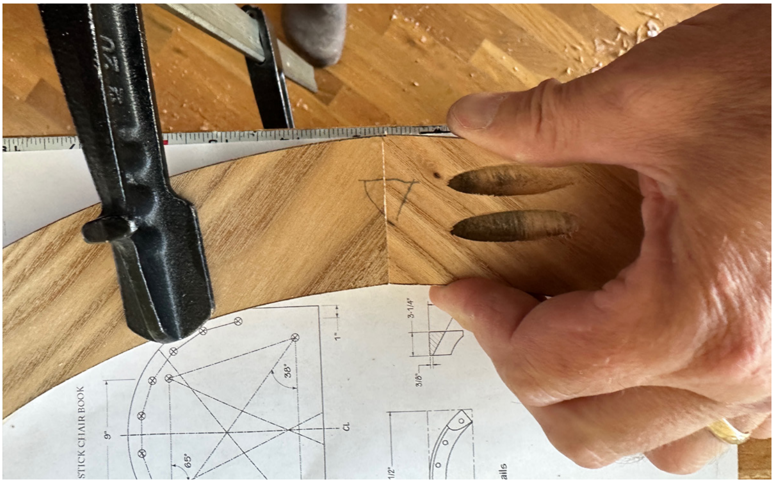
A couple pocket screws pull the armbow parts together better than any clamping scheme I've tried. I usually remove the screws after the glue has dried. Other options are to use dowels at the head joint and to pull things tight with pinch dogs.

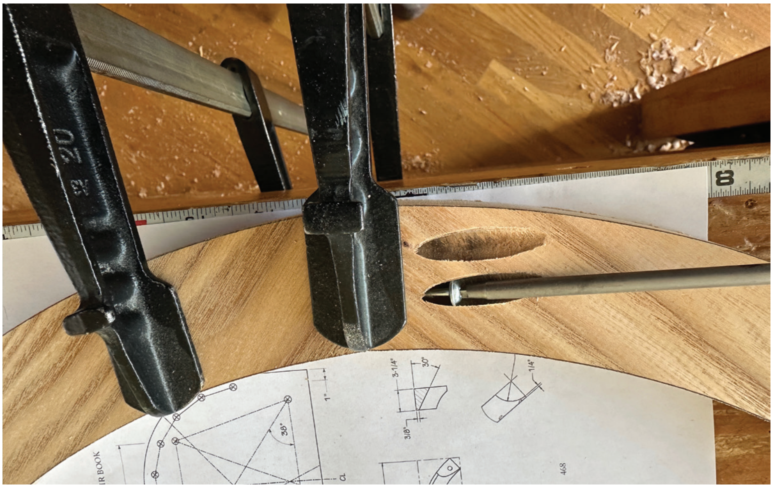
After the glue is dry, cut the shoe to shape and glue it on top.

If you prefer complex joinery, you can use a half-lap or scarf joint to join the pieces of your armbow. These joints are simple to cut and look nice.

The illustration on the next page shows some common pieced armbows. One variation is to cut the ends of the lap joints with a miter to help prevent the joint from delaminating. This mitered joint is shown on the next spread.

Making the complex joints is more time-consuming than difficult. When I make them, I saw out the half-laps and true the surfaces with a shoulder plane. The trick is getting the ends of the half-laps mated tightly. First, saw them closely. Then press the joints tightly together, clamp them in place and run a fine saw through the butt joint you created. This saw cut trims both pieces. After a cut (or three) the pieces





STRATEGIC CLAMPING

Two clamps do the job. One fixes the armbow. The other is clamped over the seam. This keeps the two parts in line as you drive the screws. Once the screws are in as far as they can go, remove the clamps and drive the screws a little more.

ADD A LAYER

The shoe reduces the chance that any short grain will split in service. It's like a basic form of plywood. Trace the shoe's shape directly from the armbow for a good match.

should mate tightly.

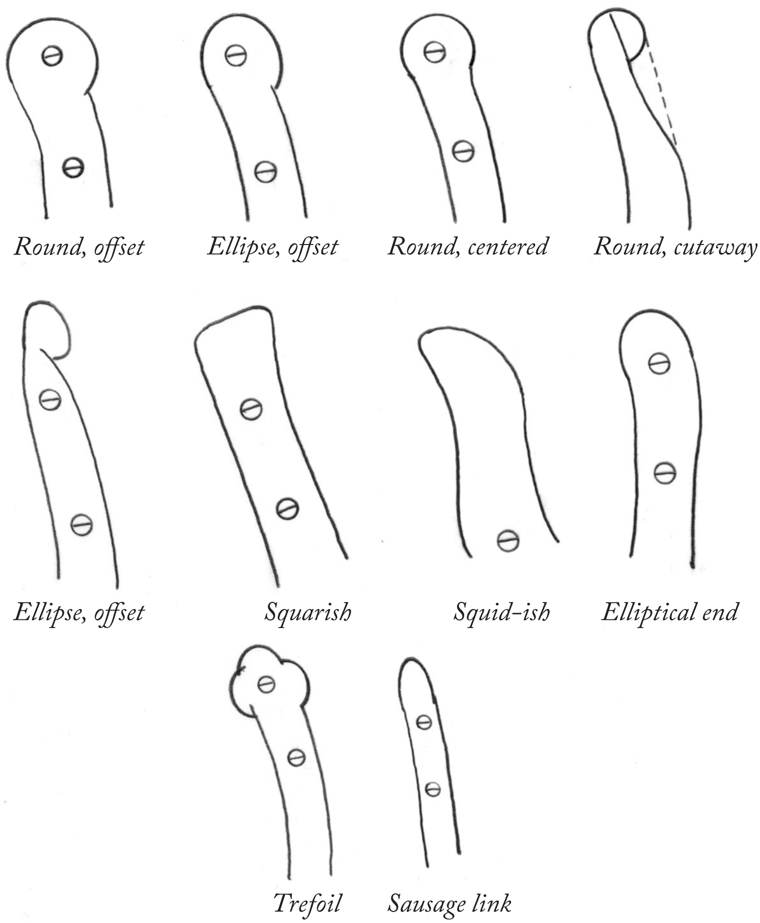
CHOOSE YOUR HANDS

The last thing to do before making the patterns for your arms is to decide what sort of "hands" the arms will have. The hands can be as simple as rounding over the corners of the arm pieces to make them more comfortable. Or the hands can be more elaborate.

After looking at a lot of stick chairs, I think the most common hand shape is for the arms to end with some sort of circle, partial circle or something elliptical. The second-most common hand shape is (probably) just rounding off the corners of the arms with a rasp. Some hands end at a bit of a point, or a little curve and a point.

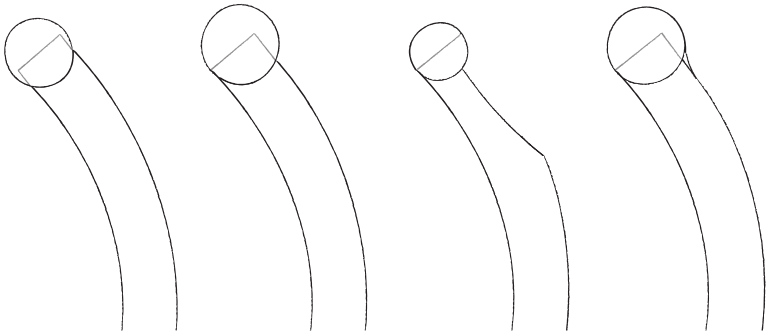
Forest chairs have far more elaborate hands, including carved bits that look like a bird's talons. They're impressive, but sometimes the ornamentation interferes with holding your drink.

Sometimes I draw my hands freehand. Sometimes I use a compass. Sometimes it's a bit of both. Look at old chairs. Draw what you see. And don't be satisfied with your first drawing. Force yourself to make



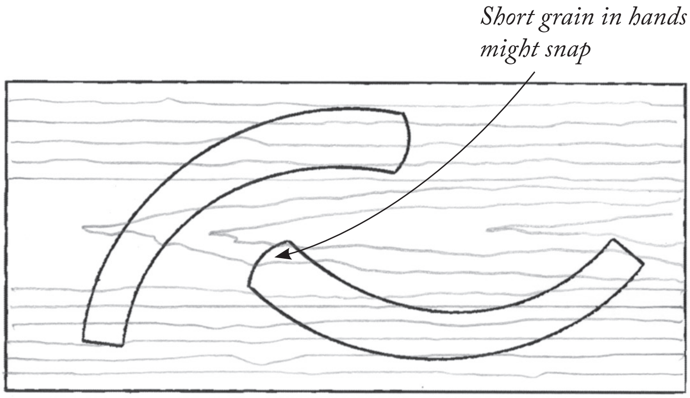
SOME BASIC HAND SHAPES

Many stick chairs have hands that have a portion of a circle or ellipse as part of their shape.



ROUND HANDS

Shown here is how I draw those hands. The centerpoint of the circle typically falls on the square end of the arm (shown in gray).



SHORT GRAIN AT THE JOINT

Keep the short grain near the head joint of the armbow, and the shoe will cover the short grain. Short grain in the hands can snap during assembly.

CLAMP FROM BOTH SIDES

When you glue a shoe to an armbow, the best practice is to clamp from both sides of the assembly. This prevents a gap from opening on one side.

two more. I might make five drawings or more. Sometimes getting the perfect hand shape requires a bit of luck.

MAKE PATTERNS

Now you can transfer all of your design decisions to patterns. I probably have about 50 arm patterns around my shop. I write notes all over them, and they serve as the foundation for future chairs. I might take an arm and alter its hand, or make the arm longer or wider. Having a pattern as a starting place makes my next design far easier.

To make my patterns, I use my yardstick as a trammel, plus compasses and straightedges to draw the armbow pieces full-size on cheap 5mm underlayment plywood. Once I create a shape I like, I cut it out and smooth its edges.

ASSEMBLE THE ARM (MINUS THE SHOE)

Now you can use your patterns to mark out the parts for your arms (except for the shoe). This is where beginners make mistakes. After all this work, it's easy to forget the primary edict of the arm: avoid short grain. If the parts of your arms have short grain, they need another piece glued on top (typically a shoe or the lapped joint in a mating arm) that reinforces the short grain.

The grain in the hands should be as straight as possible through the hands. The area of the arms that gets covered with the shoe can have considerable short grain. The shoe is there to reinforce it.

With the arm pieces cut (except for the shoe), I join the two or three pieces with glue (and/or screws) to make the completed arm.

ADD THE SHOE

After the arm is assembled, I decide if the armbow needs a shoe or not. The shoe, which is the functional and decorative cap on top of the armbow, has three jobs.

- It strengthens any other parts below it that might have short grain.
- It reinforces the chair's back sticks, which receive a lot of force.
- If properly placed and shaped, the shoe provides lumbar support.

The shoe can be 5/8" thick up to 1" thick. It is usually shaped at the ends to add some decoration. The part that touches the sitter's back is eased or rounded to add some comfort.

The shape of the shoe comes from the assembled arm itself. A shoe pattern isn't much help because the curve of the arm can change based on how much you had to plane the joints between the arm pieces.

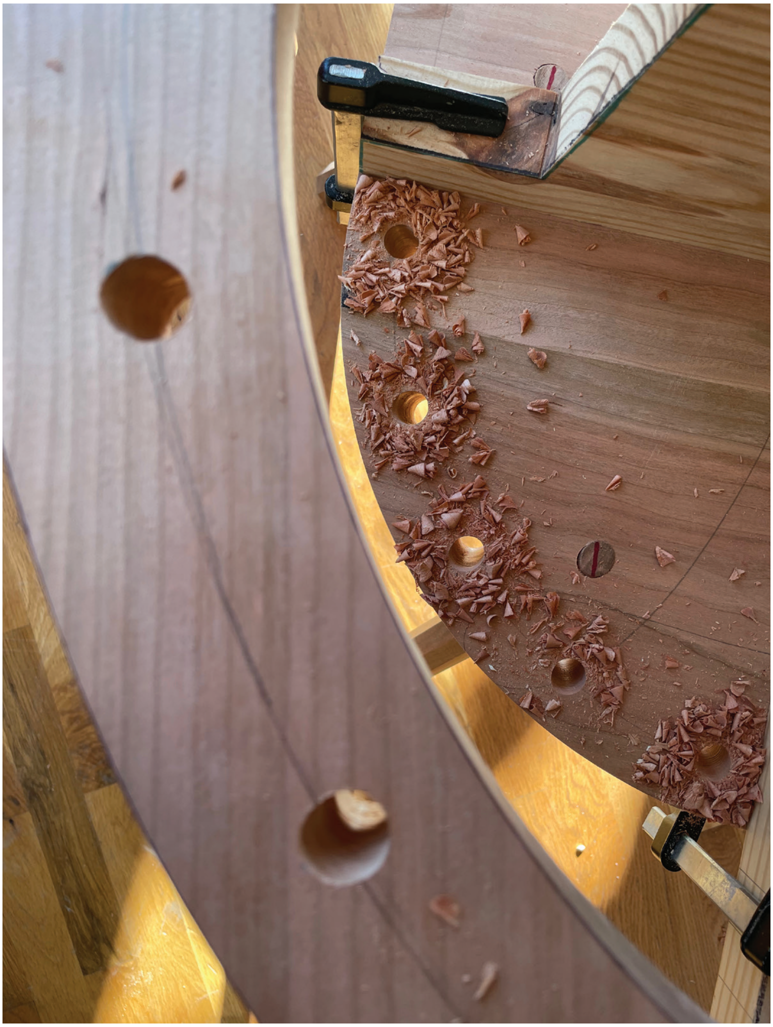
So I use the assembled arm to trace out the finished shoe for every chair. I might make a rough pattern for the shoe that helps me remember the spacing of the mortises for the sticks and the finished length of the shoe. But I don't use the pattern to make the real-deal shoe.

First clean up the top of the assembled arm, then glue the shoe in place on top of the arm. Be sure to put clamps on the inside and the outside of the arm to avoid gaps opening between the arm and shoe.

Once the glue is dry, fair all the arm pieces with spokeshaves, rasps or sanding. Your basic arm is complete. Don't go nuts shaping it now. First you are going to drill the mortises for the sticks. And saddle the seat. So hold off on an your arty impulses for now.

SIMPLE HANDS

This old-style hand is easy to make. The tip is a 1/2"-diameter circle. Then I joined that circle to the wider arm with freehand lines.



DON'T DESPAIR

Drilling the mortises for the sticks seems impossible without mad skills or an expensive jig. Luckily, you don't need either.

DRILL THE ARM & SEAT FOR STICKS

Drilling the mortises for the chair's sticks might seem as baffling as skydiving into a glass of water. What are the angles? How do I drill through both the arm and the seat so the mortises line up? Isn't there a Drill-O-Matic out there that I can buy to make this dirt simple? (Yes, there is.)

I had the same questions when I started making chairs.

The first time I did this operation was in a chairmaking class with David Fleming in Cobden, Ontario. How, I asked Fleming, do I line up the brace and auger bit at the correct compound angle to hit a target in the seat I cannot see?

Fleming put a small washer on the seat and aligned its center hole with the place I needed the auger bit to go. He tapped the washer with his finger.

I said: "I can't see the washer."

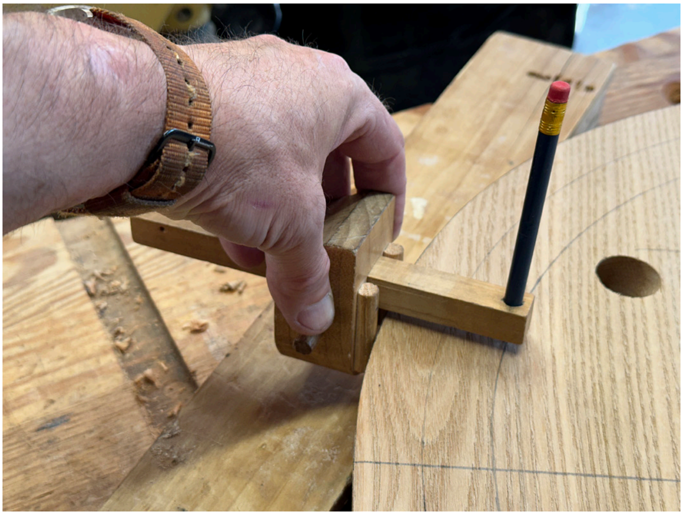
"Pretend you can see it," Fleming said. "Pretend the arm is invisible. Use the Force."

He wasn't wrong. Muscle memory makes chairmaking easier (after some practice). But it doesn't help a greenhorn. Luckily, there are simple tricks that help you get the process in your blood and bones.

LAY OUT THE SPINDLE DECK

Use a pencil to lay out the spindle deck, which is where the seat's saddle starts. This is (typically) about 2" in from the perimeter of the seat. The mortises in the seat are (also typically) about 1" from the perimeter. Mark a line for the mortises. If you are working from plans, mark the locations of the mortises on the seat using dividers or a ruler.

Now pencil lines on the armbow for the mortises. In general, these are centered on the width of the armbow – unless the armbow is narrow. If you have a narrow armbow that has been bent, then you should draw out the angle of the back sticks to figure out where the sticks should enter the armbow, especially with backs that lean 20° or so.



THE SPINDLE DECK

Pencil in the border between the spindle deck and the saddle. Then strike a second line for the mortises in the seat.

THE ARM-DRILLING JIGS

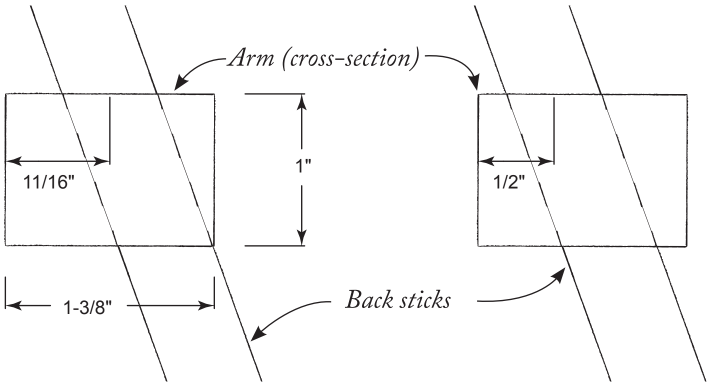
There are ways to drill the mortises for the sticks without the arm-drilling jigs, but you have to be certain that both the spacing of your sticks and the angle of your backrest are bang on. No matter how many times I've built a particular chair, I always clamp my arms above the seat using these jigs.

That's because many times I change my mind about how I want the sticks to be spaced. Perhaps I want the short sticks to rake forward or back. This "jig" – just two chunks of wood – lets me make changes to see what they will look like before I drill.

I make the jigs from 2x10 construction lumber. The longer front board clamps near the front of the seat to hold up the hands of the armbow. The smaller back board clamps to the rear of the seat and supports the back of the armbow.

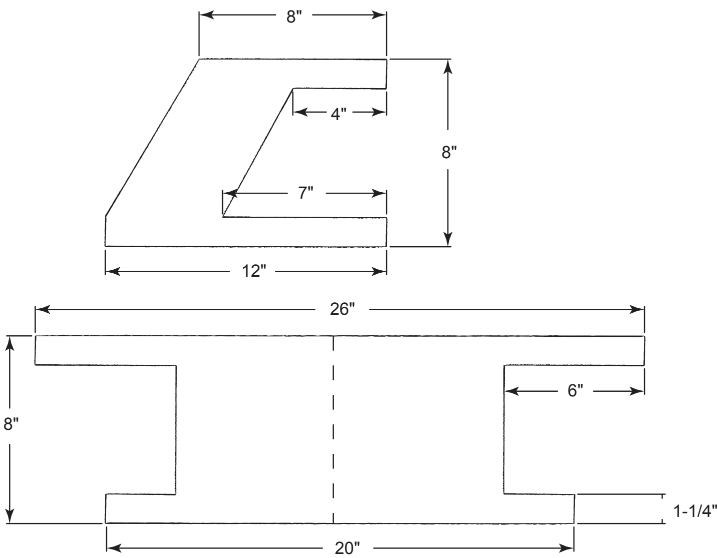
The width of the jigs represent how far above the seat your arm will sit. I usually use 8", though 9" is also common. Sometimes I use a 9"

DRILL THE ARM & SEAT



DRAW BEFORE YOU DRILL

With narrow arms, make sure the drill bit won't emerge in the wrong place, especially when using angles near 20° (shown here). The left image shows what happens when you center a 5/8" bit on the top of the arm. The image at right shows a better way. (You also could practice on scrap until you get it right.)



THE ARM-DRILLING JIG

I use these jigs for most every chair I build. They keep the armbow fully supported while I drill and don't get in the way of the drill bit during the process. And they are dirt simple.

MEANINGFUL MARKS

Here you can see the numbers and inch marks on the top edge of the front board. Plus centerlines that help position the arm in the correct position.

jig at the front and the 8" jig at the back – this tilts the armbow a bit. This tilt adds some motion to the chair's design, and it also can make it easier to drill mortises through a narrow armbow.

Cut the jig parts out on the band saw. Then draw some lines on the jigs to help guide you. On the front board draw:

• A centerline across its width on the faces and edges.

• Inch marks on the top edge of the jig. These marks start at the centerline and radiate out. These marks help you center the armbow on the jig.

On the back board draw:

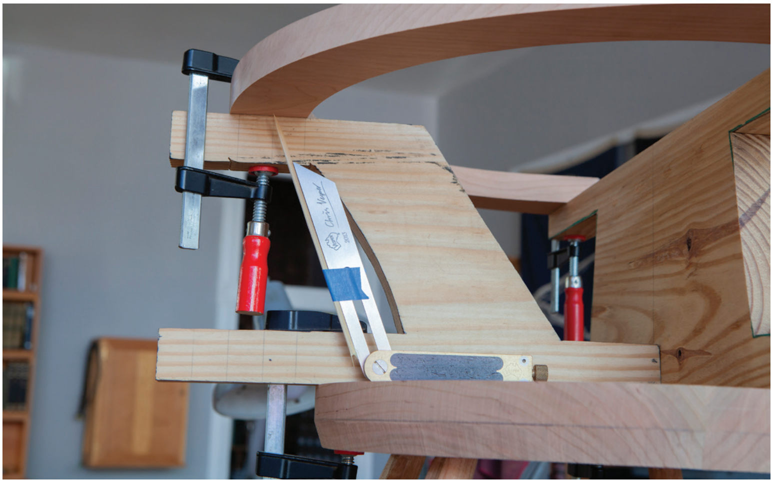
• Centerlines on the edges of the jig. One centerline where the jig touches the seat. One centerline where the jig touches the armbow.

• Inch marks on the top edge of the jig.

These marks help you position the jigs on the seat and the armbow on the jigs. Clamp the jigs to the seat. Then lay your armbow on the jigs.

LINED UP FOR DRILLING

The joint in this armbow touches the centerline of the rear board of the jig. The hands touch the same lines on the front board. The arm is clamped in place. Now all I need are some small backing boards and I'll be ready to drill.



SETTING THE BACK ANGLE

Decide how much you want your back to lean and set a sliding bevel to that angle. Place the bevel on the seat and use it to position the armbow correctly. Note that I have used a barbecue skewer to increase the reach of the sliding bevel.

WHERE TO PUT THE ARM?

Where the arm is positioned is critical to how the chair sits. The back sticks can lean anywhere from 8° to 20° on a chair that can be used for both dining and lounging. My favorite numbers are 8° for a formal dining chair, 14° for a typical dining/desk chair and 20° for a fireside chair that can also work at the table.

The backrest angle can be more extreme than 20°. A typical Irish Gibson chair has a 25°-30° lean, and it's fantastic for sitting and talking with a beer. When you see photos of the chair, it looks like an early dentist's chair. But it doesn't sit like that at all.

I position my armbow on the jigs by setting a sliding bevel to the desired backrest angle. Then I place it on the seat so the bevel's blade is directly over the pencil line for my mortises. If the tip of the sliding bevel doesn't reach the armbow, extend its reach by taping a barbecue skewer to its blade.

I move the arm until the sliding bevel points to where the sticks will emerge on the underside of the armbow. This is a little bit of a guess, but it certainly beats having to engineer it all on a computer.

LAYING OUT THE STICKS

The sticks are the heart of this chair form. How the sticks are spaced and their angles play an outsized role in how the chair looks (along with the rake and splay of the legs). The sticks can be upright, laid back or raked to pounce.

The method I use to space my sticks involves eyeballing and a little math. With a handful of barbecue skewers I temporarily stick the skewers to the arm using the putty that kids use to hang posters on their bedroom walls. A dab of putty on the arm is usually enough. When you get into more radical angles a little additional putty on the seat helps.

So where to begin? Typically, the mortises on the seat are equally spaced. A good place to start is to space them every 2-7/8" or 3".

The spacing of the mortises on the armbow varies. Usually, I start by spacing the back sticks that pass through the armbow's shoe with the same interval as on the seat. Then I move things around.

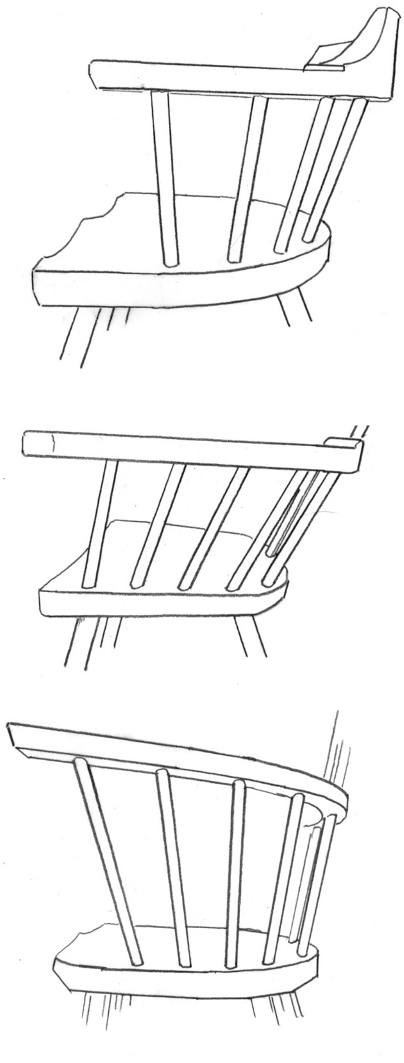
The short sticks can vary quite a bit. Here are some typical arrangements to consider.

• Space the short sticks so they go from leaning back to straight upright (90°) when you reach the front stick. This gives the chair a balanced look.

• Space the short sticks so they go from leaning back to leaning forward. I usually have the forward rake of the sticks match the forward rake of the front legs. Sometimes I will rake them even more (up to 15°) to add some forward motion to the chair. These sorts of chairs look ready to pounce on their prey.

• Space the short sticks so they continue to lean back like the back sticks. This gives the chair the appearance of speed, like the chair is in a wind tunnel.

I space the sticks by eye until I get something that looks good. Then I use dividers to look for a pattern to the spacing of the mortises in the arm. Do the short sticks accelerate 3/4" with each mortise? Do they jump from 2-7/8" spacing for the back sticks to 4" spacing for the short



THE MEANING OF THE LEANING

The short sticks can do a lot to the design of a chair. Sticks that move toward vertical say: stability. Sticks that lean back say: speed. Sticks that lean forward say: I'm gonna pounce.

STICK REHEARSAL

I check the spacing of my sticks when I make even the slightest changes to the arm or the seat. And when I design a new chair, I move the sticks about a lot and agonize over the spacing. Barbecue skewers and a little sticky putty make it an easy job.

sticks? Sometimes this involves rounding numbers up or down. It's a balance between what the eye sees and a mathematical progression. I seek to get both working – the eye and the math. But in the end, the eyes have it.

NEGATIVE SPACE

You can introduce negative space to the design by dropping out one or two short sticks on both sides of the armbow. This reduces the durability of the chair (a little), but it can create some punctuation or sep-

MISSING STICK

The negative space between the short sticks and the long sticks will absorb awkwardness that you couldn't resolve when spacing your short sticks. It also allows you to make a change in the angle or spacing of the short sticks that, thanks to the gap, won't look as sudden. And it lightens the chair's look.

aration between the back sticks and the short sticks. It's also a feature found on Welsh chairs.

Again, use skewers and sticky putty to visualize how this will look. After you have found the stick arrangement you like, mark the final mortise locations on the armbow and the seat.

WHY SPADE BITS?

After years of trials with bits, I recommend you start with spade bits for drilling the mortises through the arm and into the seat. The bits are cheap. They are easily modified and sharpened. They don't clog like a Forstner. And you can purchase them with an extra-long shaft. A typical 5/8" spade bit with an extra-long shaft will be 16" long overall. When chucked into a drill, you can easily drill through the armbow, then through the entire seat (if you wish).

The other option is to use a standard spade bit with a bit extension.

The downside to spade bits is that most cause significant blowout as they exit. So you need backing blocks under the armbow to reduce the splintering. I usually use scraps of 5mm ply that I've cut to 2" wide and 4" long. Clamp them to the armbow with small F-style clamps.

If I can get my hands on them, I'll sometimes use the Japanese 16mm bits that drill a clean exit hole (one brand is Star M F-type bits). These bits are more expensive and can be difficult to find. They have a hex shank, and you'll need to use them with a bit extender. Also, these bits heat up quickly, so I recommend you cool them down in a cup of water between each hole. (If you don't cool them, they will dull in short order.)

DRILL THE MORTISES

With everything laid out and your first backing block in place, it's time to drill. I usually start with the back sticks.

Just like with drilling the stretchers, figuring out where to put your drill is a matter of moving the drill left-to-right and up-and-down.

Place the tip of the spade on the mortise location on the armbow. Sight down the drill, the spade bit, the armbow and the mortise in the seat. You should be able to move the drill left and right until all those points are in line.

The tricky part – the part you cannot easily see – is if you have the drill positioned properly forward or back. After you make a few chairs,

WHAT I SEE

This is what the driller sees when lining up the drill bit with the mortises. The long bit should look like it's pointed right at the mortise in the seat.

USING A SPOTTER (AKA BORING BUDDY)

The spotter sits at 90° to where the driller is facing. The driller can see if he is off left-to-right. The spotter can see if he is off front-to-back. The spotter can hold up a straight stick at the angle that joins the two mortises (right). Then she can call out if the driller needs to move forward or back.

you will be able to "feel 20°." But if this is your first chair, I recommend you get a spotter, a mirror or a laser to assist you.

THE SPOTTER & THE 'SIGHTING STICK'

A spotter is a person who sits at 90° to where you are standing. The spotter can see if you need to move the bit forward or back.

If the spotter is a family member or dude off the street, you can help them by giving them a "sighting stick." A sighting stick is anything that has a long straight line – a dowel or yardstick works well.

The spotter holds the stick up and visually connects the mortise location on the seat with the mortise location on the arm. They hold that position. Then they can tell you if you need to tip the drill forward or back so you are lined up with their stick.

KEEP IT CENTERED

After drilling through the arm, drill into the seat. Use your fingers as a simple "bushing" to keep the bit's shaft centered in the hole.

Then you drill and listen to their instructions: Move forward. Move back. And you are in charge of left-to-right.

After you drill through the armbow, the spotter takes a break. You place the tip of the spade bit on the mortise location on the seat. Drill down. You can drill all the way through the seat if you like (it's traditional). Or you can make a blind mortise. You can grind or file a notch in the bit that tells you when to stop. Or you can use the structure of the bit to guide you (example: Stop drilling when the taper on the body of the spade bit touches the seat).

Most spade bits measure 1-3/4" from the tip to where they taper to the bit's shaft. That's a good stopping point if your seat is thicker than 1-3/4". As you drill the seat, use your fingers to keep the bit's shaft in the middle of the mortise through the arm.

After you have drilled your first set of mortises, put a long dowel or other scrap through them to stand in as a stick to guide you on your next set of mortises. The stand-in stick will be tilted at the right angle, which will make it easier and faster to find the right angle for the next set of mortises through the arm and seat.

BY MIRROR

Instead of a person, place a mirror at 90° to where you are standing. You can look at the mirror and see if you need to move the drill forward or back. Drill through the arm and seat as described above.

BY LASER

If you own a laser level and a tripod, that can be your spotter. Set the laser at 90° to your position and angle it so that the laser line joins the mortise in the seat with the mortise in the arm.

When you start to drill, you can move the bit forward and back until the laser shines up its shaft. This method is accurate.

BLIND OR THROUGH-MORTISES?

As mentioned above, the mortises in the seat can be blind or through. Both types appear in old chairs. Blind mortises have shorter tenons, which are easier to make. The underside of the chair is a little tidier. And you won't have a shower of glue to deal with at assembly.

Through-mortises are certainly more durable – the tenons are lon-

ASSIST THE EYES

If you don't have a spotter, mounting a cheap laser level on a tripod works well. Position the laser 90° to the driller. Tilt the laser to match the drilling angle. You do this by aligning the laser so it touches the mortise on the arm and the mortise on the seat.

THROUGH-MORTISES

Many chairs use through-mortises in the seat. This adds some gluing surface, so the sticks are less likely to come loose over time. It's also easier to repair a stick in a through-mortise. The downside is that you can have some significant splintering on the underside if you don't back up the hole with scrap (or use a bit designed for a clean exit).

ger. They are easier to repair (should they ever require it). And they are simpler. Just drill until you are all the way through the seat.

Should you wedge the tenons below the seat? In looking at old chairs, most of them are not wedged. They are just glued. But some are wedged. So make yourself happy.

With the holes drilled, turn your attention to making the sticks.

TROUBLESHOOTING

Many beginning chairmakers despair when their drilling goes astray. This is an emotional part of the process because it seems like you are teetering on the verge of making either a chair or a bonfire.

The good news is that there are ways to fix a mis-drilled mortise. The two following strategies are used when the hole is so far off that

REAM TO REPAIR

If the chair won't go together because the mortises in the arms are off, use your tapered reamer to open the mortises on the underside of the armbow. This allows the sticks to move and (usually) get into their mortises in the seat.

the chair won't come together. (Minor misalignments of mortises are OK and can add some tension to your assembly, which isn't all bad.)

The first repair is the most common one I perform on student chairs. I'll use a tapered reamer to open up the mortise on the underside of the armbow. Making the mortise slightly cone-shaped along part of its length usually allows students to pull an errant stick into the seat.

Yes, this weakens the joint, but if it's the difference between "chair" or "no chair," I'll opt for "chair" every time.

If you attempt this repair, take it slow with the reamer. I don't like to ream the entire mortise. I start by reaming one-third of it from below, then testing it to see if it works. If it doesn't, I ream one-half the mortise and test again.

The second repair is more radical. If the back sticks that pass through the shoe are way off, I first saw off the shoe and plane the armbow flat.

Then I plug the holes in the armbow and glue on a new shoe. Then the student can re-drill the mortises through the shoe (or I do it for them if they are really rattled).

The other problem you will encounter when drilling the mortises in the armbow is blowing out the grain in the arm with your drill bit. This is usually caused by using too much downward pressure with the drill, forgetting to add a backing board under the arm, or your bit going astray.

If the blown-out grain is minor, you can sometimes plane away the damage on the underside of the arm. If it's more significant than that, I'll make the repair after assembling the chair. I'll fill the scar with Durham's Rock Hard Water Putty and sand the repair flush with the arm. Then I'll start picking out paint colors for the chair.

STICKS FOR STRENGTH

Without sticks, your chair is just a stool. Whether you use dowels or rived wood, make sure that the grain does not run out. The grain can be a little wavy (as in the stick at right) as long as it doesn't run out.

MAKE & SHAPE THE STICKS

I think of a chair's sticks as being like a mammal's ribcage. The thin members must be flexible, strong and well-spaced to support and protect the sitter. There are lots of ways to do this, from riving out your stock with a froe and a drawknife, to sawing them out to using well-chosen dowels from the home center.

In the end, all that matters is that the grain is straight, the wood is dry and the sticks are the right size.

DIMENSIONS, SHAPES & MOISTURE

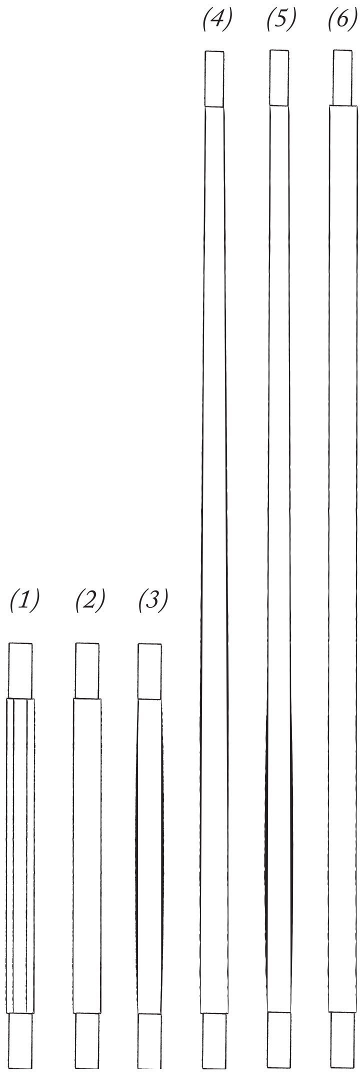
Sticks can vary in diameter quite a bit. Many antique and modern stick chairs have sticks between 5/8" and 3/4" in diameter (with 5/8"-diameter tenons). Some older Welsh stick chairs I've examined have sticks that are heavier: between 3/4" and 7/8" in diameter (with 3/4"-diameter tenons). Chairs with fewer sticks, such as some Irish chairs, can have sticks that are between 1" and 1-1/4" in diameter (with 3/4"- or 1"-diameter tenons).

The other thing to consider is the shape of the stick. Sticks can be a straight-sided cylinder – like a dowel. This is quite common. I have spent hours enlarging photographs of chairs (and looking at them in the wild) and found lots of dead-straight sticks, particularly the short sticks that run between the seat and the arm.

Some chairs have sticks with a subtle bulge along their length, called entasis. Let me repeat "subtle" so you don't make the same mistake I did. When I first started making sticks with entasis, they looked like a garter snake that had swallowed a corn dog. The difference between the thin and thick parts was dramatic – 3/8" or so. Today my sticks might be 3/4" or 11/16" in the middle and 5/8" at the ends.

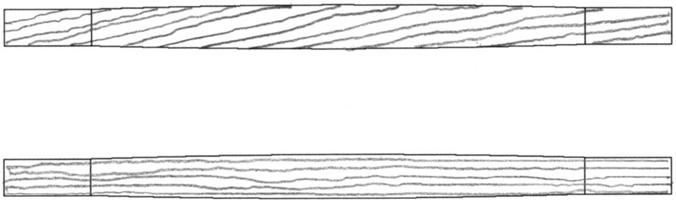
Other shapes include a double-tapered octagon, or a literal stick – right from the hedge.

The long sticks at the back of a chair can have a slightly more complicated shape. Under the chair's arm, a long stick might have a lit-



SOME STICK SHAPES

These are all common stick shapes: (1) Octagonal (2) A straight-sided cylinder (3) A short stick with entasis (4) A long stick that is a cylinder at the base that tapers above the armbow (5) A long stick with entasis at the base with a taper above the armbow (6) A straight-sided cylinder (a dowel) with no taper.



SHORT-GRAIN TROUBLE

The short grain in the top stick will snap in service. The lower stick will survive incredible abuse.

tle entasis. But above the arm, the stick is pretty straight as it heads toward the comb. Perhaps even tapered up to the comb.

My typical long sticks start with 3/4"-diameter stock. Below the arm, the stick tapers to 5/8" at the seat and 5/8" under the arm. Above the arm, the stick is usually a 5/8" cylinder.

But really, almost anything goes with sticks. The above dimensions and shapes are places to begin. After you see a lot of original chairs you will form your own ideas about what makes a good stick.

No matter what the shape, the sticks, stretchers and legs should be the driest components in a chair. Some people remove all the water from their sticks by keeping them in a kiln. After assembly, the sticks take on moisture and swell, locking the joint.

You don't have to do this. If the sticks are at equilibrium moisture content with your shop, then things will go fine. There are other ways to get the joints tight. (For example, you can make your tenons a little oversized and compress them before assembly. More on this later.)

STRAIGHT GRAIN

Because the sticks are the thinnest component in the chair, use the straightest-grain stuff on hand to ensure the grain runs continuously through the stick's length. Short grain in a stick can be a disaster – it can snap under normal use.

RIGHTEOUS DOWELS

Dowels can make fine sticks. As long as the grain is dead-straight, then it will not snap in service. I've built dozens of chairs with dowel stock. And while dowels offer some challenges (color, for the most part), you shouldn't be ashamed to use them.

And if you ever wonder if a stick is strong enough, hit it with a sledgehammer as described earlier. That will give you an answer in seconds instead of years.

ON DOWELS

I have built dozens of chairs using oak dowels from the home center. Grain is grain. If you can find dowels with dead-straight grain, they will work fine. It can be expensive and time-consuming to gather enough dowels for your chairs, but it is do-able.

When I taught beginning chairmaking and used dowels for the chairs, I had to collect hundreds of dowels. So anytime I was near a hardware store I would stop. I'd grab all the 5/8" oak dowels in the store and put them on the floor to examine them. I got good at spotting the straight-grained ones. Each chair needed seven dowels (about $25 in material). Every home center I visited yielded about six usable dowels and four confused stares from customers.

It takes a while to train your eye to see the grain, but once you get it, the good dowels jump out at a glance.

Some caveats: Matching the color on dowels is a puzzle. Some will be red oak (and there are several species of red oak that end up in dowel factories), and a few will be white oak. Usually, I recommend people paint a chair built with dowels. The other option is to put the finish on the dowels before you select ones for your chair. That way you can pick dowels that are close in color.

Second caveat: Some dowels will be oval in cross-section because they were wettish when they were run through the dowel-making machine. Here's how I deal with that: I make the mortises for these oval dowels a little undersized, then I compress the dowels until they fit the undersized mortise.

Final dowel caveat (I promise): Most dowels are sanded enough for paint but not enough for a clear finish. If the chair will get a clear finish, scrape them to clean them up.

SAWING OUT STRAIGHT-GRAINED STICKS

I saw out my sticks on the band saw much like I do when making legs. I start with 8/4 stock that has dead-straight grain along the board's edges. Each blank for my sticks is 27" long. That length allows me to cut one long stick or two short sticks from the blank with ease.

Then I make a saw cut on the face of the blanks that is dead parallel to the board's face grain. From there, I can rip out straight 3/4" x 3/4" sticks (or larger). And because I am using 8/4 stock, I usually get a lot of sticks. A board that is 1-3/4" x 8" x 27" will provide all the sticks I need for a typical comb-back chair (with sticks left over).

I slice up the board into 3/4" x 3/4" x 27" lengths, then I pull out the best sticks for the long back sticks and leave them at full length (27"). Then I cut the rest into 12-1/2"-long short sticks. This is an ideal length for all the short sticks in chairs in this book.

RIVING STRAIGHT STICKS

Riving narrow, long stuff is trickier than riving legs. When I rive out sticks from a kiln-dried board I shoot for 1" x 1" chunks. Then I shave those to 3/4" squares. I have found that sawing sticks gives me a better yield than riving them.

SPLIT YOUR STICKS

You don't have to saw your sticks out. With straight-grained wood, you can split them out with a froe and a mallet. Aim to make them oversized in case the grain runs out a bit.

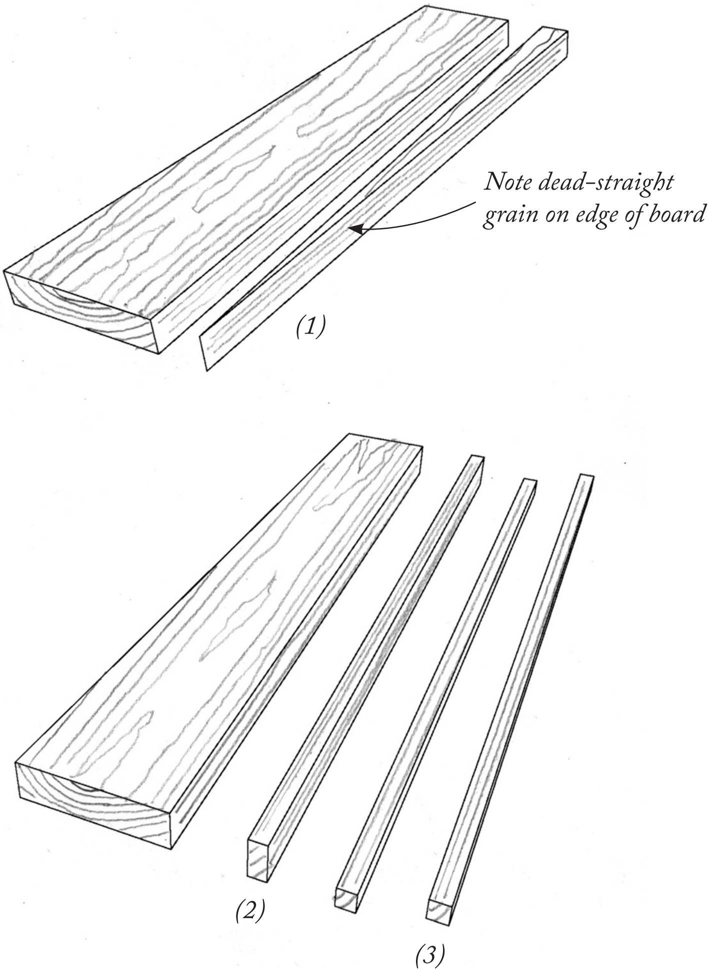
I do like to combine riving and sawing at times. When I have a board with grain that is straight along its edges but angled on its faces, I rive a chunk off one edge. This shows exactly how the grain is running through the board. Then I saw out my sticks using the riven edge as a guide.

STICKS WITH A DOWEL-MAKING TOOL

After denuding the tri-state of 5/8" dowels for a few classes, I still needed to make hundreds of sticks for future classes. I didn't want to visit a new Metropolitan Statistical Area, so I bought a Veritas Dowel Maker.

This clever machine makes dowels of almost any size. You saw out straight, square stock and chuck it into a socket (included) in an electric drill. Then you spin it through the dowel maker. Two cutters shave the square stick to round with a fairly clean surface finish.

The machine is expensive – especially if you just want to make 5/8" sticks. So I devised a hack that allows me to make 5/8" sticks for about



MAKE STRAIGHT STICKS

Here's how I get sticks from a lumberyard board. First, choose 8/4 stock that has dead-straight grain on the board's edges. Then (1) saw or split off a wedge of stock to establish a line of dead-straight grain on the face of the board. Then (2) saw or split off blanks for the sticks. And (3) split or saw these in half to make two straight sticks.

ROLL YOUR OWN

The Veritas Dowel Maker lets you pick the dead-straight stock for your sticks. After the jig is tuned up, you can make all the sticks for a chair in about 15 minutes.

STICKS ON THE CHEAP(ER)

You can convert a 5/8" tapered tenon cutter (left) to a 5/8" dowel maker by installing a cutter with a curved edge as shown.

20 percent the cost of the dowel maker. First, buy the Veritas 5/8" Tapered Tenon Cutter. To cut tapered tenons, this tool has a straight blade. But if you grind a 7" radius on the tool's blade, the tool will cut a perfect 5/8"-diameter stick.

I got the idea from Lee Valley, which sells dowel/tenon cutters for sticks that are 1/2" and smaller.

So I took a blade from one of the smaller tenon cutters, dropped it into the body of the Veritas 5/8" Tapered Tenon Cutter, and bam. I can now make 5/8" sticks all day long for a fraction of the price of the Veritas Dowel Maker. I drive the 3/4" x 3/4" sticks through the modified Tapered Tenon Cutter with a 3/4" socket and a drill.

The only "problem" with my hack is that the tool gets hot when you drive material through the tool with an electric drill. After two or three sticks, I dunk the entire tool in water to cool it. I then wipe it with some oil and get back to work.

A FAST WAY TO MAKE STICKS

I make chairs for sale, so speed is important. So here's an overview of how I make short and long sticks in a hurry.

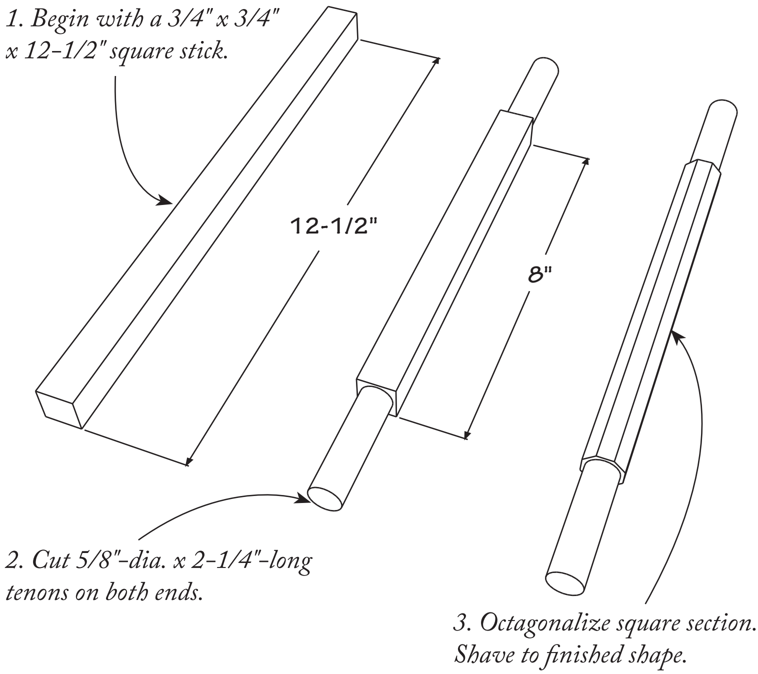
All my short sticks are 12-1/2" long. This length allows me to use one of these short sticks for multiple chair designs. Short sticks have a 2-1/4"-long tenon on both ends with an 8"-long straight section between. So I first tenon both ends of the short stick with a Veritas Power Tenon cutter (I use a 5/8" tenon cutter for 3/4" sticks and a 3/4" tenon cutter for thicker sticks).

Then I octagonalize the square section of the stick between the tenons. I do this on the band saw or with a jack plane. Finally, I shape that middle section to whatever shape I want for the chair: a cylinder, a cylinder with entasis, a double-taper etc.

The long sticks are more complex. First I make a bold ink or pencil mark on all the 27"-long sticks that's about 10" from one end of the stick. Then I chuck that square 3/4" stick into a 3/4" four-point socket chucked into an electric drill. (Note: You can use any 3/4" socket, but a four-point socket is more reliable when spinning square sticks.)

I use the drill to spin the stick through my dowel-making tool (there are many options out there besides the ones mentioned here). When the pencil mark enters the dowel-making tool, I stop the drill.

Next, I cut a 2-1/4"-long tenon on the square end of the stick using



MAKE A SHORT STICK

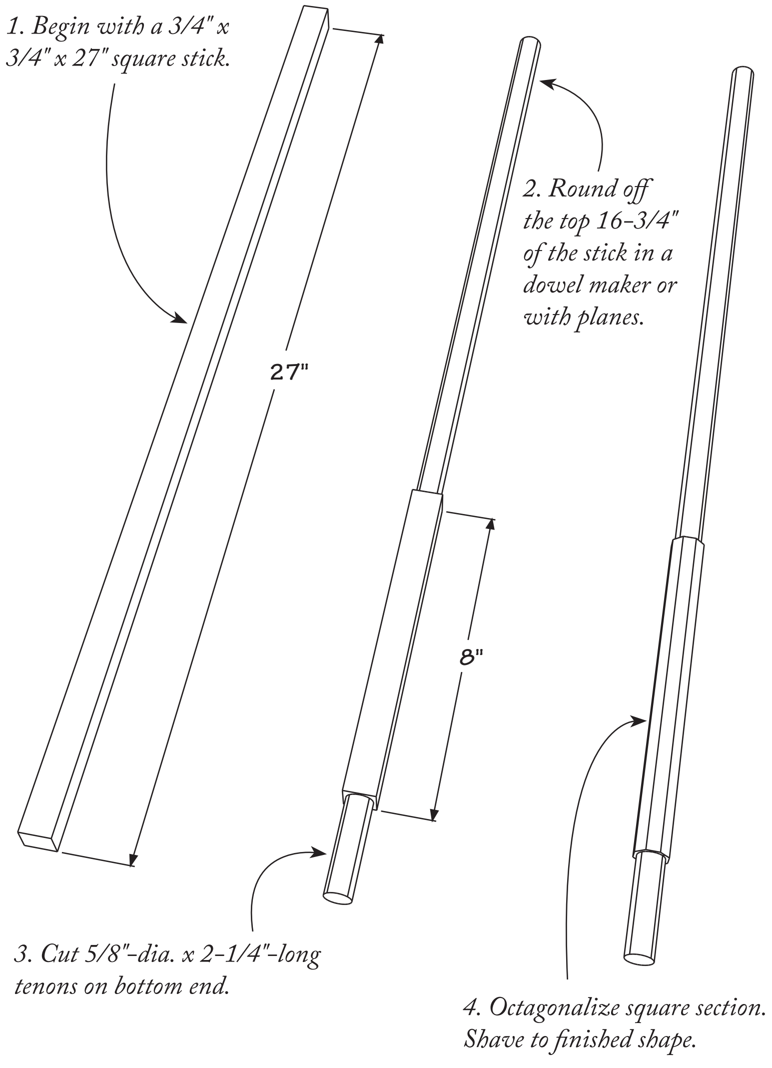
The steps to tenoning and shaping a short stick.

the Veritas Power Tenon cutter. Finally, I octagonalize and shape the entire stick to shape with a plane.

MAKE TENONS, THEN SHAVE THE STICKS

So let's talk first in detail about making tenons on sticks. I prefer to cut my tenons with a 5/8" power tenon cutter set to make a 2-1/4"-long tenon. The tenon cutter makes a tenon the perfect diameter and length. The tool is compact and portable. And it doesn't require a lathe – just a drill or a brace.

How do I get perfectly fit tenons? I start with a dummy stick – usually a stick I rejected because of its short grain. I cut a tenon on one end and test it in the mortises in the seat. If it is too loose, I adjust the tenon



MAKE A LONG STICK

The steps to tenoning and shaping a typical long stick.

ROUND TENONS ON SQUARE STICKS

Level the stick in your vise. Otherwise, the tenon will be offset from the center of the stick. In extreme cases, the tenon might be out of line with the stick. If your tenons are consistently angled weird, try moving the stick up or down in the vise until you find the sweet spot for your stance.

cutter. If it goes in smoothly, I still think that's too loose. What you want is for the stick to barely enter the hole – squeaky tight.

Then, before assembly, I compress the sticks slightly with soft-jaw pliers. In soft woods, such as walnut and cherry, it's easy to over-compress the tenon. So take it easy at first. Once the compressed tenon goes into the mortise smoothly, you are golden.

When the water-based glue hits the tenon it will swell in the mortise, locking things up.

Cutting the tenons on the sticks is exactly like cutting the tenons on the chair's stretchers and legs. All the tips and tricks mentioned before apply. First level the stick in your vise. Secure the drill against your body by any means possible. Press the mouth of the tenon cutter against the stick and use its bubble level to make sure it's level. Then

STICKS IN PROCESS

Here's a batch of sticks for two chairs. For this batch, I octagonalized these short sticks before tenoning them. This is a little slower, but it works.

PRESS FIT

You can get your tenons fitting exactly how you want them with soft-jawed pliers. When the wet glue hits the tenon, it will expand, making the joint even better.

SHAVE DOWN TO THE TENON

Use tapering cuts to shave each end of the stick down to the tenon at the end. I usually leave a tiny shoulder to prevent the stick from going deeper into the mortise than planned.

you cut the tenon with confidence.

Short sticks need two tenons – one for the seat and one for the arm. Long sticks need only one tenon at the start – the tenon into the seat. You'll shave the tenon for the comb (if necessary).

SHAVE STICKS WITH HANDPLANES

With the tenons cut on the short sticks and long sticks, you octagonalize their straight sections. Then shape them with a plane at a workbench. No shaving horse required.

I always warm up by shaving the short sticks. They're fast and easy. I use a block plane with its mouth set quite tight, which reduces tearout. I work against a stop. I press the stick against the stop and shave half of it down.

To make a stick round, shave the arrises (aka the corners) first. First

A QUICK SHAVE

It takes about five minutes with a block plane to turn an octagonal stick into a shapely stick with entasis.

shave an arris, which will create two other arrises. Shave those down. Rotate the stick. Do this over and over and the stick will become round.

The other thing you are doing as you shave the stick round is you are tapering it down to the tenon. You do this by taking your first stroke near the tenon, then taking a second stroke a few inches back. Then take a final stroke along two-thirds of the short stick.

It won't take long, and soon half the stick will be tapered and round. Flip the stick end-over-end and repeat.

You also can make the stick faceted by tapering the flats of the octagon down to the tenons.

If the mouth of your plane is set tight, you shouldn't see much tear-out in the stick. If you get some, turn the stick around and plane it out.

Important tip: Do not shave away the shoulder of the tenon. The shoulder is what stops the tenon as it enters the arm or the seat. You don't need to leave a lot of shoulder; even a tiny shoulder is strong.

SHAVE THE SQUARE PARTS
After rounding and tenoning a long stick, then you can plane the square section to an octagon (or round).

SHAVE THE LONG STICKS

When shaving long sticks, I begin by octagonalizing the square section, then I shape them with a block plane.

The process is similar to shaving a short stick. One hand holds the stick and presses it against a stop. The other hand skews and pushes the block plane. The weight of the plane keeps the tool in the cut.

With your off-hand, grab the long stick directly above its tenon. Your hand acts as a stop, protecting the bottom of the stick from the plane. The other thing your off-hand does is help support the stick from below. As the stick gets thinner, it becomes more flexible. The stick will flex, and you won't be able to take a cut in the middle of it.

As you work, use the wrist of your off-hand to flex the stick upward a bit. It doesn't take much effort.

The goal is to make the top section of the stick into a 5/8" dowel and

TAPER THE TRANSITION

On the long sticks, plane down the transitional area between the octagonal and round sections with short and aggressive strokes.

PLANING THE ROUND PART

After you plane away the transition between octagonal and round, plane the top part of the stick with every stroke.

leave the lower part octagonal to shape with entasis – like the short sticks.

To round off the top part, here's what I do. Start the block plane up against my off-hand. I skew it. And I take a cut that is 5" or 6" long in the area where the stick changes shape from an octagon to a cylinder. I work this ares alone all around the stick until I've tapered the octagonal section down to the round section.

When that taper is complete, then I shave the stick's entire length above my hand, removing tool marks and tearing. I do this all around the stick until the stick above my hand is clean and smooth.

Then test the stick in your armbow. When the stick goes into the armbow so that it sticks where it is supposed to (usually protruding about 8", plus the tenon) then stop planing the top part of the long stick. Turn the stick around and taper the bottom of the stick with your block plane. Blend in the octagon with the tenon, leaving a shoulder like you did with the short sticks.

Do this for all your long sticks and you are done.

ALTERNATE TOOLS: SCRAPERS, CHAIR DEVILS, SANDPAPER

There are lots of ways to get the sticks clear of tear-out. There also are lots of ways to make your sticks lumpy.

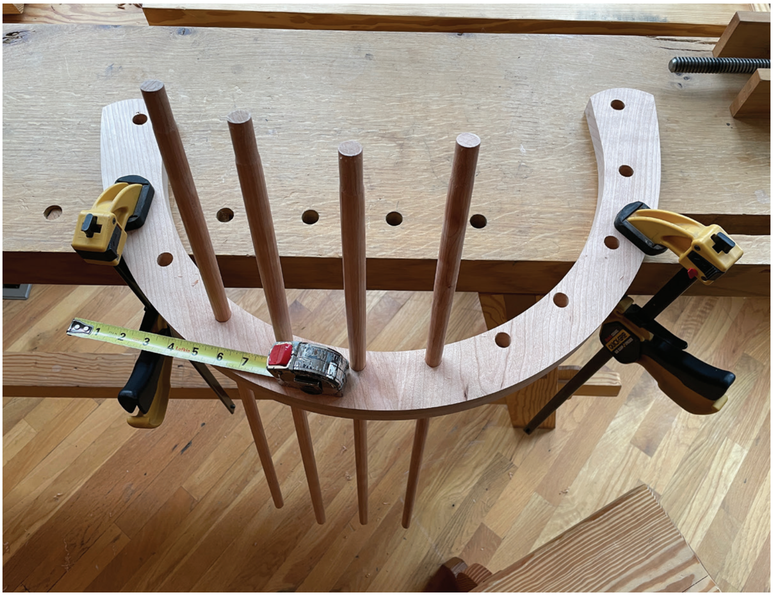
A card scraper can remove small bits of tear-out, but if the wood is ring-porous, you will find the scraper can make the stick lumpy. It will cut more deeply in the soft parts, leaving the hard parts. Ergo: lumps. With ring-porous woods, I prefer a tool that has a sole. The sole ensures the cutter removes the high spots.

A chair devil (sometimes called a gunstock scraper) looks like a spokeshave that has a card scraper as the blade. And that's a fair description of the tool. You sharpen it like a card scraper, with a hook that does the cutting. The sole of the tool helps prevent your sticks from getting lumpy.

At times, sanding your sticks is your only option. Wrap a cork sanding block with abrasive to avoid making your sticks lumpy.

KERF & COMPRESS THE TENONS

If you are going to wedge your tenons at assembly time, it's best to compress the tenons and cut any kerfs in the stick now so you don't forget when the glue bottle is out, the clock is ticking and your IQ has



HOW YOU KNOW YOU ARE DONE
Clamp your armbow upside down on a bench. Test the long sticks in the holes until they seat at the correct spot – usually 8" + the tenon.

dropped.

For sticks, I usually use a fine saw to cut the kerf, usually a dovetail saw. I kerf my sticks about two-thirds the length of the tenon. If the tenons are still too girth-y to go into their mortises, use a handsaw or a band saw to make a wider kerf.

After you have finished your sticks, keep them safe. Don't let them get knocked around by other chair parts. I keep mine on a padded moving blanket until it's time to put the chair together. If this is your first chair, you probably should try to dry-fit all the parts together. This will give you a feel for how tight the joints are and how much "umph" it takes to pull the chair together. It can be shocking.

One of the challenges with dry-fitting sticks is they can get stuck in the seat if the tenons are too tight. In time, you'll learn what is a good fit and what is too tight. You can practice with a scrap tenon and

SCRAPING TEAR-OUT

If you cannot get your sticks clean of tear-out with the plane, a card scraper (left) or a chair devil (a scraping tool) can finish the job. The sole of the chair devil leaves a flatter surface when you have a lot of material to remove.

mortise. Make the tenon fit looser by squeezing the tenon with plastic-jawed pliers. If you go too far, you can tighten the joint by wrapping the tenon with a plane shaving.

If a stick gets completely stuck, wrap the stick with a rag and wrench it out using pliers. In extreme cases you might have to saw the stuck stick flush and re-drill the mortise into the seat.

With the sticks complete, it's time for the last big operation before assembly: shaping the seat. This can take a few hours – or it can be over in an instant.

THE RESULT

The sticks play an outsized role in the appearance of a stick chair. Entasis and facets make a huge difference. Well, that's what I tell myself when my brain says: You could have just used dowels and been done a lot faster.

DON'T MAKE A CLOCK OUT OF IT

When I started chairmaking, I thought my saddles would never look nice until I found the magic sequences of cuts. That sequence doesn't exist. You just have to make a few seats and your hands will figure it out.

SADDLE THE SEAT

I saddle my seats after all the joinery is cut in both the seat and the arms. I don't want to invest time in saddling until I know the chair is not headed for the firewood pile.

But first it's good to ask: Do you have to saddle the seat?

The majority of vernacular chairs I've studied have little or no saddle. They are flat boards with a little rounding on the front edge of the seat. To many people, flat seats look uncomfortable. Are they?

Not really. Especially if you sit in them correctly.

Vernacular chairs could be covered with sheepskins or blankets. Or they had a cushion on the seat or tied to the backrest. In fact, a long-time student of these chairs suggests that the wooden parts of these chairs were rarely seen in the cold months because they were covered in animal skins and wool blankets. In other words, stick chairs are like the interior framework of a traditional upholstered chair.

So consider this: Perhaps we are going to a lot of trouble to make something in wood that wasn't seen all that much.

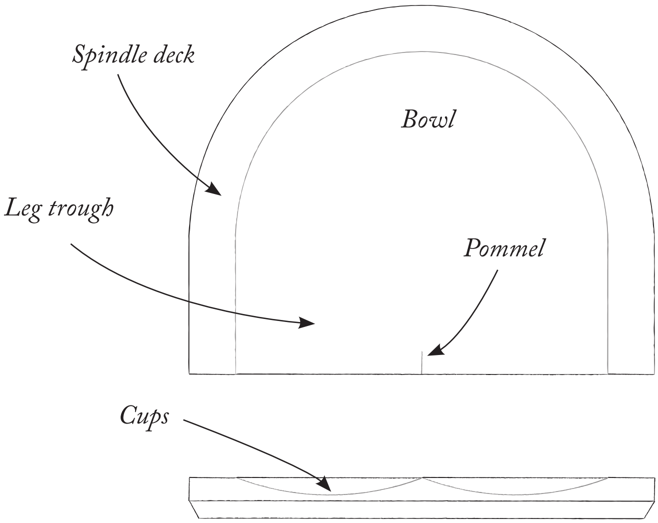
OK, maybe don't think that.

Even so, I know one thing: Customers prefer saddled seats. And from a visual perspective, I agree. Saddling is more attractive than a flat board. It implies that extra effort went into the chair. The saddle also highlights how the chair's parts reflect the parts of the human body: legs, arms, hands and seat. These parts mirror the shape of our bodies. And human butts (well, most of them) are curvy.

I will say that saddling a seat with deep valleys is unnecessary and can reduce a chair's comfort. A deep saddle can restrict a sitter's movement and become uncomfortable. I also contend that a deep saddle looks wrong on a vernacular chair, like a weasel in a track suit.

I think the ideal middle ground is a shallow saddle – about 1/2" deep. This saddle looks attractive enough to show you care. And it won't restrict a sitter's movement.

You should also know that the saddle is not the only thing that



PENCIL LINES

Here you can see the spindle deck, the pommel and the 3/4"-deep cups on the front edge of the seat. These lines can get smudged during saddling, so you might need to redraw them as you work.

makes a chair comfortable or uncomfortable. Here are some other factors: the tilt of the seat from front to back, its height from the floor, plus the curve, angle and height of the chair's backrest. (We'll talk more about these factors in the chapter on chair design.)

Last tip on saddling here (and I know I'm repeating myself): Use quartersawn boards for your seat when possible. It's much easier to saddle than other cuts of wood.

LAY OUT THE SPINDLE DECK & POMMEL

The first step is to lay out the saddle in pencil. You should have marked out the spindle deck when you drilled the mortises in the seat. Your goal is to keep the scooping tools on the inside of the pencil line. Tools with flat soles (like your smoothing plane) work on the outside on the flat spindle deck.

There are alternatives to working to a pencil line. In some of the

A SHARP LINE

A router, a template and a bearing-guided bit is a sharp way to delineate the saddle from the spindle deck. Once you make the pattern, it's a five-minute operation.

photos in this chapter, you'll see I cut a shallow rabbet to demarcate the saddle from the spindle deck. This is simple router work. Make a template from plywood. Stick it to the seat with carpet tape. Use a bearing-guided pattern bit to make the cut, which is about 1/8" to 3/16" deep.

I have seen this rabbeted detail on a few old chairs (nothing is new). But the rabbet looks modern to me. It provides a hard shadow line all around the spindle deck. The biggest downside to the rabbet (besides hauling out the bee-buzzing, dust-puking router), is that it can be a chore to smooth the saddle close to the rabbet. I usually dress that part of the saddle with #80-grit sandpaper. Then scrape it.

Now mark the pommel – if you want one. They are common on antique chairs, but some contend the pommel restricts a sitter's movements. If you are going for a modern stick chair, consider skipping it.

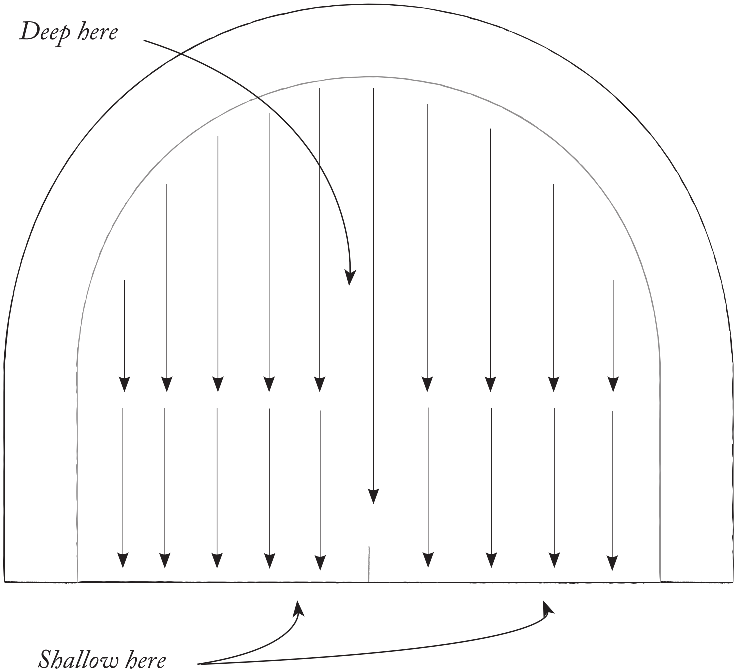
The pommel is the high point at the front of the seat that rises between your sitter's legs. I think pommels should travel a short dis-

JUST TWO SCREWS

There are lots of schemes to immobilize the seat while you saddle it. I have yet to find a simpler method than screwing a 2x4 to the underside (thank you, Don Weber). I reuse the 2x4 and screws until the board is splinters.

FOR MARKING & SANDING

This pattern marks the cups on the front edge of the seat and becomes a sanding block for final shaping of the cups.



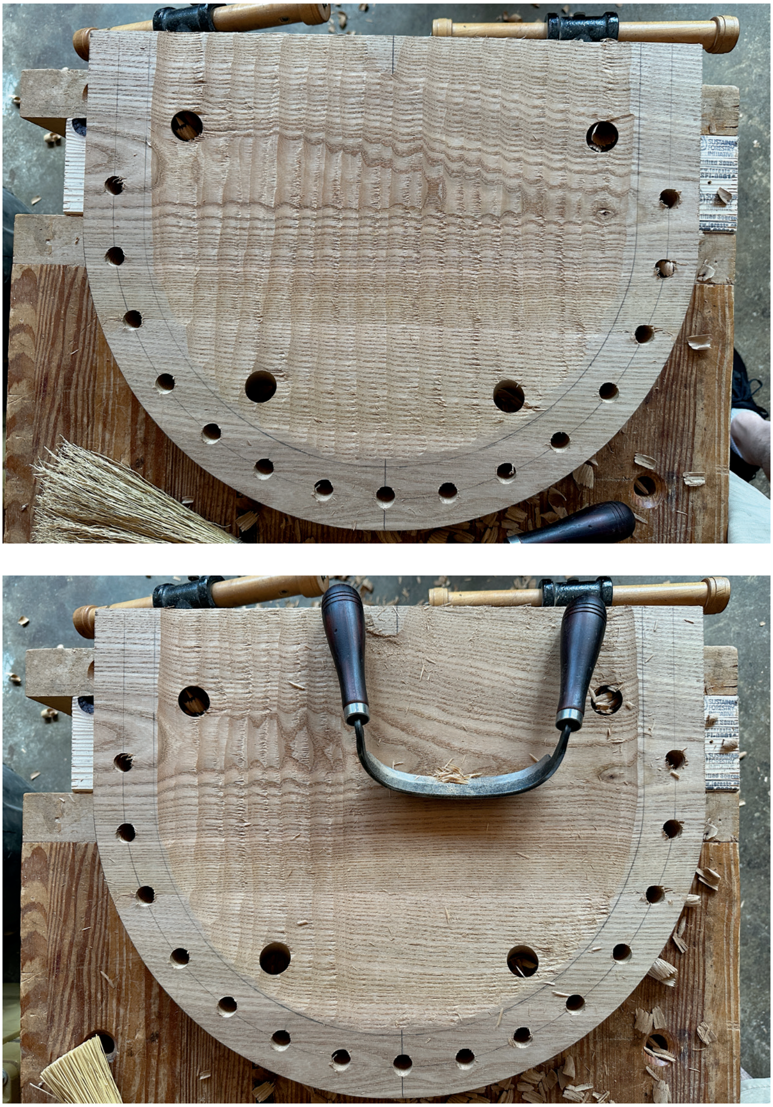
SCOOP TO THE FRONT EDGE

This is the donkey work. Scoop out the bowl all the way to the front, with your depth of cut diminishing as you near the front edge. A little splintering on the front edge is OK.

tance – 1/4" to 1" back from the front edge of the seat. Some chairs have 8" long or longer pommels. I sat in one of these long-pommel chairs recently, and I think the chair should have bought me dinner and flowers before we entered that stage of our relationship.

Mark the curves on the front edge of the seat that swoop below the pommel and join the spindle deck. The proper name for them is "cups."

I like the cups to swoop down 3/4". On a typical 20"-wide seat with a 2" spindle deck, that curve is an 11" radius. I made a wooden pattern of this curve out of 3/4"-thick material. I use this pattern to lay out the



THE FIRST STROKES

Work across the seat, keeping the furrows as regular as you can. Once you hit the target depth, use the flat section of the scorp to flatten the bowl.

cups. After I scoop out the cups, I wrap the pattern in abrasive to fair the curves. (You'll see a lot of this approach in the book.) If you are skipping the pommel, draw a pencil line 3/4" down from the top of the seat. Join that line with the spindle deck using some curves.

To hold the seat for saddling, screw a chunky stick (I use a 2x4) to the underside of the seat and clamp it in a face vise.

ROUGH IT OUT

The first step is to remove as much material as possible with a coarse tool. That can be a rotary cutter in an angle grinder (wear your diapers and your chain mail) an adze or a scorp, sometimes called an inshave.

I am competent with an adze, but I am far from expert. If you use axes and hatchets in your work, you will find the adze familiar. I don't think you need both a scorp and an adze. They do the same job.

I have always preferred a scorp to rough out the saddle. Its cutting action is more like a plane, with the tool's bevel held nearly parallel to the grain as you scoop out the wood.

Keeping the scorp sharp is important. I never let mine get really dull. After I scorp a seat, I sharpen it so it's ready to go the next morning – even if it doesn't really need it.

For the most part, the scorp cuts across the grain of the seat, like a jack plane. This lets you to take a big bite and avoid digging too deep a saddle. There are times, however, that I use the tool with the grain.

While cutting across the grain, skew the tool in your hands as you pull it straight toward you. Skew it in the same direction as the grain runs through the seat. For example, if the grain in your seat runs left-to-right, then skew the tool a little to the right as you cut. This is also what you do with a jack plane when you traverse a board – skew the tool but cut straight across. It is another reason the scorp appeals to me.

The first area to work with the scorp is what is sometimes called the "bowl." The bowl is the deepest part of the saddle, which is between the pommel and the back edge of the saddle.

Start the scorp at the back of the spindle deck and pull it toward you all the way to the front edge. The cut should begin lightly, then get deeper in the bowl and then get light again as you come off the seat's front edge. Your stokes should be regularly spaced. And don't forget to avoid the pommel.

Then return to the back edge of the spindle deck and repeat. But this

ANGLED BUT STRAIGHT

The grain in this seat runs left-to-right. The scorp is angled to the right. But I am pulling it directly toward me.

time your stokes should try to take off the high parts of the furrows left behind by your previous pass.

Repeat this over and again until you've burrowed almost 1/2" deep in the middle of the seat.

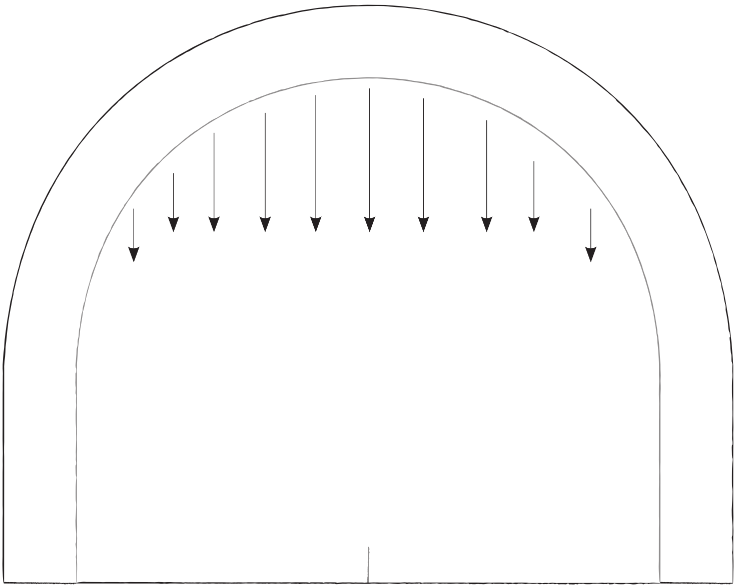
Now turn your attention to the back of the bowl. Scoop away the waste up to the line. This ensures the back of the bowl will look like the sides. And it allows you to get a crisp line at the rear of the seat.

Now scoop out the cups on the front edge of the seat. These scorp cuts are with the grain. Work from the end of each cup down to the bottom. Then scoop from the pommel to the bottom of each cup.

When you remove the last bit of waste, you might have a small bit of tear-out at the bottom of the cup. Remove this with the travisher or with sanding, as mentioned earlier. Still, try to produce a consistent curve with the scorp, and you will save work later on.

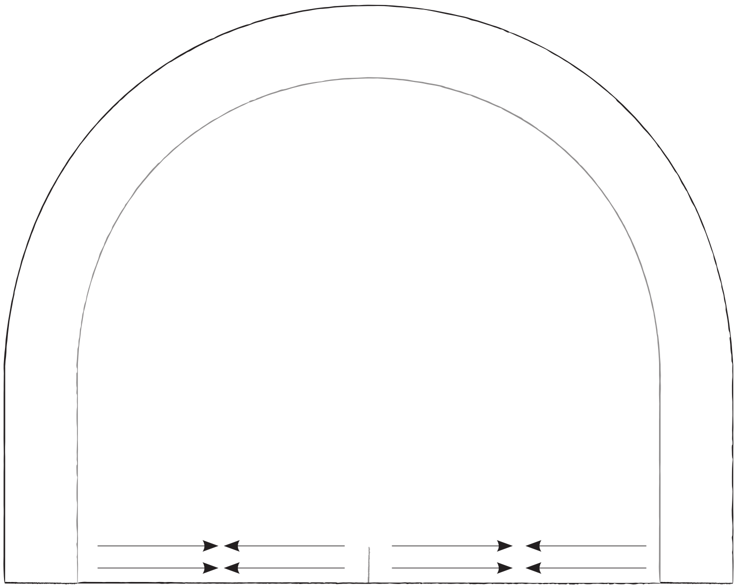
You'll probably have some high spots between the bowl and the cups. The next step is to blend the bowl area down to the cups. This area is called (unromantically) the leg troughs.

SADDLE THE SEAT



SCOOP THE BACK OF THE BOWL

Scoop out to the line at the back of the bowl. This ensures the back gets enough attention, and that you get a crisp line back there.



SCOOP THE CUPS

Work parallel to the grain to remove the waste in the cups. You can also do this with a drawknife or round-bottom spokeshave.

FOR FLAT BOTTOMS
If you want the bowl to look flat in reflected light, use a block plane to skim the bowl.

You scorp this area in the same way you worked the bowl. Use across-the-grain cuts. With each subsequent pass, try to remove the high spots from your previous pass. You'll have to work around the pommel a bit, but this should be easy work.

Before you put the scorp away, place a yardstick across the spindle deck and check the consistency of your bowl. You can measure the depth of work by eye. Look for high spots you can slice away with the scorp. It's tempting to stampede to the travisher. Try to do as much work with the scorp as possible. A couple quick cuts with a scorp can replace 20 cuts with a travisher.

SIDE QUEST: A FLAT BOWL

Sometimes I want the bottom of the bowl to be flat. Why? I'm a glutton for punishment, I guess. To do this, I use a finely set block plane and plane diagonally all around the bowl. It's surprisingly effec-

LIGHT STOCK REMOVAL

The travisher smooths thecuts from the scorp and trims the line between the saddle and spindle deck.

tive and satisfying. In fact, I'll do it sometimes just to get a feel for how deep my bowl really is (before I go deeper).

YOUR FRIEND, THE TRAVISHER

The travisher is often compared to the smoothing plane. Yes, it takes fine cuts. But don't expect too much of the tool. If your seat is a tough species (oak, hickory, elm) or has nasty grain, then scraping or sanding is in your future. Many students expect the travisher to leave a shimmering, ready-to-finish surface (like a smoothing plane). That's not common in my world where the seats are gnarly woods.

For the most part, I use the travisher across the grain. If the wood is well-behaved, I'll make with-the-grain cuts as well.

In general, the travisher is pushed forward as you work. And it is pushed from the high areas down to the low ones. However, you will be surprised what you can get away with once you master the cutting action of the tool.

Unlike a smoothing plane, a travisher doesn't have a knob that con-

NOW SAND & SCRAPE

The travisher can get your seat very close to the final finish. A little hand sanding and scraping finishes things.

NO POMMEL

Here's a saddle without a pommel. No cups. Just scorp to the center seam from both directions. This walnut chair is detailed later in the book.

trols its cutting depth. Instead, the tool's bite is determined by how much you tilt the tool as you start the cut. Tilt it forward, and the cut is light. Rotate it back a little and the cut becomes aggressive. Finally, as you are cutting, tilt the tool forward significantly to get it to stop cutting.

Despite how the tool appears, don't grab the tool by its handlebars. Instead, pinch the tool's body as shown. Push the tool with your thumbs. You don't have to press the tool's sole down hard against the seat. Instead, push it forward smoothly, looking for high spots to slice away. As the surface becomes more consistent, your shavings will become longer.

I begin by travishing the bowl to get a feel for how the seat is cutting. Remove tool marks from the bowl and cups. I also shave down the back of the pommel as much as possible here.

Once I feel warmed up, I use the travisher to gingerly trim the transition between the bowl and the rest of the saddle. This takes care. Once the seat looks clean, check it with the yardstick.

Before I put the travisher away, I plane the spindle deck clean and examine the line between the saddle and the spindle deck. I'll make adjustments to that line with the travisher or the smoothing plane.

From here, many chairmakers go to the scraper. I prefer to do a little sanding first – then get out the scraper.

WHAT IF YOU CROSS THE LINE?

It's easy to cut into the spindle deck with a scorp or a travisher, especially as you learn to control the tools. When you cross the pencil line, don't panic. There are several ways out.

1. Redefine the spindle deck with a pencil so it is a little narrower.

2. Plane down the spindle deck until the overcut has disappeared. Then redefine the spindle deck with a pencil.

3. Decide to blend the spindle deck and saddle with sandpaper to soften the transition between the two. I aim for a crisp line between the saddle and spindle deck, but that's a design choice. Many vernacular chairs have gentle rolling hills for the saddle.

SANDING & SCRAPING THE SEAT

I don't do a lot of power sanding in my work. But this is a place where a few minutes of sanding saves lots of fussing. I put some #80-

SCRAPE ALL AROUND

A curved card scraper can reach all corners of the seat and be used in almost any direction. Curved card scrapers are a helpful chairmaking tool.

grit abrasive on my random-orbit sander with a soft pad on the tool and blend all the areas of the seat. It's two minutes of work.

Power sanding horrifies some, but random-orbit sanders are a new and helpful technology – like antibiotics. A few minutes of work with this tool can save hours of agony – especially for a beginner. As you get better with the travisher, you will sand less. With some seats, I can get away with a little hand-sanding only.

Then I use the card scraper to remove the sanded surface. Scraping reveals low spots that might require more scraping, sanding or (in rare cases) work with the travisher. If I can scrape the seat clean and it looks good in a raking light, then I'm done.

Sometimes, however, I need to go back and forth between the sander and scraper for a bit. Your fingers and your eyes will tell you when you are ready for the real test: jump your butt into your seat and give it a sit. And if you are a person experiencing buttocks deprivation (I'm a lifetime member), ask a normal person to sit in it.

This little step is important. Once on a set of chairs that were set to go out to a customer, my shopmate, Megan, sat in them right before they went in the crate. The pommel was way too … intrusive. I had to travish down the back of the pommel and repaint the chairs. Ever since then, I have become a big supporter of the "cheek check."

ONE LAST TASK

Before I call the seat "done," I do one more thing. I drive the legs into their mortises and mark where the tenons emerge from the saddle. After tracing around the tenons, I remove the legs and saw close to the pencil lines. This brief task saves me a lot of work after assembling the undercarriage. Trimming long, proud tenons after assembly can be tricky. And there's the risk that you'll score the saddle with a gouge or your scorp while leveling the tenons.

If you trim the tenons before assembly, there's usually much less cleanup after assembly.

AND ALWAYS REMEMBER

Like all worthwhile things in woodworking, learning to saddle a seat is a progression. Every seat is better and easier than the last. Even after two decades of work, I still see my seats improve a bit every time.

So, you better get started today.

One last detail: No matter how good you get at saddling a seat, get a sheepskin (or a synthetic baby Modacrylic Polymer Skin). It adds to the comfort and warmth of any wooden chair, even the perfect one I've never made.

CUTTING THINGS CLOSER

After saddling the seat, drive the legs back into the seat. Draw a pencil line around each tenon. Then saw them close. This will make the final clean-up of the seat much much easier.

HOARD THEM

In our shop, we use so many wedges that they are almost like currency. I keep mine in an old rotary parts bin, arranged by size.

WEDGES

Without wooden wedges, stick chairs wouldn't be chairs – they'd just be sticks. I've seen many old stick chairs that were built without glue – or the glue is long gone. And the wooden wedges still hold everything together.

So wedges are important. However, many of the early books I read on chairmaking dealt with the topic by stating only: "Now make the wedges."

What sort of wedges? What size? What angles? What material? And how do I make them? Should their tips be pointy or blunt?

Some people rive out their wedges. Others saw them out. I make a few thousand wedges each year for chairs, stools, classes and the hammers we produce in our workshop. Even so, I think there's lots I could learn about the simple wedge. If someone wrote a book about wedges, I'd be first in line to buy it.

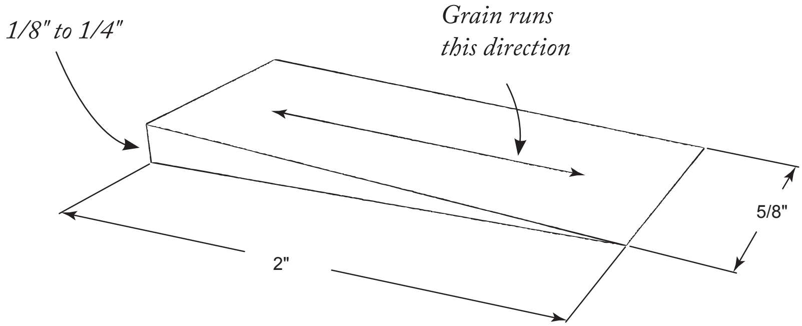
MATERIALS, SIZES & ANGLES

Wedges for stick chairs must absorb a lot of shock so they don't snap when you install them. So I steer clear of weak (sycamore) or brittle (ebony) woods.

Most of my wedges are hickory, oak or ash, species that are plentiful and inexpensive. And I prefer wood from a fast-growing tree with annular rings about 3/16" to 1/4" apart. I have used walnut and cherry wedges at the request of customers. They work, but you have to be deliberate when hammering them in because they will snap.

The grain in a wedge should run dead straight along its length, from its thin tip to its fat end. For chairs, I use wedges that are 2" long. The fat end is about 1/4" (or a bit more) thick. The tip comes to a sharp point. If I need a blunt tip for some reason (say the tenon is loose and shallow), I'll snip off the pointiness.

The angle of the wedges I use is usually somewhere between 4° and 8°. The shallower angles are easier to hammer in, but the wedge is



SIMPLE MACHINES

Wedges that are thin and strong can move mountains, or keep chairs together for a century. This is a typical wedge. I make at least 100 a month and am always pleased by their effectiveness.

more likely to crack. A wedge with a larger included angle can cause the wedge to bounce out of the tenon when you hammer it in. The solution is either to hit the wedge harder until the wedge hopefully grabs, or switch to a wedge with a smaller included angle.

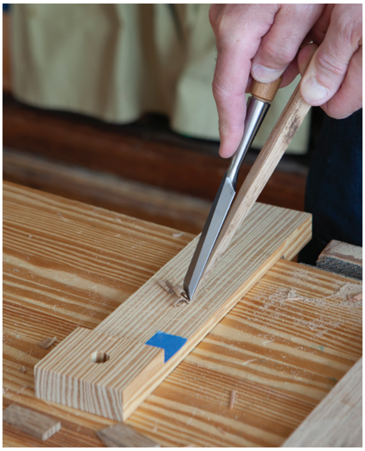
Wedges with included angles smaller than 4° can work, but the wedge is even more likely to snap off when struck.

WAYS TO MAKE WEDGES

If you want to make wedges by hand, shave them out from a long sliver. Try a 3/8"-thick, 5/8"-wide and 16"-long oak sliver. Taper one end with a jack plane. Shave the tip with a wide chisel and crosscut the wedge free. I usually work on my bench hook when I do this.

Because I make a lot of wedges at a time, I prefer to use the band saw. Here's how. We use the saw's miter gauge and the fence. We add a wooden liner to the miter gauge that adds some safety. The band saw's fence is used as a stop so all the wedges are consistent.

Crosscut a 5/8" x 2"-long chunk off a board that is about 6" to 12" wide. Set the saw's miter gauge to cut one-half of the angle you desire (i.e. 3° off 90° for a 6° wedge). Put the chunk on the miter gauge and cut off a thin sliver. Flip the chunk over – end grain-for-end grain. Slide

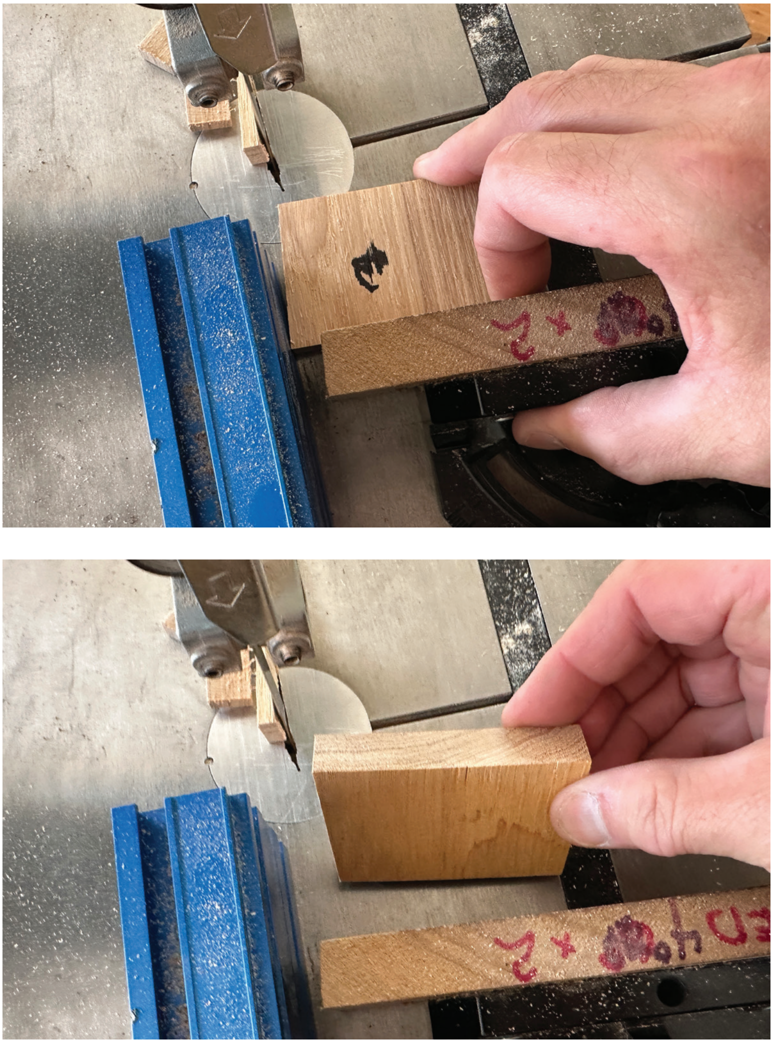


WEDGES BY HAND

Rive a long sliver (16") of oak. Taper one end with a jack plane (working against a small stop). Chisel the tip sharp (right) then crosscut the wedge free. Repeat with the same sliver.

MAKE IT FAST

Fast-growth red oak (top) is better material for wedges than slow-growth oak. Why? Simple answer: fewer pores means fewer holes made of air.



SET THE FENCE, CUT, FLIP

The fence acts as a stop, so every wedge has the same dimension at the tip. Press the blank against the fence, push forward, then flip the block over end over end. Repeat.

the chunk toward the blade and nick the front of the block – right where it makes a perfectly pointy wedge. Turn off the saw.

Slide the fence over to just touch your wedge block and lock it. (Note: our fence slides back – as shown in the photos – so wedges don't get trapped between the blade and fence. If your fence doesn't slide, you can clamp a stop to the table instead.)

Turn the saw back on and finish the cut. Now flip the wedge block over and press it against the fence. Push it forward into the blade. It should make a perfect wedge. If not, adjust the fence and try again.

Once everything is set, you can make wedges for days.

Keep flipping the chunk over and over. Make wedges until your wedge blank is so small that it feels dangerous to make the cut while so close to the saw's blade. This is usually about the time your fingers get close to the band saw's throat insert plate.

One more thing I should mention about this technique: If you feed the wood too fast into the blade, the blade will deflect and create weird-looking wedges. Keep your feed rate steady, and your wedges will look great.

We usually dedicate some time to wedge making ever few weeks, so we build up a supply and wedges are always handy. If you don't want to keep wedges in stock, just be sure to cut about twice as many as you need. For example, if you have to wedge four leg tenons, then cut eight wedges for that operation. Wedges tend to split and get lost when the glue bottle is open.

SHOULD YOU MAKE WEDGES OVER-WIDE?

Some chairmakers make their wedges 1/32" to 1/16" wider than the hole the wedge is destined for. And they taper the long edges of the wedge a bit to make them easier to start. When you do this, the wedge will either cut into the wood surrounding the arm or seat, or the excess width of the wedge will peel off.

The argument for making the wedges over-wide is that the excess will "key" the joint and prevent the tenon from rotating. Makes sense to me. But it also can look unsightly when it doesn't go to plan. I've seen it both ways in a lot of historical chairs.

I put this question in the "It's your call" file.

WHERE YOU WANT IT

A paper cup and a modified acid flux brush help you get glue exactly where you want it – and in the right amounts.

GLUING TOOLS

Gluing up chairs isn't much like gluing up cabinets. Chairs have lots of tiny mortises that need to be coated perfectly with glue – and quickly. It's easy to get glue smears and drips everywhere. And cleaning up around the joints is tricky.

Fortunately, there are simple and inexpensive tools that remove a little stress from the assembly process. Here are my favorites.

BETTER GLUE BRUSHES

Forgive me for being blunt, but most of the specialty gluing tools in the stores are worse than spreading glue with your elbow. You don't need special silicone brushes or custom-shaped applicator spouts for your glue bottle.

Take the money you just saved on those things and buy a gross of acid flux brushes for less than $25 – that's enough brushes for 720 years of woodworking. These brushes have a tin handle and bristles made from horsehair or boar hair that can be shaped with scissors so they are perfect for chairmaking.

When acid flux brushes are born, their bristles are 3/4" long, 3/8" wide at the ferrule and spread out about 1/2" to 5/8". If you've ever used a stock acid flux brush with glue, you know what happens. The bristles get sopping wet and flop around like a wet mop.

It's almost impossible to get glue where you want it.

Give your animal a haircut. Trim the bristles so they are 3/8" long. Then trim the width of the bristles so they are 3/8" wide, matching the ferrule. If there are any errant bristles, snip them off.

A brush with this shape grabs a decent amount of glue and puts it where you want it. The bristles will be stiff, but flexible enough that you can press glue into corners and crevices. The 3/8"-wide ferrule will easily navigate into 5/8"- and 1/2"-diameter mortises. There is little chance that you will accidentally paint glue on the rim of the mortise (unless you intend to).

GREAT FOR GLUE

I have long used acid flux brushes for applying glue. At left is how they come from the acid flux factory. The two in the middle have been trimmed and are ready to go. The one on the right has been used a lot and needs a quick trim.

When the glue-up is over, clean the brush in water (I've had brushes last five years or more, hence the 720-year supply). If the glue had hardened to a rock, run them through your dishwasher. When it's time for another glue-up, first inspect the brush. If there are stray bristles, snip them off.

If acid flux brushes are too low rent for you, there are nice glue brushes for sale (Torrington is one great brand). These brushes cost more than an acid flux brush, but they don't need to be modified or trimmed.

PAPER CUPS

I don't recommend squirting glue directly from a bottle into a tiny chair mortise. Chances are you will put too much or too little glue into the mortise. Then you have to get in there with a brush to add or remove glue and paint the mortise walls – all while the clock is ticking.

JUST ENOUGH GLUE

These 3-ounce cups hold enough glue for any chair glue-up I've ever done. With the help of my acid flux brush, they allow me to dispense the right amount of glue in the right location.

I prefer to use 3-ounce paper bathroom cups to hold my glue. I hold the rim of the cup right over the mortise, and I shovel up what I need with my acid brush. Then the brush goes right into the mortise. With tenons, I dip the tip of the tenon into the cup of glue and use the acid brush to spread it around.

Why not use a little plastic, ceramic or glass cup instead? The paper is easily folded, so at times I will shape the cup's rim into a spout so I can pour glue onto an edge or into a large mortise.

Environmental note: The little bathroom cups aren't coated with wax, so they can be recycled if they don't get too nasty. And they definitely can be composted, especially if you use hide glue.

TOOTHBRUSHES

I clean up my glue squeeze-out while it is still fresh and wet on the wood. I have never had a problem with it sealing the wood and

SCRUB AWAY GLUE

My dentist gives me these toothbrushes. So every six months, I get a new woodworking tool – for free. He also gives me a specialty glue applicator for wicking glue into tight cracks (dental floss).

preventing finishes from penetrating. Nor have I had a glue joint fail because water got in there. (Glue scientists at Franklin International have studied this issue and say it's just about impossible to weaken a joint by washing glue away on the surface.)

Removing glue requires the right tools. Chairs have lots of tight corners that a rag can't touch. Years ago, woodworker Kelly Mehler told me to use a toothbrush to clean out my corners, and now I use toothbrushes on every chair. The bristles need to be tidy – don't use an old toothbrush where the bristles have been smashed. Those won't clean glue well, and they'll fling water everywhere.

Dip the toothbrush in hot water then scrub at the joint for a few seconds. Clean any water drips with a rag. Then wash any glue off the brush, apply water and scrub again.

When the bristles eventually get smashed, recycle the toothbrush (most manufacturers take them back).

SQUARE-BACK

I designed this comb-back for bigger customers. The armbow is square-ish at the back and roomier for a bigger torso. The long sticks fan out a bit more to support wide shoulders.

DON'T BE SHY

Assembling the undercarriage requires force and finesse. It's all about when to stop hitting things.

ASSEMBLE THE UNDERCARRIAGE

Assembling the undercarriage is a bit like beating a bouncing spring into submission. Because the stretchers and legs are all in tension you need to hit the legs – hard – until they stop fighting you. But not so hard that you split the seat. Plus, there's wet glue everywhere, and if you have any short grain in your stretchers, you are about to discover it.

I won't lie, assembling your first undercarriage can be stressful. But it will become routine if you think ahead. Some of that prep work happens way before assembly day. Especially when you choose your glue.

I use animal glue because it is easily reversed, repaired and cleaned off wood. I prefer "liquid hide glue," which is (usually) liquid at room temperature. It allows me about 20 minutes to get a chair together (as opposed to 10 minutes for yellow glue). And if I fail to get my parts together, I can heat the joints, take everything apart and start again.

Hot hide glue is also reversible. But it sets up too quickly – sometimes in a minute or two – for complex chair assemblies.

Yellow glue is reversible in the first few hours after assembly – it will plasticize when heated and allow you to take mistakes apart.

As always, use whatever glue you've got. If you cannot easily purchase liquid hide glue, don't let that stop your chairmaking. Put your chair together with a glue stick, hot-melt glue gun or children's art class paste if you have to.

CLEANUP & SET-UP

First inspect all your parts for dings and tool marks. Plane the parts clean, but don't worry too much about the seat's saddle. It will get beat up by the wedging, so you'll have to clean it up later anyway.

I always lay out my parts the exact same way every time I assemble a chair. This has saved me from making many mistakes.

Years ago, I developed a checklist for assembly.

• Heat the liquid hide glue in a bucket of hot water (or electric glue

ALMOST READY

I have arranged my chair parts and tools the same way for every glue-up since I started making chairs. I have memorized the checklist. Until you have yours memorized, write it down.

pot) so it flows easily.

• Lay down paper on the workbench.

• Place the seat upside down on scraps that will allow the leg tenons to seat fully. Arrange the legs so their tenons point to their mortises. Dry-assemble the stretcher's pieces and place the assembly on the underside of the seat.

• For applying and removing glue, grab glue brushes, a paper cup for holding glue, a toothbrush for removing glue and paper towels.

• Choose your wedges and put them on the bench. Have a pile of back-up wedges for emergencies.

• Gather your tools: a small sledge for driving the legs, a wide chisel in case you need to open up the through-tenons for wedging, a mallet and a softwood block for knocking the stretcher pieces together, and a 16 oz. hammer for driving wedges.

• Fill a small bucket with hot water for cleaning glue.

Pour some glue into a paper cup and begin with the stretchers. Take

GLUE & TWIST

Put glue in the mortises and drive the stretcher tenons home. Twist the assembly until it will sit flat on the workbench.

the stretchers apart. Brush glue into the mortises and onto the tenons. Assemble the stretchers and twist the assembly so it lies flat on the benchtop. If glue has squeezed out of the joints, clean it up immediately with a wet toothbrush, hot water and paper towels. Put the stretcher assembly down for the moment and move to the legs.

TWIST OR HIT

Next is joining the stretcher assembly to the legs. Put glue in a leg mortise for the stretchers. Put glue on the tenon. Twist the leg onto the stretcher's tenon.

Then put the leg (dry, no glue) lightly into its mortise. Don't drive the leg in just yet. Repeat this process for all the legs. Once you get all four legs and stretchers assembled and in the seat mortises, look for squeeze-out on all those joints. Clean it up with hot water and a toothbrush.

Remove the leg/stretcher assembly and set it aside for the moment.

Brush a healthy coat of glue into the mortises in the seat. I usually put my glue brush into the mortise and pour a glob of glue on the brush

CRITICAL JOINTS

Apply glue to both the mortises in the seat and the tenons on the legs. There is no room for error or glue-starved joints here.

– then swish the glue around. Make sure to paint the entire mortise. Then paint the tenons on the legs with a thin coat of glue.

Wrangle the tenons into their mortises. Knock the legs one by one until they are all stuck in their mortises (this could take a few hits). Hit one leg hard. If the leg moves, hit it again hard. If it won't move, stop hitting it. When the legs are seated, the sound of the sledge on the leg will change its tone. You'll notice. Repeat this process with each leg.

If you hit the leg too hard, you might split the seat. So watch the joint and stop hitting the leg when it won't budge and the tone has changed when you strike the leg. Clean up any glue squeeze-out on the joints.

WEDGES & THEIR TROUBLES

Now wedge any through-tenons. Paint glue on both faces of the wedge. Make sure the wedge is perpendicular to the grain of the component surrounding the tenon. Drive in the wedge with a hammer. When wedging tenons in the undercarriage, you might need to use

GOBS OF GLUE

Do not skimp on glue with your chair. It is the least expensive part of the project.

LITTLE BY LITTLE

Knock a leg until it sticks, then do the same to its neighbors. Then knock each leg more and more until they are all seated and will not go any deeper.

WEDGE THE STRETCHER TENONS
It's easy to get turned around and have the kerf running the wrong way. If this happens, split the tenon with a chisel the correct way and drive a wedge in.

scrap blocks as an anvil to support the stretchers from below.

Here are some problems you might encounter:

• If the wedge won't enter the tenon, open its kerf up with a chisel and mallet and try wedging the tenon again.

• Sometimes wedges will enter the tenon but refuse to seat, popping out of the tenon after a hammer strike. Hit them harder several times. This usually works. If they keep bouncing out, wait about 5-10 minutes for the glue to get tackier. Then try again. If the wedges still bounce, find a skinnier wedge in your pile of emergency wedges.

• If the wedge goes in at a weird angle, first knock it from the side to see if that will fix it. If it is still wonky, pull it with pliers and try again.

• If the wedge won't fill the kerf and there's a gap, fill that gap with a small offcut of a wedge.

• If the wedges snap when you drive them, dig them out with a chisel and try to drive in another wedge. If you can't dig them out, drive in another wedge anyway and see what happens.

DRIVE THE WEDGES

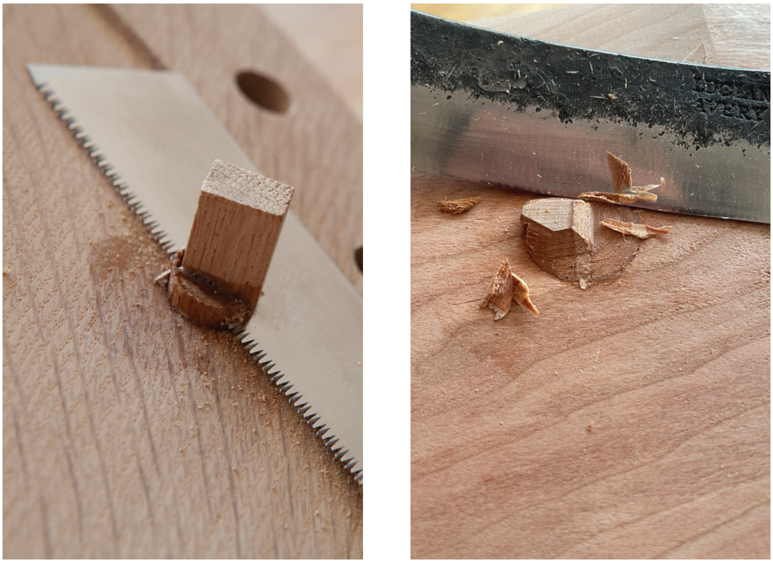
Drive a wedge into each joint. If the wedge won't go in, open up the kerf with a chisel and a mallet. Try again.

Then do one more round of cleanup. A few minutes of cleaning now will save a lot more scrubbing later.

Walk away. Leave the assembly overnight so the glue can reach its almost-maximum strength.

THE NEXT DAY

Saw and chisel the tenons close to the surface of the seat. I cut them as close as I can with a flexible flush-cut saw. Then I use my inshave to



TRICKY TENONS

Use a flush-cut saw to trim the tenon close to the surrounding curved saddle. Then use an inshave or scorp to whittle the tenon flush to the seat. Sand and scrape the seat.

whittle away most of what's left. Some sanding and scraping will get the saddle back to smooth.

Take your time when cutting the tenons flush. A small mistake – like sawing or chiseling into the seat – can take a long time to fix.

FIX A CRACKED SEAT

If the seat splits, take a deep breath. Can it be closed with a bar clamp? If so, pour some thinned glue into the crack and clamp the heck out of the seat. Let it sit overnight. If you can't close the crack with a bar clamp, or the split is in an awkward place that cannot be easily clamped, take everything apart. Clean off all the glue.

Try to glue up the crack in the seat without the legs in place. Sometimes you have to make some curved clamping cauls to pull things together. Sometimes a well-placed pocket screw (or a wooden butter-

SPLIT SEAT

This serious split was repaired by pulling the crack open a bit, flooding the joint with glue, then clamping it overnight. In some cases, I have used a syringe to inject glue into the seat.

fly) can help secure a difficult crack.

No matter what sort of repair you make, wait until the next day to try assembling the chair again. If possible, leave the clamp on the seat while making your second assembly attempt.

Also, a cracked seat is not the end of the world when it comes to stick chairs. Many antique ones have cracked seats and have survived with the help of an iron strap or two.

PUSH, PULL & TAP

Chairs need a few good taps to bring all the parts into place.

ASSEMBLE THE UPPERCARRIAGE

Assembling the top part of a stick chair can be stressful. If you are going to crack an arm, this is when it will happen.

After years of working with students, we've developed a "pre-flight" procedure that greatly reduces the chance of a cracked arm. Follow these instructions, and a broken arm will be unlikely.

(Note that the instructions in this chapter show how to glue up a stick chair with an armbow. If your stick chair has two separate arms, the procedures are similar – just easier. Glue the back posts/back sticks in place in the seat. Slide the arm and its short sticks down into place. The chapters on the armchairs later in the book illustrate this assembly process.

COMPRESSION? CHECK

Arms crack when the chairmaker hits the arm too hard during assembly or if the sticks are egregiously misaligned with their mating mortises. Assembling the chair should require only soft taps in a few places to set the tenons and the arms. But in many cases, beginning chairmakers make joints that are way too tight or disturbingly wonky, and they resort to heavy blows to move the sticks or the arm in place.

Then the arm cracks.

One solution is to compress the tenons once – or a couple times.

For many years I have cut my tenons so they are initially quite tight. How tight? So that they won't go into their mortises without sharp hammer blows. Then I compress them once with soft-jaw pliers so they go in a little snug. Then, when the hot, wet glue hits the compressed tenon, it swells and locks the joint.

Sometimes, when working with beginners, this is still not enough "forgiveness" for a first chair. So when I am worried that a chair won't go together easily, I compress the tenons a second time so that they enter the mortise with (almost alarming) ease. Surprisingly, these double-compressed tenons swell up just fine and lock when the warm,

A LITTLE SQUEEZE

After the first compression, the tenon is 0.615", and the fit in the mortise is snug. After the second compression, the tenon is 0.610" and enters the mortise without any effort.

wet glue hits them.

These double-compressed tenons allow you to pull the arm and sticks into position without having to resort to heavy blows. Result: Fewer cracked arms.

STICK 'PREFLIGHT' CHECK

Another cause of cracked arms is that the mortises in the seat and arm are misaligned, usually because the drill bit went astray during the mortising process. The misalignment forces the chairmaker to wrench the sticks in place. Then the woodworker must hit the sticks and the arm to get them into the proper position.

And then the arm cracks. A second strategy is to do an "almost assembly" of the chair to check for misalignments.

This "almost assembly" isn't technically a full-on dry assembly. I

WHAT PREFLIGHT LOOKS LIKE

The two unassembled sticks on the left won't go into their mortises without brute force. To fix this, ream the mortise on underside of the arm of the offending sticks. A little reaming gives the stick the mobility it needs during assembly.

avoid dry-assembling chairs because the process can deform or loosen joints. Or the dry-assembled chair simply won't come apart.

Instead, an "almost assembly" looks like this. Put all the short sticks and long sticks into the arm. Now place the arm and sticks onto the chair's seat. Insert the chair's short sticks so they are in their seat mortises, but in only about 1/16" or 1/8".

If all the short sticks won't go in their mortises, mark the errant ones and ream the offending mortise in the underside of the arm to give that stick some mobility.

Once you get the short sticks in position, pull the long sticks down from the arm and see if they will go slightly into their mortise without any wrenching. If there are any misaligned long sticks, ream the mortise in the underside of the arm to give these long sticks some mobility.

In the end, all the sticks should be able to enter their mortises about

INEXPENSIVE INSURANCE
Install the metal plates across the short grain of the arm. The width and length of the plate can vary depending on the armbow you've made.

1/16" deep without any gymnastics or wrestling moves on your part.

This stick "preflight" – plus the double-compression – takes care of most problems.

A METAL PLATE – BEFORE ASSEMBLY

So let's say you try both techniques discussed above, and you are still wary of assembling a certain chair. I've been there. Some students struggle until they have built a few chairs and can understand the entire process.

For parts that look really wonky, I'll screw a mending plate (or two) to the underside of the arm to reinforce the short grain. And I'll do this before assembly. Many old stick chairs have been repaired with steel plates during their lifetimes. The plates shore up cracks or damage suffered by the chairs during a hard life.

But if an arm is going to crack, it is usually going to crack at the short grain where the arm and end of the shoe are joined.

AN EXTRA SET OF HANDS

Clamp the armbow in a vise as you glue the short sticks into their mortises in the arm.

Screwing a brass or steel plate on the underside of the arm before assembly in this fragile area helps prevent the arm from bending and cracking during the assembly process. After assembly, you can remove the plate – or leave it.

I typically use 5/8" x 3" mending plates (brass or steel) that I get from the hardware store. These take #8 screws. If I intend to leave the plates in place, I use slotted screws and clock them so it looks intentional – and not like a later, sloppy repair.

GET READY & GLUE

I use the same checklist I used to glue up the undercarriage to prepare for the uppercarriage. But there are additional items on the list. You need:

1. A tape measure or ruler to measure the height of the arm off the seat's spindle deck.

2. To examine all the short sticks and make sure one end is kerfed to

A GOOD COAT OF GLUE

I don't ever want a chair to come back for repair. A good coat of glue on the mortise and the tenon help me sleep at night.

receive a wedge.

3. To place all the sticks – long and short – into the armbow. Rotate the short sticks so that the kerf in each short stick is perpendicular to the grain of the armbow. Now slide the long sticks upward until they wedge in their holes in the armbow. (If you are using dowels, you can slide the long sticks in place after attaching the arm.)

Pour some glue into a paper cup and begin the glue-up process. Clamp the armbow in your vise so you have both hands free during this step. To glue a short stick into the arm, I remove the short stick from its mortise, paint glue in the mortise and on the tenon. Re-insert it into the arm and rotate it into position. Now paint the mortises in the seat. Don't be stingy – glue is cheap. After gluing the mortises, return to inspect the first mortise you glued and make sure each mortise has enough glue to wet the tenon.

If any glue spills into the spindle deck, clean it off with a wet rag.

When you are done, put the glue aside for a moment and get ready to

SHORT STICKS FIRST

Pull the short sticks into their mortises. Then pull the entire armbow down. Note the long sticks aren't touching the spindle deck.

marry the armbow to the seat.

STICKS MEET THEIR MORTISES

Here's a quick summary of the assembly process: Knock the short sticks into their mortises in the seat. Knock the long sticks into their mortises in the seat. Tap the arm up and down so it is the correct height above the seat. Done.

Before you begin the docking procedure, make certain all the long sticks are still stuck into the armbow. This move makes assembly a little easier – the long sticks are temporarily out of the way so you can get the short sticks in place.

Grab the armbow assembly by the short sticks and maneuver the short sticks into the mortises.

You probably will have to tap the arm downward at this point. Use a mallet and a backing block.

Then I tap the top of the short sticks to seat them deeper into the

DRIVE THE LONG STICKS

With the chair on the floor, drive the long sticks into their mortises. Drive them hard if the seat can take the abuse without splitting.

seat. I tap a little on the right, then a little on the left. Keep tapping until all the short sticks are driven to full depth in the seat mortises (the stick will stop moving). You will have to tap the arm down some as you sink the tenons. Don't hit any area of the arm that has short grain.

As you tap these short sticks, keep an eye on the kerf in each short stick. Sometimes the stick will rotate as you drive it in. The kerf must be perpendicular to the grain of the armbow.

Now tap the long sticks down so they slide free of where they were wedged into the armbow. Pull each long stick into its mortise, then drive it home with a mallet.

SET THE HEIGHT OF THE ARMBOW

Now you need to tap the armbow up or down and into final position. Depending on how much tension is in your assembly, this could be a

SET THE HEIGHT

Tap the arm down (don't forget a backing block) until the arm is the correct distance above the seat. It needs to be close, but not perfect.

simple thing or it can be a struggle.

Some chairmakers put the drilling jig under the arms to control the height of the armbow. They knock the sticks and armbow down until the armbow hits the drilling jig. This works, but it's one more thing to manage during glue-up. Try it and see if you like it.

I use a tape measure, a mallet and a block of softwood to seat the armbow. Before I hit anything, I measure the height of the arm off the seat in three locations: under the left arm, under the right arm and at the center of the armbow.

I then tap where the arm is highest, either over the left arm, right arm or the center of the armbow. I use the softwood block to cushion the mallet taps. After I tap the arm, I measure the armbow's height again at the three positions. Sometimes the arm will move up on the left side when you tap down on the right side.

I keep tapping and measuring until I get the armbow into position,

TRIM & WEDGE

If the tenons stick up a lot, trim them with a saw (note the 5mm ply protecting the arm). Then apply glue to the wedges and drive them in.

CLEAN IT NOW

Scrub excess glue off everything before you declare victory. This will make life easier.

or until I can't get it to move down anymore.

At this point I need to decide when I'm done fighting the armbow.

1. If the armbow is the same height (8" in this case) in all three positions, I'm done.

2. If the left and right hands are within 1/16" of each other, and the center of the armbow is within 1/8" of that measurement, I'm done.

If neither of those is the case, I keep tapping. And the tapping might need to get upgraded to "mild banging" to move a stuck arm.

Also, sometimes the solution in the end is to tap one arm up instead of down. For example, if the left hand is at 8" high and the right hand is at 8-1/4" high, sometimes the best solution is to knock the left hand up to match the height of the right hand.

After you have tapped everything into position, put your tools down for a moment. Grab the chair by the seat and put it on the floor. Observe the height of the arm off the seat. Does it look fine? If it looks fine from all angles, then it is fine. If it looks wonky, try tapping the arm, perhaps with a heavier mallet.

Now wedge the tenons in the short sticks. Paint glue on both fac-

WALK AWAY

Sometimes glue-ups don't go perfectly. And you occasionally get to the point where a repair attempt might ruin the chair. Remember that there is a third choice – live with the error. Mistakes that look huge in the afternoon usually look smaller the next day.

es of the wedge. Start the wedge in the kerf with a hammer. With your off-hand, grab the short stick under the armbow to stabilize the chair. Drive a wedge into the kerf in each short stick. Keep hitting the wedge until the wedge stops moving and the tone changes. If all goes well, clean the excess glue from the tenons, sticks, armbow and seat. Use a toothbrush and hot water. Let the glue dry overnight.

LEVEL THE TENONS & WEDGES

The next day, cut the tenons flush using a flush-cutting saw. Then clean up the arms with a block plane and a scraper. Now you can shave the arm to final shape, blending in the tenons and wedges to that shape.

TROUBLE-SHOOTING

Here are a couple problems you might encounter while assembling the uppercarriage.

DON'T DESPAIR

Even dramatic splits can be fixed. Some repairs (top) require clamping in several directions to close the split. Others (bottom) can be closed with pressure only from above.

1. The arm cracks. Small cracks can be repaired in place. I do whatever I can to wick some glue into the crack. Minor splits can be repaired with cyanoacrylate (aka "super glue"). Deep splits need a stronger glue, such as yellow glue. Sometimes I use dental floss or a syringe to sneak glue into the crack. Then I tape some scrap wooden blocks across the crack and use clamps to pull things tight. Sometimes cracks need to be clamped from above, below, left and right.

2. The arm splits in two. Immediately remove all the sticks and armbow. Clean off all the glue you can]. Then attempt to fix the arm. Sometimes you can make the fix using only glue. Other times it might take a pocket screw, wooden peg and/or a metal mending plate to keep everything in place. Clamp and let the glue dry overnight before trying to assemble the chair again.

3. Occasionally the tenon in the armbow ends up recessed below the top surface of the armbow. Or the tenon splits below the top surface of the arm. To fix this unsightly problem, wait until you saw the tenons and wedges flush the next day. Save the waste – the little bits of tenons glued to the wedges. These are part of the fix. On the arm, chisel out the damaged area. You might have to drill the top of the tenon to deepen the hole as a whole. Put glue in the top of the tenon and drive one of the waste wedges-and-tenon pieces into the hole. After the glue dries, cut this flush.

COSMETIC REPAIRS

This tenon didn't survive assembly. I chiseled out half of the tenon. Then I used the waste bits to plug the hole. It's a clean fix if you take your time.

CAREFUL NOW

The comb is one of the most visible aspects of the chair – it pokes up above a tabletop for all to see. So don't get lazy when it comes to its design or construction.

MAKE THE COMB OR BACKREST

I think of the comb as the hat of a chair. A good comb (sometimes called the “crest” or the “backrest”) can energize a so-so chair design. A bad comb can almost ruin a chair where you did everything else right.

That’s because the comb on a stick chair is (in my opinion) one of the most important aspects of its design. The comb sticks up above a table like a giant flag that says “Look at Me.” That means you have to get the comb right every time.

First the bad news: The variation in combs is almost endless. Combs can be anything from a flat board to a curved and scrolled thing with pinstripes. There are so many choices that it is easy to become paralyzed.

Now the good news: You can try multiple combs on the same chair until you find one that makes the whole thing sing. It’s almost as simple as changing your hat before you go out. When I make a new chair design, I rough out three or four combs before I find one that works.

CONSTRUCTION, DIMENSIONS & CURVES

The dimensions of the comb can be confusing at first. What’s the thickness and what’s the width? It really depends on how the comb is made. Combs can be bent (via heat or technology), cut from solid stock or be a naturally curved branch from the woods.

Depending on which method you use, the thickness and the width of the stock can be interchanged. To avoid confusion, I use these terms:

• Length: The measurement of the comb from left to right on the assembled chair.

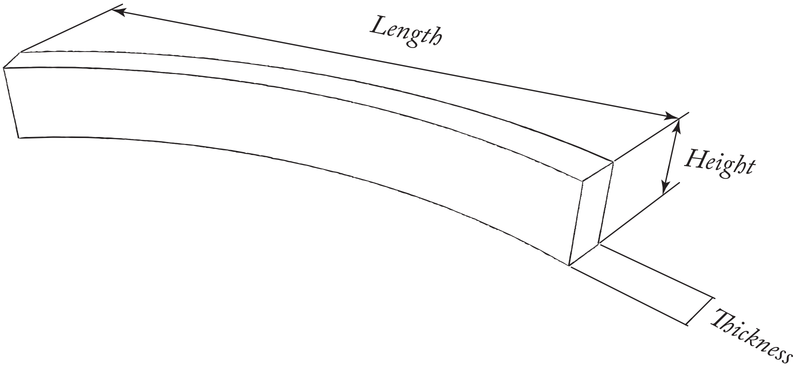
• Height: The measurement of the part up and down on the assembled chair.

• Thickness: The measurement of the part from front to back of the assembled chair.

The illustration on the next page explains it. You might use different terms – that’s fine. But these are the terms in this book.

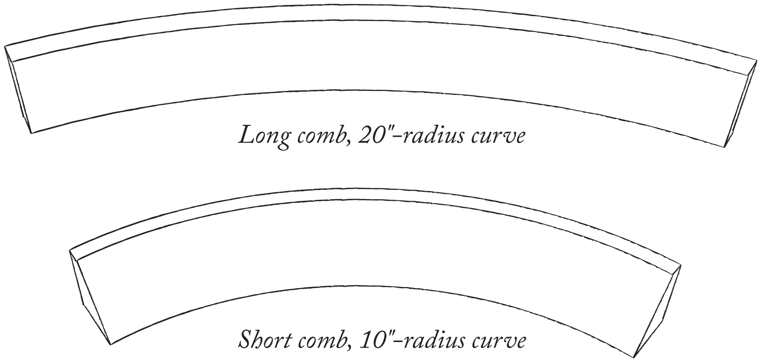
FIND THE COMB

A curved comb with angled ends and a curved bevel is easy to create using a series of simple steps. The end result always looks more complex than it is.



EXPLAINING THE NAMES

I like to use "height" to explain the comb's vertical dimension. The traditional word "thickness" can incite confusion.



TWO CURVES FOR MOST CHAIRS

For short, narrow combs, you can use a tight-radius curve or a shallow-radius curve and the chair will look fine. For chairs with long combs, it's best to use a shallow-radius curve, such as 20".

In general, steam-bent combs can be thinner – 3/4" to 7/8" thick – and be plenty strong. When you saw out your combs from solid material, it is best to make them thicker – 1" to 1-1/2".

The height and length of the comb is something that I fuss with constantly. While I have seen antique combs that are only 1" high, I usually make them somewhere between 2" and 3" high for tall comb-back chairs, and 4" to 6" high for lowback chairs.

The overall length of the comb is determined mostly by the spacing of the chair's long back sticks. The comb needs to be longer than the spread of the back sticks. The sticks can be fanned out on a longer comb or pulled in a little on a shorter comb.

The last consideration is how curved the comb should be. For me, the radius of the curve can be driven by the length of the comb. If you are making a chair with only four back sticks and a comb that's about 12" to 14" long, its curve can be really tight – as tight as the radius of the armbow – or fairly shallow (16" to 20").

But when you have a long comb, you should use a larger radius so you don't cage the sitter's shoulders. After much experimentation, I usually start with an 18" to 20" radius for chairs with a comb as long as 19" or 20".

Of course, some chairs have a comb that has no curve whatsoever. For tall comb-back chairs, I think a flat comb looks odd. Yes, you will find some antique comb-backs with a flat comb, but even those look awkward to me. I use a flat comb/backrest only on lowback chairs or armchairs where the back sticks don't curve (you will see this on one of the Irish-y chairs later in this book).

MAKE SAMPLE COMBS

When I experiment with comb shapes, I use scrap pine 2x8s or leftover stock that is otherwise hopeless. For curved combs, I glue together two 2x8 boards face-to-face to make a blank that is 3" to 3-1/4" thick, depending on the raw material. For lowback chairs, which have taller backrests, you might need to use three layers of 2x8s to get the height you want.

Then I decide on the radius of the curve and lay it out on the blank using trammel points. Make the sample comb over-long so you can trim it back until it looks good. Then saw out the sample comb and lay out the mortises for the long back sticks.

Laying out the mortises in a comb requires thought. My first instinct is to lay out the mortises so their spacing matches the spacing of the sticks in the armbow. This produces a decent-looking chair.

You can change the look of the chair by fanning out the back sticks a bit. It doesn't take much movement to make a difference. Spacing the sticks out 1/8" from the center adds drama. With the sticks bent outward, the chair looks welcoming, like it wants to give you a *cwtch* (a hug).

You also can pull the sticks inward by 1/8". To my eye, chairs with the sticks bent inward look like the chair is more compact.

To see how the sticks will look when they are fanned out or pulled in, I mock it up by clamping the long back sticks to the sample comb with spring clamps. Once I find a spacing I like, I lay that out on the sample comb and get ready to drill the mortises.

If the long sticks are perfectly 5/8" in diameter at their tips, you can drill 5/8" mortises in the sample comb. If the sticks are smaller than 5/8", use a tenon cutter to shave them to 1/2" in diameter then drill 1/2" mortises in the sample comb. If the sticks are larger than 5/8" in diameter, I will waller out the mortises in the comb a bit and then peg them.

12"-long x 1-7/8"-high comb, 10" radius

19"-long x 2"-high comb, 20" radius

25"-long x 3"-high backrest, no curve

23"-long x 3-3/4"-high backrest 20" radius

SAMPLE DIMENSIONS

Combs/backrests can be a variety of sizes and have different curvatures. Here are four sample chairs and the statistics on their combs.

CURVES & CUTS

Set the trammel for the outside radius (21-1/2" here). Then set the trammel for 20" and use the same centerpoint to draw the comb's inside curve. This makes a comb that is 1-1/2" thick.

No matter which size mortises you drill, you have to decide if they should be drilled at 90° to the edge of the comb or at an angle that matches the slope of your back sticks.

I know this seems like a lot to juggle. Here's my advice: If you are bending your comb, then it is pretty thin and typically you should drill your mortises straight – 90°. If you are sawing out your comb from solid, it is thicker and the mortises should be angled.

How do you drill the angled mortises? It's easy. Use a sliding bevel to measure the angle of your back sticks – let's say it's 20° – off the spindle deck. Lock the bevel. Put the comb on your benchtop. Orient the curved comb so it looks like it is frowning at you and clamp it to the benchtop. Now put the bevel on the bench and use it to guide your drill bit at 20°. I usually make these mortises about 1-1/4" to 1-1/2" deep. Note that if your sticks fan out (or in), you'll also have to tilt the dill bit a little to the left or right.

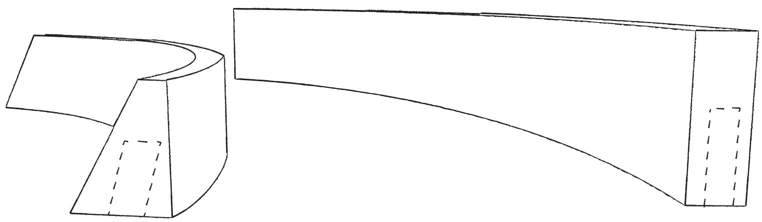
After you drill the holes, knock the sample comb onto the back sticks

PROTOTYPE YOUR COMBS

Sample combs can be made quickly out of inexpensive pine. I use pine or junky bits that are headed for the burn pile.

TENONS ON THE LONG STICKS

A tenon cutter shaves the sticks to a perfect 1/2" diameter. After cutting the tenons, shave the stick (I use a curved-bottom spokeshave) to blend the transition between the stick and its tenon.



A thick comb has room for angled sticks

A thin comb does not have room for angled sticks

WHEN TO TILT

In a thick comb (left) you can angle the sticks. This makes the top of the comb parallel to the seat and gives the chair a finished look. In a bent comb, your material is usually thinner and you should drill your mortises straight down.

and take a good look.

Before I start altering the sample, I usually mock-up my ideas with painter's tape. If I want to cut the ends of the crest at 7° or add curlicues or whatever, I'll draw out my cuts in pencil. Then I might use blue painter's tape to cover the parts I want to cut away. It's easier to move pieces of tape around than make a new comb.

MAKE A STRAIGHT COMB/BACKREST

Straight combs are easy to make as they are simply a flat board. Straight combs are typically made using thin stock (7/8" to 1" thick), so the mortises are drilled straight down at 90°. After I drill the mortises, use a jack plane to shape the face of the board that touches the sitter's back. A little curve adds comfort to an otherwise flat board.

The ends of the comb can also be decorated with curves, angles or whatever else you got.

SAWN FROM SOLID

Most of my combs are sawn out from solid material. Why? It's faster

ANGLED MORTISES

Set your bevel to the angle that the back sticks lean. Use the bevel to guide your drill bit. A piece of tape acts as the depth stop.

CHEAPER THAN WOOD

Some blue tape can help you visualize what the comb will look like – better than just pencil lines.

MAKE & KEEP PATTERNS

I always make a pattern of a successful chair part so that I can duplicate it in the future – or adapt it in some way for a different chair.

and easier to saw out a comb than bend a comb.

While I think that bent combs can look better (especially in unpainted chairs), you can make some nice sawn-out combs by carefully selecting the boards and their grain patterns (flat sawn, rift or quartered). If the face of your board is flat-sawn, there's a great chance that the edge will be quartersawn. And the edge of the board will become the front face of your comb.

Before I saw out a comb in good wood, I'll make a plywood pattern of it. The pattern records the shape of the comb and spacing of the mortises. I usually record the radii on the plywood pattern and any other information about any angles or shapes on the comb. With the pattern complete, I'll use it to lay out the comb on the good wood.

When you saw out a comb from solid wood, it is usually pretty beefy so it doesn't snap because of its short grain. Many times I cut a big bevel on the front of the comb that matches the back angle of the sticks. Set the band saw's table to the angle of the bevel. Draw a line where the bevel should begin and make the cut.

BEVEL ON THE BAND SAW

Sawing the bevel on the front of the comb is easy band saw work. Keep the waste piece as it will be the perfect sanding block for finishing the curve.

A big bevel on the front of the comb greatly reduces its visual bulk. And the bevel makes the chair look more comfortable.

(Is it more comfortable? That depends. With most stick chairs with tall backs, your head or back will rarely touch the comb. With lowback chairs, however, the backrest almost always touches the sitter's back.)

One last tip with curved combs made from solid material: it's best to make them a tad longer than your plan. You will have some short grain at the ends of the comb. It's easy to break a small chunk off the ends while sawing or shaping the comb. A little extra length allows for some small problems as you shape the comb.

BENT COMBS

Bent combs are easier to make than bent armbows. Combs are shorter overall than armbows (usually less than half the overall length). And usually their curves are shallower. If you want to learn steambending or to work with cold-bend hardwood, the comb is an excellent place to cut your teeth because there is a much lower rate of failure.

BENDING FORM

Here is one of my comb-bending forms at work. This bend was made with cold-bend hardwood. The excess length at the end is cut off immediately and used for other projects.

As mentioned in the section on bending armbows, steambending requires a fair amount of equipment and jigs. And there is a learning curve. Bending stock with cold-bend hardwood, on the other hand, requires only a band saw and a bending form. But the raw material is kinda expensive.

Either way, you need to make a form to wrap the wood around. I make them from plywood or MDF that is stacked up as tall as the comb. When I make a form, I record a bunch of information on it, such as the spacing of the comb's mortises and the size of the blank it requires. I bend the comb around the form and clamp it in place until the wood's shape sets. You can let the comb dry in your shop (this takes a few days) or put it in a kiln powered by a light bulb (this takes one day).

After the comb is bent, dry and off the form, you can shape it just like any other piece of wood – saw it, plane it, rasp it, sand it.

Some chairs can use the same form for bending the arms as for the comb – especially chairs with short combs. Tip: If you bend an armbow and part of it gets messed up, you might be able to salvage a comb from the wreckage.

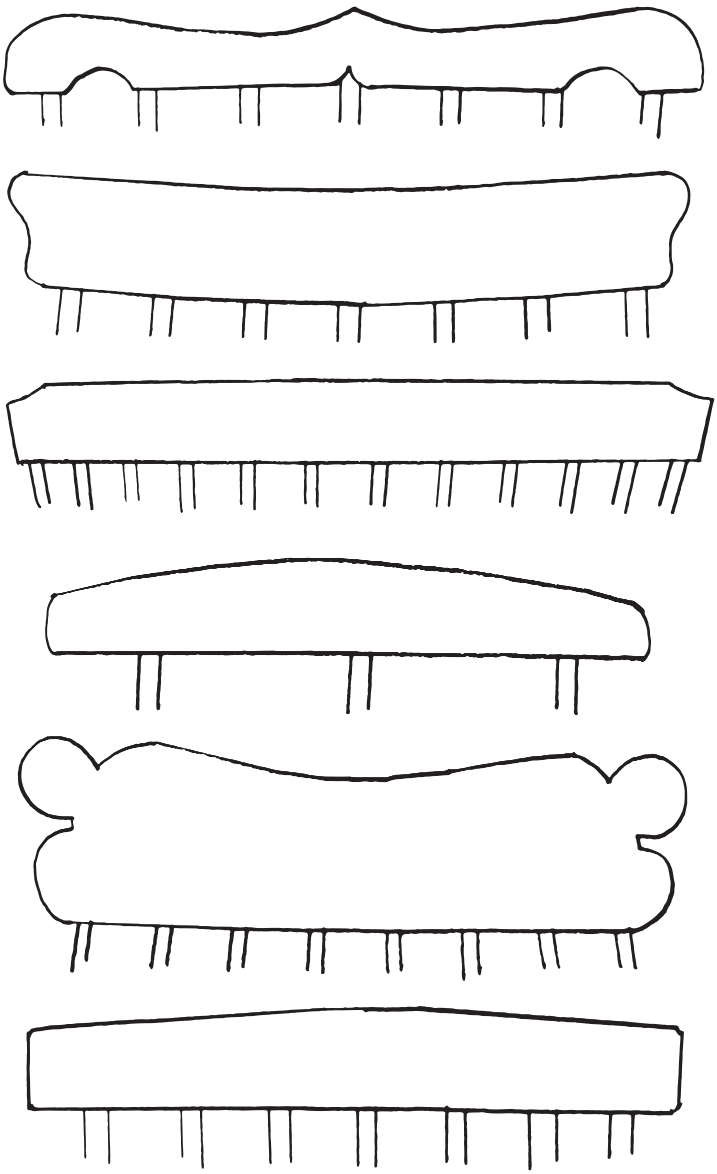
ORNAMENTATION

There is no way to cover all the possible comb shapes out there for stick chairs. While there are some common shapes, which I will illustrate, I find new ones almost every day that I go looking for them. When I find a shape I like, I take a photo and store it in a folder so I can look at 100 or more combs when I am looking for inspiration.

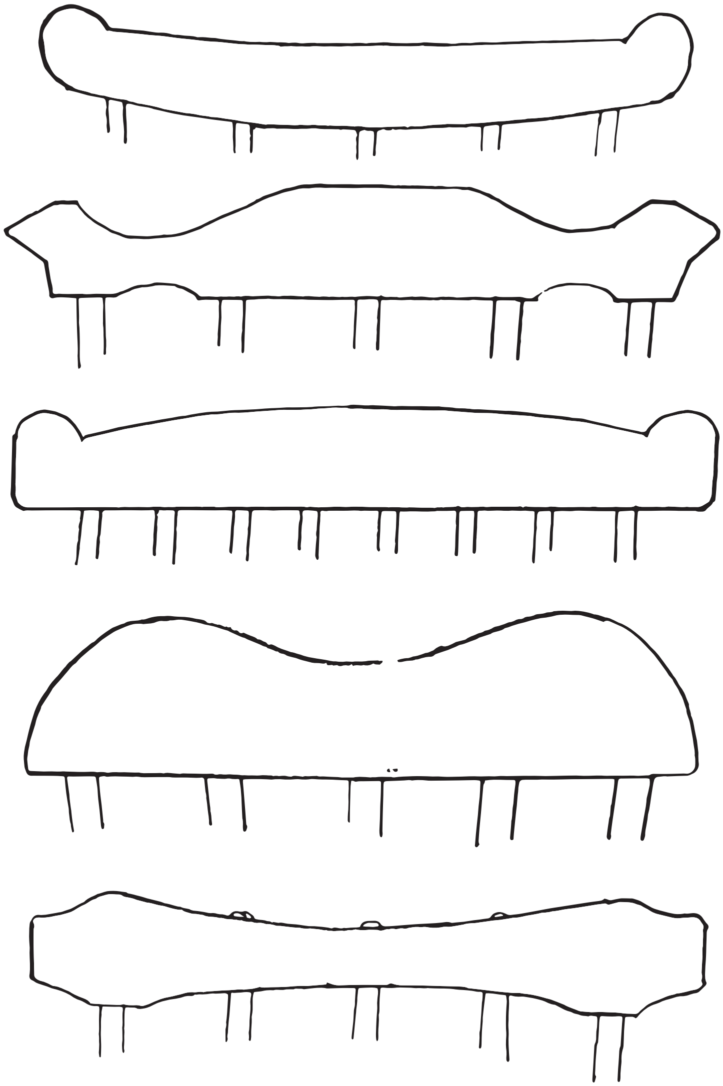
Most combs on stick chairs are simple and utilitarian. The front face might be rounded so that no sharp corners can touch the sitter. The ends might be angled or simply curved to echo some other part of the chair – perhaps the curve of the hands or the splay of the front legs.

And if you are looking to keep things simple, that's where I would begin – a little rounding and maybe some angles – and leave it at that.

The illustrations on the next spread show some of my favorite combs that I have encountered during the last two decades. These only scratch the surface of what is out there.



MAKE THE COMB OR BACKREST



NICE HAT

While some of these combs might look complex, they are mostly straight lines, simple curves and segments of circles. Any of these combs can be curved.

A COMPLEX GLUE-UP

The back legs of this chair are braced against a block of wood. I knocked the comb onto the sticks but struggled to get it parallel with the armbow. In the end, I had to use a spreader clamp (left) to push one end up and a bar clamp (right) to pull the other end down.

ASSEMBLY & PINNING

After you sort through all the variables to design and make your comb, it's a matter of attaching it to the long back sticks of the chair.

Gluing the comb to the sticks is quick, but it can be either messy or clean. The messy way is to paint glue in the mortises and drive the comb onto the sticks while the chair is on the floor.

Usually the glue runs out of the mortises, weakening the joints and making a mess on the long back sticks.

The better way to glue the comb to the sticks is to recline the chair on its back on your workbench. The long sticks should hang out over the end of the bench. Brace the chair's back legs against a board clamped to the bench if necessary. Now paint glue in the mortises of the comb and drive the comb onto the long back sticks. (Use a backing block so you don't dent the comb.)

THE VIEW FROM THE OTHER SIDE

Here you can see the back legs braced against a piece of scrap (it's actually the scrap I use to immobilize the seat when I saddle the seat). This scrap allows me to knock the comb in place with ease.

Using this method, I have yet to lose a drop of glue.

No matter how solid your joints are, you should pin the tenons. Most surviving antique chairs have combs that are pinned to the long sticks. These joints see a lot of movement and stress.

Some chairs pin every stick to the comb. Others pin every other stick. Still others pin only the sticks at the ends of the comb.

I pin my sticks with tapered hardwood pegs (one brand is Kakuri) or with bamboo barbecue skewers. These skewers cost pennies at the grocery store. The skewers from my grocery require a 5/32" drill bit. I bore through the comb and the stick, but I stop short of drilling all the way through the comb to avoid splintering/blowout embarrassment.

Then I put a drop of glue into the hole and drive the skewer in with a small hammer. When the skewer hits the bottom of its hole, I put down the hammer and pick up the saw. I saw the bamboo flush then move to the next stick.

PIN THE TENONS

Bamboo skewers make excellent (if not historically accurate) pins for the crest. The hole in the comb is blind so you only have to saw off the pin at the front.

After the sticks are pinned to the comb you can clean things up. Look for any glue drips on the sticks or around the pins. Clean them up with scrubbing. Or, if everything is dry, clean things up with scraping and sanding.

FIREDSIDE CHAIR

Most comb-backs look at home by a fireplace. This one, made with bog oak, has lots of facets that catch the light.

ONE WAY TO DO IT

One luxury in my shop is this Benchcrafted Hi Vise, which can hold an assembled chair with ease. If you don't have a Hi Vise, you can clamp the chair in a handscrew or a carver's vise.

LEVEL THE LEGS

Cutting down the legs of a chair so they rest flat on the floor is another one of the "great mysteries" faced by most beginning chairmakers. If you've never done it, it seems difficult. But if you've done it even once, it seems completely obvious.

If you've never done it, know this: Leveling the legs requires no special talents in geometry or math. The only skill required is being able to saw to a pencil line.

SET THE STAGE

To trim the legs of your chair you need a flat worksurface that is level. This can be a piece of MDF that you have shimmed with wedges, the top of a table saw, your workbench or that one patch of floor in your shop that is inexplicably level.

To level the worksurface, I use a spirit (aka bubble) level and construction shims. I test the surface in the X axis and Y axis and add wedges until the surface reads level according to the spirit level.

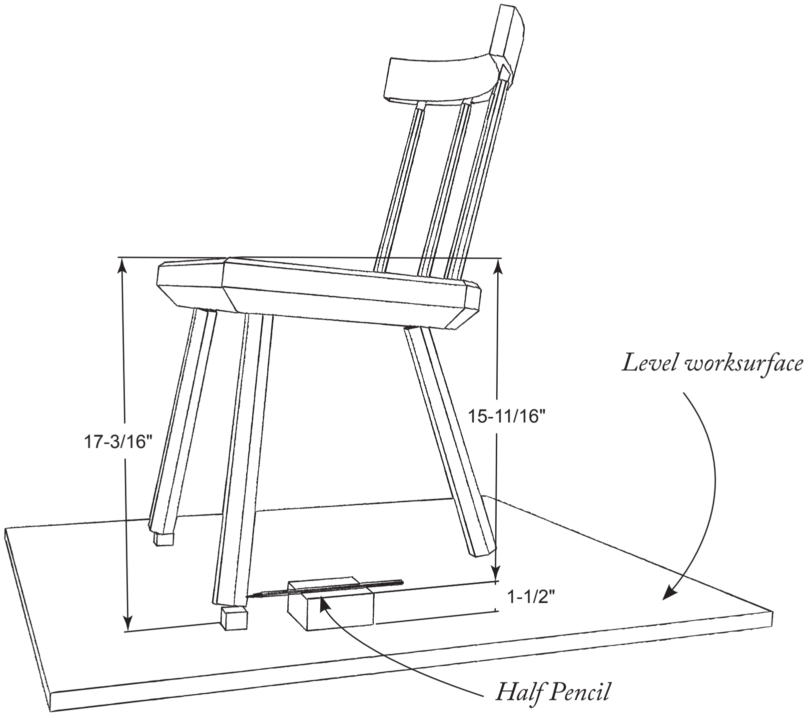
Then I gather the tools necessary for laying out the cuts on the legs: a handful of small wedges, the spirit level, a modified carpenter's pencil, a tape measure, a 6" rule and some scrap wood.

THE MODIFIED CARPENTER'S PENCIL

One of my favorite layout tools is a carpenter's pencil that has been planed to half its thickness. We call it the Half Pencil, and it is a useful thing to have around. It allows you to make pencil marks in the same way a spear-point marking knife works.

A marking knife works well for joinery because you can run the flat back of its blade against one surface (such as a try square) to accurately mark another surface below. The same principle applies to a Half Pencil. You don't have to tilt the pencil to make an accurate mark.

If you are skeptical, plane a carpenter's pencil in half. This is easily done by placing the pencil against a planing stop. If you don't have a



ONE WAY TO LEVEL THE LEGS

The chair is sitting on a level worksurface, the front legs are raised on blocks to achieve the proper tilt to the seat. The seat is then leveled from left to right with shims (if necessary). Measure from the front of the seat to the worksurface – 17-3/16" in this case. Decide on a final seat height – 15-11/16" in the illustration. Subtract the seat height from the overall height to determine how much wood you need to cut off – 1-1/2" in this case. Cut a block of wood to that length. Use the block to scribe the legs with the help of a Half Pencil.

THE HALF PENCIL

Plane a carpenter's pencil in half with a jack plane until you get to its lead. This pencil (turned upside down in this photo) can scribe your legs without accounting for the pencil's thickness.

planing stop, stick it to a scrap board with carpet tape and plane it in half with a jack plane. Once you own one, I suspect that you will find uses for it outside of chairmaking.

THE TWO BIG IDEAS

Put the chair on your level surface. I'm sure that (like my chairs) it will wobble on the flat surface and look a bit awkward.

The goal is to prop up the legs so the seat is:

1. Level from left to right.
2. Sloped from front to back so that the chair is ideal for either dining/keyboarding or lounging.

Getting the chair level from left to right is straightforward. Place your bubble level on the seat and shim the legs so none of the legs wobble and the seat is level to the floor.

Now you need to set the "tilt" of the seat. How much does the seat slope downward from front to back? A seat that is level from front to

LEVEL, LEFT TO RIGHT
Use shims to level the chair's legs from left to right. Make sure the legs don't wobble.

back isn't ideal. The sitter will feel like she is being pushed forward a tad. The seat needs to slope backward for most sitters (exceptions: some people with knee problems and guitar players).

But how much?

The system I use is based somewhat on the way chairmaker John Brown worked. The seat should slope backward by "one finger" for dining chairs. And "two fingers" for lounging chairs. Feel free to experiment with "three fingers" for even more lounging.

Place the level on the pommel and the back of the spindle deck. Place one finger under the level at the back of the chair. Does the bubble level read level? If yes, then your chair is pitched correctly for a dining chair.

Usually, most chairs need to have their front legs propped up on scrap blocks to be sloped two fingers or three fingers back. If your chair (as built) is pitched at "one finger" and you want it to be "two fingers," then you need to prop up the front legs by "one finger." My

TWO FINGERS

I have put blocks under the front legs of the chair until the bubble level reads level from front to back with two fingers under the rear of the level. This pitch is ideal for lounging.

fingers are about 3/4" wide. So, I'll cut scrap blocks about 3/4" wide and place them under the front legs – plus any wedges.

Then I check the slope from front to back. If I can put two fingers under the bubble level at the back of the chair and the bubble level reads level, then I'm where I need to be. If I want more pitch, I'll add taller blocks at the front legs. If I want less pitch, I'll use shorter blocks.

Mess with the blocks and wedges until the seat is level from left to right and pitched like you want it in real life. And make sure it doesn't wobble on the block and wedges.

SET THE HEIGHT OF THE SEAT

Now you need to decide how high the front of the seat will be from the floor. Standard chair height is 18". I think that's too high for most shorter people. Older chairs were more like 15" or 16" off the floor, which allowed shorter sitters to keep their feet flat on the floor (instead

SET THE SEAT HEIGHT

The tape measure is set for the seat height and hangs down from the pommel. I am measuring the distance between the tip of the tape and the level surface with a 6" rule.

of swinging uncomfortably free).

If you are unsure about the seat height, mock it up with a standard 18"-high seat. Put a 1"-thick board on the floor in front of it (for your feet) to see how 17" feels. Prop that board up on 1"-thick blocks to see what 16" feels like.

When you settle on a seat height, set your tape measure to the seat height and lock its blade. Hang the blade off the pommel of the chair. With your 6" rule, measure the distance from the tip of the tape measure's blade to your level worksurface below. Write down that measurement (for example, 2-3/8").

Now crosscut a scrap to that dimension. I like to think of this chunk of scrap as the "floor" that the chair will sit on. I place the scrap on the level surface and put the half pencil on top. Now I can scribe all around the legs with the half pencil.

Take your time scribing the legs. If you get in a rush, the pencil's tip will ride up or down on the angled legs. You'll know this happened if your pencil lines don't meet at the corners of your legs.

The scribing is done. Now cut the legs to length.

OTHER SCRIBERS

You can use a cabinet-scribing tool instead of the block of wood shown in the photos. These scribing tools are adjustable. The scriber I prefer is called the Tooley Park Scriber. Another option is to tape a pencil to your sliding bevel to transform it into a scribing tool.

SAW THE LEGS

To saw the legs down, you can use a vise or clamp that has jaws that stick up above the benchtop, such as a Hi Vise or carver's vise. Another option is to put the chair on its side on the shop floor. Use one foot to hold the chair in place and a handsaw to cut the legs. Saw one leg, rotate the chair, repeat.

When sawing legs in a vise, I use a Dozuki. If the leg is hexagonal or octagonal, I begin by making a shallow kerf on one facet of the leg. Then I make a shallow kerf on the two adjacent facets and deepen the cut. Then I'll saw two more adjacent facets. Then I saw the rest of the way through the leg. To reduce splintering, be sure to lighten up on your downward pressure as you cut through the far side of the leg.

If the leg is round, the procedure is similar. I start a shallow kerf,

CONFIRM THE SETUP

Below the tape measure is the block of wood I will use to scribe the legs. I am confirming that the block will produce the desired seat height.

SCRIBE THE LEGS

I usually use a block of 4x4 to scribe the legs, but sometimes I don't have one handy. As always, use what you have.

OR USE A SCRIBER

A dedicated cabinet scribing tool (foreground) or a sliding bevel with a pencil can also scribe the legs' final length.

HANDSCREWS MAKE IT EASY

One jaw of the handscrew is clamped in the leg vise. The other can move free. This allows me to clamp odd items (like chair legs) for sawing.

then extend its length a little forward and back. I deepen the cut and extend it a bit more until I feel like the kerf is well established. Then I go for it. While the freshly cut leg is in your vise, round over the sharply sawn corners of the foot with some #80-grit sandpaper. This will prevent the legs from splintering.

COMPLETE THE FEET

I use a rasp to bevel the edges of the feet – a 1/8" x 1/8" bevel is nice. You also can use a knife or block plane to cut the bevel if you prefer.

I like to add soft pads to the feet so they won't scrape up a wooden floor. Good choices include quality self-stick wool pads or gluing shop-made leather pads to the feet.

In general, avoid the hardware-store adhesive furniture pads. The adhesive doesn't last. I've had headaches last longer than cheap pads.

TROUBLESHOOTING

The most common problem when leveling the legs is making an errant saw cut. Straying from the line a little will make the chair wob-

FIX YOUR FEET

Hold one of the too-long legs against a sacrificial surface. Run a ryoba between the foot and the surface. Then test again.

ble. Tracking down the problem and fixing it requires patience.

You will need a flat worksurface. If you still have your worksurface set up then use that. If you don't, you can use an old chairmaker's trick: Use a window in your shop. Glass is dead flat. Put the chair on the worksurface (or against the glass) and note which two legs are touching the flat surface and which two are wobbling. One of the two legs that are touching need to be reduced in length. Mark those two legs.

Place the chair on a flat surface on your workbench. We use a crap piece of particleboard. Press one of the two long legs against the flat surface (it doesn't matter which long leg you choose). Run a Ryoba or a flush-cut saw between the foot and the particleboard. This will saw away a bit from the foot of the long leg. Test the chair again. If it still wobbles, repeat the process until it sits flat.

WILL THE PATIENT LIVE?

Dedicating a day to improving the details on a chair always pays off in the end. A moving blanket protects the chair from further damage as you move it around.

MAKE PRETTY

At some point I decided to add one more step to the construction process of every piece of furniture I build. Instead of stampeding from assembly into finishing, I added a day of work that's called: Make Pretty. (Chairmaker Peter Galbert came up with the term, which is awesome.)

On this day I do nothing but try to bring every surface of a piece up a notch. I look over every inch to find small defects that can be remedied, or details that can be made crisper. I look at bevels and mouldings to see if I can tweak their corners so they flow more smoothly. I look for tiny bits of glue or splinters (even on secondary surfaces) that I can pare away. I check curves and overhangs to see if they can be subtly altered to be more harmonious with the rest of the piece.

Make Pretty might sound like a drag. But I find it to be the most satisfying part of making a chair. For one whole day I get to look at a thing I've made before it heads off to a customer. So many times, I've looked at photos of my pieces that are now 1,000 miles away, and I can barely remember working on them.

Make Pretty is the conjugal visit before the great separation.

I have a set of tools that I use for every session of Make Pretty:

- A moving blanket/furniture pad.
- A freshly sharpened cabinet scraper.
- A handful of flat sticks covered with #100-, #180- and #220-grit sandpaper (basically shop-made emery boards).
- A sharp 1/2" chisel.
- A cork sanding block and #220-grit abrasive.
- A small UV flashlight (to highlight smears of hide glue).
- Hot water and a toothbrush (to remove smears of hide glue).
- My shop's two logo stamps.

For me, Make Pretty begins with basic surface preparation. I plane all surfaces until I can't improve them. I then scrape out any bits of

SANDING STICKS

These bits of oak are 3/8" x 3/4" x 5" and have different grits adhered to their broad faces, but not their edges. This configuration allows me to sand one surface without touching adjacent ones.

tear-out that planing refused to tame. Lastly, I blend the planed and scraped surfaces with #220-grit sandpaper. A consistent surface helps create a consistent finish.

If the surfaces of the chair don't feel smooth enough at that point, I'll take handfuls of shavings and burnish the surfaces that are frequently handled. This usually does the trick without interfering with the final finish.

Next come the small details. I put the chair on a moving blanket and look at every joint in the piece. I ask: Can I do anything to make this better? In a case piece, this might mean a little bit of glue and sanding dust to conceal a hairline gap. In a chair, it might require a sliver of a wedge to fill a void where a wedge shifted during assembly.

I look for stray splinters where tenons were driven hard into mortises. I look for tiny beads of glue that evaded my eye after assembly.

After looking at joinery, I look at individual components. I examine each stretcher to see if there are odd flats where the double-tapers meet. Is there tear-out I can remove? Do the stretchers transition evenly into the tenons? Can they be evened up?

The same goes with the chair's sticks. Mostly I look to see if there are small irregularities I can correct. Sometimes a stick's tenon is slightly offset from the center of the stick. A little scraping on the heavy side of the stick conceals this.

On legs I look for dents that occurred while moving the chair about. Can they be steamed or scraped away? On the arms and the shoe I look for tear-out, corners that aren't crisp and bevels that don't meet evenly.

This process continues over every single component.

After that, I look at broad surfaces. Can I improve the line between the spindle deck and the saddle? Can I make the pommel crisper? Is the curve on the comb perfect, or can I eliminate small bumps or hollows with some sanding? Are the arms perfect to the touch?

I spend extra time looking at end grain that shows in the piece. Because end grain is more difficult to work than face grain, it's common for the end grain to need extra attention to remove scratches so it matches the finish level of the face grain.

GETTING READY FOR FINISHING

When I have corrected every error I can find, I turn to making the arrises of the piece ready for finishing. In most production woodwork, all edges get "broken" by a quick rub with fine sandpaper. Breaking the edges makes the piece pleasant to touch – and can prevent sharp arrises from cutting flesh.

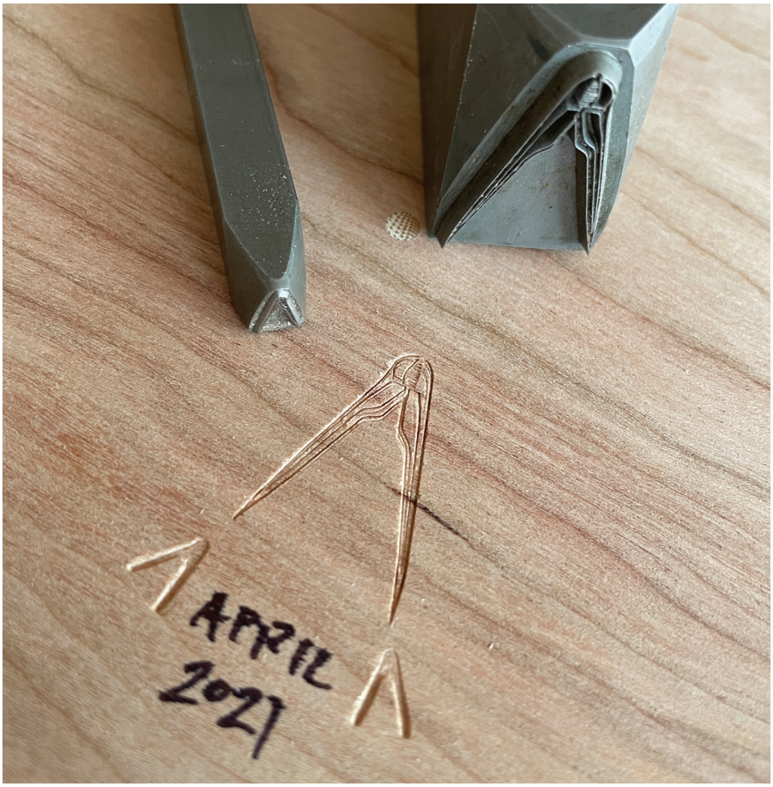
I like to go one step further. On the most visible surfaces – the comb, hands and seat – I'll sand a small bevel using my sticks that are coated with adhesive-backed sandpaper. This bevel is about 1/32" across. And it takes time to do it right. When the bevels meet at corners they need to be the same size.

Has a customer ever noticed this? Probably not. But I do it anyway. I love to see the consistent little bevel as it catches the light on the corner of the comb or the hands.

Even if you aren't as crazy as I am, make sure you break all the edges of the piece before you add any finish.

TINY BEVELS

On the most visible surfaces, I use my sanding sticks to make a small bevel, instead of breaking the edges with a piece of loose sandpaper. A beveled corner feels the same to the hand, but it looks tidier (to me, at least).



TWO DEMERITS

I made two careless errors on this chair that only I'll notice. Perhaps the next chair will have only one small mark.

Once I complete Make Pretty, I mark the chair with my shop symbol – a pair of dividers. I have two shop marks. One large and one small. I first mark the underside of the seat with the large dividers. Then I add one mark with the small dividers for every unforced error in the piece. These remind me I'm human and I acknowledge my mistakes. I've never told my customers this, so keep your trap shut, OK?

Lastly, I write the month and the year below my shop mark in permanent marker. I don't try to imitate old work, but I'd hate for some idiot to represent it to some moron as an antique.

PATINA

The less-durable finishes have one distinct advantage: They look better with age. I like a finish that is easy to apply, fairly non-toxic and looks better with some miles on it.

CLEAR FINISHES

While the joinery in a chair has to be durable, its finish does not. In fact, I prefer chair finishes that readily accept oils, burnishing and tiny scratches. In my opinion, patina improves a chair.

As a result, I prefer finishes that don't seal up the work in a tenacious film of goo. My two favorite chair finishes are 1) linseed oil/beeswax and 2) soap. Followed quickly by: 3) any sort of paint.

Most woodworkers on the planet disagree. They want a finish that is strong, easy to apply and shows off the beauty of the wood. Sometimes my customers request these sorts of finishes, so I use them on occasion. But when I build a chair to please myself, I apply oil, wax, soap or paint to my work.

If you are unsure about finishing, I have written the following explanation of how I grapple with the safety, durability and looks of common finishes. My diatribe is far from definitive (so that's one thing we can all agree upon), but it is heartfelt.

FINISHING FOR THE LONG %^&%$#@ HAUL

When I talk about finishes with customers and fellow woodworkers, most are concerned about impenetrable, absolute durability. That is, how much toddler can the varnish on this chair take? One toddler? Perhaps 2.3 toddlers?

I've always struggled when having this conversation because my opinions are upside down compared to most commercial shops, factories and (sometimes) home woodworkers. They favor polyurethane, lacquers and other hard film finishes as the armor against the army of the babies, the platoon of hot pots and the rivers of fingernail polish remover and spilled chardonnay.

Because my work is on the vernacular side, I prefer finishes that can be easily repaired, that look better with some miles on them and (here's the downside) require routine maintenance and care.

I dislike finishes that form a seemingly impenetrable surface film. Why? When these "highly durable" film finishes fail under duress, they tend to fail spectacularly with ugly chipping, crazing and scuffs. And repairing these durable film finishes can be difficult or impossible. Sometimes you have to remove the stuff (a health hazard), re-sand (a lung hazard) and reapply another finish (another opportunity to bathe in volatile organic compounds, aka VOCs).

Put another way, using "durable" lacquers, varnishes and polyurethanes is like buying cheap clothing. It looks great for a while, but in a few years, it won't be good enough for even a Goodwill donation.

So, when I choose a finish, I ignore the industry-standard scratch and adhesion tests. Instead, I separate finishes into four buckets:

1. Finishes that look incredible immediately but look like crap in 20 years (the short-run finishes).
2. Finishes that look incredible when worn (the long-run finishes).
3. Finishes that want me dead.
4. Finishes I can apply while buck naked.

If you like graphs and stuff, you could create a four-quadrant matrix chart and place every finish into one of the quadrants. Perhaps I'll do this some day. Or maybe it's best if you do some of the work as you ponder your favorite finishes. For now, let's talk about what each of these categories means.

FINISHES THAT LOOK FANTASTIC IMMEDIATELY (SHORT-RUN FINISHES)

My first woodworking job was at a factory that made high-end exterior doors. While part of my job was to cut rails and stiles, most of the time I worked in the finish room. Our goal was to make doors that looked great on the showroom floor and could endure the indignities of sun, rain and snow.

So, we used lots of pigments and glazes to color the wood. Plus, lots of two-part high-tech film finishes to protect the color and wood below. This finish was so nasty you couldn't even go into the automated spray booth without a protective suit on. (What exactly was the finish? They wouldn't say.)

THE LUST FOR LACQUER

When it comes to finishes that are fast, easy and hard (get your mind out of the gutter), it's impossible to beat spray lacquer. Spray it on the project, wait 10 minutes and spray it again. And you should be good for at least a decade. After that, however….

But when the finished doors came out of the booth, they were stunning. Though I didn't own a house at the time, I wanted to own one of those doors.

I think it's fair to say that a spectacular finish is one of the two key ways to impress a customer (the form of the piece is the other). Customers aren't (in general) a good judge of joinery or wood selection. But they do know smooth and shiny – thanks to plastics.

As a result, most people prefer finishes that offer the feedback of a Tupperware bowl. And commercial shops prefer finishes that are fast to apply. Combine both properties – smooth and easy – and you have a winning commercial product.

Lacquers, shellac and varnishes (including polyurethanes) all offer that plastic feel with minimal effort in the workshop, thanks to spray equipment and solvents that make them easy to apply. These finishes are, in general, quite durable in the short run. They are not likely to scratch or scuff – at first. Most are water-, heat- and alcohol-resistant – at first. And they offer low maintenance – until they cross a magic tipping point where they fail and become super ugly.

There is, of course, also the question of what the piece of furniture is used for. If you use these short-run finishes on a picture frame, an honored cabinet or decorative object that rarely gets touched, it will likely look good in 100 years if it lives in a climate-controlled environment. But this is true no matter what finish you use.

So, it's easy to see why many woodworkers prefer these short-run finishes. Heck, I loved them for many years. They look great immediately (everyone's happy), they are fairly easy to apply (the woodworker is happy) and they take a beating for a decent amount of time.

And to be 100-percent fair, there are times when I still use these short-run finishes. Some pieces are reproductions and need a shellac finish to be true to the original. Sometimes a customer insists on a lacquer or polyurethane – even after I explain the downsides. I'm in no way a purist. (Purity is for virgins and trust-fund babies whose money lets them live a deodorant-free lifestyle.)

Some finishes that look fantastic immediately:

- Shellac
- Lacquers of all sorts
- Varnishes of all sorts (wiping, spar, brushing etc.)
- Polyurethane (it's also a varnish, but most people don't know that)
- "Danish" oils that contain varnish
- Water-based film finishes, such as water-based lacquer and "poly" (a misnomer, but whatever)
- All-in-one stain and finish products (actually, I don't know if these ever look "fantastic")
- Acrylic paint
- Oil-based paint

FINISHES THAT LOOK FANTASTIC IN 20 YEARS (LONG-RUN FINISHES)

If you love antique furniture, you probably prize patina – the gentle wear and tear that a loved object develops after years of use. I think of patina as a combination of natural oils (from you, plants and other animals), grime, wax, paint, UV, scrubbing, scratching and burnishing.

ARE YOU FINISHED?

This chair is American sycamore that has been finished with soap. The sheen is incredibly low. So low that some people will wonder if it has a finish on it. If you touch it, however, the wood feels incredibly soft. Soap is a legitimate finish.

Some finishes are ideal for building patina. Oils, waxes and soap are all finishes that tend to accumulate patina rapidly because they offer little or no protection. Interestingly, I find these finishes can be less impressive when first applied (though some people like me love them). For example, a soap finish on a beech chair looks like a beech chair that doesn't have any finish on it – perhaps a little bleached. An oil finish doesn't develop any real sheen until you apply lots of coats, such as with a gunstock finish. And wax finishes fade quickly.

If you want these basic non-film finishes to look great, you need to put in the hours. That means more work and more coats as you apply the finish to achieve an initial "wow" response, plus more hours of maintenance with high-wear items, such as dining tables.

But if you stick with the program, reapply a yearly coat and stay away from the dip tank and spray booth, you will end up with furniture that is as inexplicably beautiful as a weathered face.

Finishes designed to look better with age (after years of maintenance) can be difficult to sell to a spouse or customer. And that's why our family's dining table is covered in pre-catalyzed lacquer and – after only 10 years – was a mess of ugly flakes and crazes. The wood's figure is almost completely obscured by the deteriorated finish. (Yes, I hate myself for this.)

If you don't want to end up with this sort of guilt, consider these finishes that look fantastic in the long run:

- Oils of all sorts (linseed, tung, walnut and other true oils that don't contain varnish)
- Waxes of all sorts
- Oil and wax blends
- Soap
- Milk paint
- Paints
- Scrubbed finishes – bleach, lye and soap

SIDEBAR: PAINT COVERS EVERYTHING

One of the interesting exceptions to this taxonomy is paint. Paint can fit into every category, but that's because there are so many different kinds of paint. It can look stunning when first applied, such as an automotive finish, then look bad when it fails. Or it can look great in

DEATH TO LACQUER
After about 10 years of use, the lacquer finish on our dining table is a wreck. Someday I'll scrape this finish off.

20 years, such as a true milk paint finish or a linseed oil paint.

Likewise, paint can be safe enough to eat – you can make it from raw linseed oil (or eggs) plus a little dirt and beeswax. Or it can wreck your body when it's loaded with lead.

Because we can't make many blanket statements about paint, we're going to need some adjectives when we talk about this finish. Latex (aka emulsion) paint is a different animal than casein paint (usually called milk paint). Oil paint is different than powder coating. Each paint has its own risks and rewards. There's more on paint in the next chapter – an in the book's appendix.

FINISHES THAT WANT YOU DEAD OR SICK – OR AT LEAST IRRITATED

The truth is that most of the cured finishes on the furniture in your house are inert and mostly harmless. The resins, waxes and oils in the finishes are derived from natural ingredients – wood, flaxseed, bees-

'MILK' THAT NEVER SOURS

This chair is finished (in part) with an acrylic that is marketed as "milk paint." It's a good product, but it makes me crazy that the company doesn't tell the truth about its product. The onus is on us to decipher the misleading labels.

NOT BOILED

The label says "boiled linseed oil." To my knowledge, this home-center stuff has never been boiled. Instead, manufacturers add toxic metallic driers to make it behave like a traditional boiled linseed oil or "stand oil." Go to the art supply store or a specialty finish manufacturer for non-toxic linseed oil.

wax – and would do little harm if you ingested them.

The problem, then, is the solvents and additives – the chemicals that allow the finish material to flow, to be applied to the wood and to assist the finish in drying quickly and beautifully. Solvents can be mostly harmless (water) or frightening (benzene, xylene or toluene). When I consider how "safe" a finish is, I'm mostly worried about the solvents and drying agents.

Let's take linseed oil as an example. It's derived from the harmless flax plant, and you can buy it at the grocery store to use in salads, soups and dips. It's not going to hurt you. In fact, it might be healthy. But when you buy linseed oil at the home center, it can be a different story.

"Boiled linseed oil" is not simply flaxseed oil that has been heated so it will dry in a reasonable amount of time. (If it were, that would be nice.) Instead, boiled linseed oil has been doctored with heavy-metal drying agents (such as cobalt manganese salt), so the oil is convenient for woodworking or painting. The drying agents turn this grocery store item into something that can make you feel sick if you breathe in too much.

Added to that is the problem that most people thin linseed oil with mineral spirits (paint thinner) to make it easier to wipe on than Mrs. Butterworth's pancake syrup. Mineral spirits are distilled from petroleum and contain forms of benzene, which has been shown to cause cancer in animals. Mineral spirits are also an irritant to your eyes, ears and respiratory system. So even stuff that seems natural and harmless isn't necessarily so. You have to dig a little deeper.

My goal is to use finishes that won't make me sick or shorten my life. That might seem like an easy task. The problem is that most off-the-rack commercial finishes are at least a little poisonous.

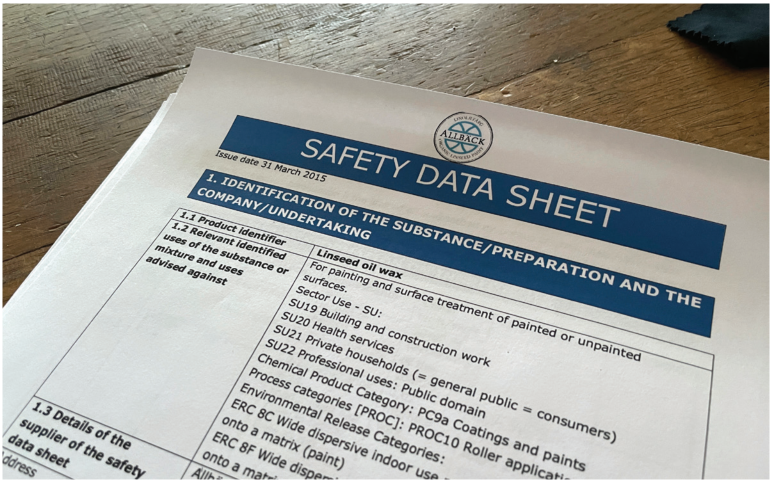
I wish I could list every brand of every finish here and rank them from mostly harmless to a hazmat. Unfortunately, finish formulas change, environmental laws change (for better and for worse) and commercial brands come and go. When you consider buying a finish that is new to you, my advice is to look up its Material Safety Data Sheet (MSDS), sometimes called the Safety Data Sheet (SDS). These are available from the finish manufacturer and are widely published on the Internet.

Read them over and keep in mind that it's like reading the side effects of prescription medicine (may cause death....). If the SDS doesn't scare the living crap out of you, it might be worth a go.

Oh, and there are a lot of finishes that are flammable. You'll find that out on the safety data sheets, too. That's also bad.

Finishes that want you dead, sick or at least irritated:

- Shellac with methanol
- Solvent-based lacquer (catalyzed and pre-catalyzed lacquers)
- Polyurethane and varnish thinned with mineral spirits
- Oils treated with heavy-metal drying agents
- Cyanoacrylate (super glue) finishes
- Finishes thinned with turpentine



BEYOND THE LABEL

The instructions on a can of finish are not enough if you really want to know what you are working with. The Safety Data Sheet (SDS) is essential to understanding the risks.

FINISHES YOU CAN APPLY BUCK NAKED

I wish this were a huge category of finishes for you to explore. It's not. Many waxes have harmful solvents. Most oils contain some heavy-metal driers. So, I have to say that most of the safe finishes are ones you make yourself. Or they are finishes that are basically raw ingredients that get applied with cleverness.

There are some manufacturers that specialize in making finishes without VOCs or other harmful ingredients. I have experience with finishes from Tried & True, though there are other manufacturers out there with similar products. The bottom line is that when searching for any finish, it's always eye-opening to read the safety data sheet (the SDS). Just because a label says the finish is "all natural" doesn't mean it's safe. Venomous spiders are all-fricking-natural as well.

I'm going to be honest and say that most of the finishes in this category require a little more skill or effort to apply. They all require main-

ELBOW GREASE

A polissoir and a little beeswax can produce a beautiful low-luster finish. The wood fibers have been burnished by the polissoir and there's a little bit of beeswax left behind – the beeswax is a lubricant applied to the polissoir.

tenance (if the finished object is regularly handled). And they might not be the always-shiny finish that reflects every sunbeam.

But I love these finishes.

Many of them are rooted deep in our history and have been largely forgotten. One of my favorite finishes in this category is a pure beeswax finish applied with a "polissoir." A polissoir is a stiff bundle of abrasive sticks – usually rush or broom corn – that is used to burnish the wooden surface with some beeswax until it is impossibly tactile and lustrous.

The downside? It's a lot of work to burnish a large object with what is basically a bit of a broom. If you did this in a high-volume commercial shop, two things would happen. First, you'd go out of business because finishing a table this way would take a day or more. (But your pecs would look awesome.) Second, your one customer would complain the first time he or she abused the table with heat or alcohol. It's a finish for a special type of customer – usually yourself.

Other safe finishes have yet to leap a cultural barrier. In many places in Europe, furniture and floors are regularly finished with plain old soap. Yes, the same thing you use in the shower (minus the detergents etc.). It's a great finish for light-colored woods. But soap requires regular maintenance and doesn't offer any significant protection.

Me, I think these finishes are worth the effort. We live in a world where everything has been formulated – processed foods to target a sweet tooth and plastics to surround us with slick smoothness. Heck, some casinos even pump their halls full of chemical smells to mask the harmful tobacco smoke and trick your brain into doing something really stupid in Las Vegas. With a donkey.

Your furniture shouldn't be like that. It's made from trees. It's built with your hands. Why should we slather it at the end with synthetic chemicals that harm us? Because let's be honest: It's the woodworker who bears the brunt of the VOCs and heavy-metal driers. By the time the project gets to the customer, most of the harmful stuff has evaporated.

There's one other benefit to these finishes that might not be obvious. Many woodworkers are worried about the future of the craft. As the older generation dies out, it's uncertain if there will be younger woodworkers out there to replace them. By using safer finishes, you'll do something to extend the craft – you'll live longer.

Finishes you can apply buck naked (without a luxury health plan):

- Natural waxes without VOCs
- Natural oils without driers or solvents
- Soap
- Oil and wax formulas (without VOCs)
- Casein paint (aka milk paint)
- Linseed oil paint (without VOCs or driers)
- Any paint that is a natural oil with safe pigments (yes, there are both safe and unsafe pigments) plus a dab of beeswax
- Some water-based finishes (check the safety data sheets)
- Shellac dissolved in ethanol (though some of you will debate me)

KNOW YOUR OILS

It's easy to side-step toxic finishes. A visit to any artist's supply store will turn up a variety of oils and waxes that you can investigate. Our local art store carries "stand oil" – linseed oil that has been heated so it will polymerize (it takes about a week to dry). And "refined oil," which dries in three days. Yes, the stuff from the art store is more expensive than the toxic stuff at the home center. Your call.

MOST OF ALL, BE REASONABLE

I won't lie to you, I use finishes from all four categories. I make a lot of different pieces of furniture for customers who have their own set of desires when it comes to a finish. I think that's OK – it's the woodworker who bears the brunt of the VOCs.

So, it's up to you to know the risks of applying a finish. You need to buy – and use – the right protective gear. Avoid shortcuts. And if you ever start to feel intoxicated or lightheaded while finishing, know that you are doing something wrong.

Also know there are always ways to make a particular finish less toxic. Substitute ethanol for methanol. Use odorless mineral spirits instead of turpentine or regular mineral spirits. Use stand oil (pure linseed oil without metallic driers) instead of boiled linseed oil.

Most of all, however, you can make your life a lot less chemical and volatile by simply opening your mind to different ways of working. A good oil-and-wax finish is easy to apply, is incredibly tactile and can be practically non-toxic. Try soap. Make your own paint. And read the safety data sheets for the stuff in your shop. Though the safety sheets can be confusing and difficult to interpret, it's pretty easy to determine if a finish is scary or drinkable.

My goal is build things that endure, and that allow me to endure as well. I know too many woodworkers whose bodies have been wrecked by the heavy lifting and the chemicals of our craft. I know too many who have had scares with unusual cancers. And I'm haunted by stories of fellow woodworkers who dropped dead suddenly as they walked out of the shop's spray booth.

I don't want to be that person. I want to die at a very old age, in a bed I made that is finished with an oil and wax I cooked up myself.

If you have the same sort of urge, these ideas are where to begin.

OK, BUT CAN WE JUST FINISH A CHAIR?

Diatribe aside, the finish I use on most of my chairs is a mixture of linseed oil and beeswax. The linseed oil has been polymerized via heat (or other processes) so it will dry completely in about 24 hours. The stuff is so safe you could eat it.

As of this writing, there are many brands of this finish out there, including Allbäck Linseed Oil Wax, Tried & True Original, Odie's Oil and Heritage BeesBlock.

I have included a homemade recipe for this finish in the appendices. This recipe was developed first by finisher and woodworker Jeff Stafford (I've modified it). Making it yourself will save you money, and it allows you to make the finish thicker or thinner if you like.

First, let me say that all the versions of this finish that I have used are fantastic. They are simple to apply without any special equipment. They give the chair a nice soft glow. And they readily accept additional coats of finish, or they can go right into service after one coat and patinate naturally.

FAIL SAFE

I have yet to fail with this linseed oil/beeswax finish. It is so simple to apply. If you follow the instructions – especially the exhortation to wipe the excess until the project is dry – you'll do great.

The only difference among the products I have found is their viscosity. Some, like the Allbäck are like peanut butter. Tried & True is like snot. And BeesBlock is like a thinned linseed oil. I suspect the difference is caused by how much wax and solvent are in the mix, but I can't say for sure. It could be the brand of oil I use that week.

Here's how I apply them. I use a gray 3M woven pad to apply the finish. I like this pad because its slight abrasiveness helps smooth any rough spots, especially up around the spindles where it is hard to work with sandpaper or scrapers.

I put the chair upside down on my bench and coat every surface I can easily reach, rubbing the finish in. End grain needs extra finish because the grain will suck it up. After I coat all the surfaces of the chair that I can reach, I let the chair sit for 5 minutes.

Then I take a huck towel (a surgical rag with no lint) and vigorously rub off any excess finish. I keep rubbing until the surface is dry.

BETTER WITH AGE

The linseed oil/beeswax finish definitely looks better the more you sit in the chair. The oils and abrasions from use blend in with the finish.

Then I turn the chair over and finish the rest of the chair's surfaces, let it sit for 5 minutes then rub it with the huck towel.

I look for dry spots, especially on the end grain, and add some more finish. When I'm satisfied, I let the chair sit overnight. Then I rub it vigorously with a new huck towel. The chair is done.

You can apply additional coats of finish if you like, or you can put the chair in service. After about a year you might want to apply another coat. Or let nature take its course.

MIXED MESSAGES

This chair was made with scraps of oak, ash, maple, cherry and poplar. I first applied a couple coats of garnet shellac. Megan Fitzpatrick then painted the right half with General Finishes Milk (not really milk) Paint in Lamp Black.

RECONSIDER PAINT

When I started building chairs I was, like most woodworkers, in love with wood's grain.

That should be universal, right? Wood is so gorgeous that people write poems about it. Its annular rings force us to ponder the passage of time and our small place in the world. And the wood's figure can be literally mesmerizing, with shimmering bands of chatoyance that flow and crash across highly figured boards.

Why would anyone except a madman paint it?

I thought the same thing as I assembled my third stick chair in 2004. It had an elm seat, an oak armbow and ash for the sticks and legs. My plan was to make it resemble the old chairs I admired. I wanted that rich dark brown that comes from decades of a chair sitting by a sooty fire – burnished by dirty hands, amorous animals and work clothes.

I decided to use a brown glaze that I had years of experience with. I'd used gallons of the stuff on Arts & Crafts-style pieces, and it always gave the oak a nice Van Dyke brown.

I applied the glaze to my chair and realized my error. The elm, oak and ash looked radically different with a coat of glaze. Instead of unifying the three species into one nice brown, the chair looked like it had a skin disease.

The next day I considered a dozen options, from stripping the chair bare to applying toners in an effort to blend the three different wood colors. But in my heart, I knew I was headed for the paint store.

I bought a quart of dark green latex. I felt defeated when I began brushing it on, but after a single coat of green, the chair came to life.

Instead of seeing the wood's grain lines, medullary rays, pores and chatoyance, I saw something far greater. I saw the chair's form. And it was striking.

I saw the curve of the seat and the angle of the sticks. The chamfer I'd planed on the arm grabbed the light and pulled my eyes around the arm. The sticks matched one another perfectly. It was like seeing the

HOW COULD YOU?

Many woodworkers have asked how I can paint over the beautiful grain of the wood and the expressed joinery of my chairs. It's easy, I say: with a 2" brush.

physical embodiment of geometry. That day I fell in love with painted chairs.

Today, I am happy to use clear finishes when the wood cooperates, such as when all the components come from the same tree. At best, these chairs balance the beauty of the grain and the geometry of the chair. It's like the tree and I each had a say in the result.

But I am just as happy – maybe happier – to paint my chairs. That's when the form of the piece takes control. The chairs become graphic statements of what can be done with a few tools and a sharp eye. Plus, I get to pick the chair's exact color from an endless palette.

Am I the only woodworker in love with paint? Hardly. Chairmaker Jennie Alexander once said something about paint and wood that I think about all the time, especially when I consider the first European colonists in the New World.

"We think of forests as beautiful places," Jennie said. "Earlier settlers might have seen things differently. Forests were a dark and dangerous place that you didn't go unless you had to. And think of it – everything in their lives was wood. The walls, the chairs, tables, tool handles, buckets, fences. Everything – wood.

"Painting wood might be a way of escaping that fear of the forest. Or demonstrating that we had conquered it – by turning it into something that didn't look like wood."

I know that paint is a hard sell with many woodworkers. It is in the same category of materials as wood putty and Bondo. It's stuff that should be used only for covering up mistakes or hiding damage.

I take a different view. In my mind, paint is the cruelest finish. It reveals the weakness of our designs. The error of our proportions. And our failure to consider the visual weight of every component. With a coat of paint, we cannot hide behind the wood's grain.

While I don't think the deceit is intentional, using a big swath of curly maple makes it difficult for viewers to really "see" a piece's form, whether that form is good or indifferent. And if you glue some contrasting bands of walnut or wenge into your curly maple panels, things will be so busy that I guarantee that no one will be able to see the form – and the failure of your design.

No matter how sharply I make these arguments, it is difficult to convince woodworkers to pick up the paintbrush. (Except the Forest chair people – they get it. Almost every Forest chair is painted.) The before-and-after photo in this chapter might help sway a few people into the paint camp. But for the rest, I know there is only one way to persuade you of the power of the pigment. The allure of the acrylic. The titillation of the tempera.

You have to build a chair that looks like shit.

YOU CAN ALWAYS ADD A CUSHION

Wooden chairs can be comfortable, but sometimes I think people ask too much of them. If you ever despair that your wooden chair isn't as comfy as a La-Z-Boy, then put a cushion (or sheepskin) on the wooden chair.

Image: Print maker Jan Luyken, 1711, Amsterdam. Now in the collection of the Rijksmuseum

CHAIR COMFORT & DESIGN

As a baby chairmaker, I read every book and article I could find on chair design. And to be honest, I still do that.

These days, most of the "new" stuff I learn about chair design comes from looking at chairs every day and reading about how they were made. But back in the 1990s, I was looking for magic formulas to ensure my chairs were beautiful and comfortable.

There is a lot of questionable design information out there. One woodworker who had been in the trade his whole life told me the "Rule of Seven." It's this: When you look at the angles on a chair, 7° is the answer to a lot of your questions. How far should the backrest tilt? How much should the seat be pitched from front to back? How much rake for the back legs? Splay for the front legs? The answer was 7°.

This is not a good rule.

Making a stick chair that looks good and sits well is more complicated than following a formula. But there are some guardrails and guidelines that can make the process easier. Plus – and I'll be damned for saying this – there is one tiny Magic Formula I can offer to help you along the way.

Before we get to the formula, there are some important numbers that determine how a chair will interact with the human body. After you have settled on a set of numbers for a chair, then you can work out how the chair will look – its design, if you will.

SEAT HEIGHT

The height of the front of the chair from the floor is one of the most important numbers. The typical modern chair height is 18", a rule few designers disobey. I think 18" is too high to be a strict rule. Old chairs were typically a little lower.

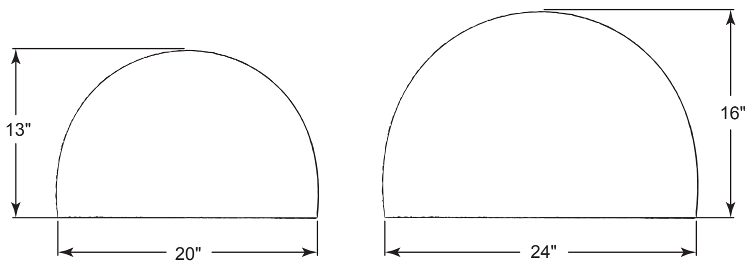
Tall seats punish shorter sitters. If their feet cannot rest flat on the floor, the front edge of the seat will constrict blood flow in the thighs, which is agony-inducing after 30 minutes or less.

Slightly shorter seats, however, are (mostly) fine for tall sitters. Their feet can still rest on the floor, and their thighs hover above the seat – allowing blood flow. The downside for a tall person sitting in a short chair is that the short chair is a little more difficult to get out of. So short seats are a problem for people who have certain mobility problems – they need a taller seat to make it easier to stand up.

But for the majority of the population, 18" is too high as a strict rule. So what should the height be? The answer is not cut and dried. Here are the questions I ask to calculate the seat height when I build a custom chair for someone:

1. What is the sitter's "popliteal height?" Some people call this "stool height." It's the distance from the bottom of the foot to the underside of the knee of a seated person. It ranges from 14" to 19-3/8" in the general population.
2. What sort of footwear will the sitter typically use? Work boots, 3"-high heels and moccasins can change the equation.
3. What is the chair to be used for? If it's for dining or keyboarding, it should be a little higher so it is easy to mount and dismount. If it is for relaxing, it should be lower. How low? Seats can be as low as 12"-13" for lounging. Low seats allow you to stretch your legs – a luxury. Low chairs are harder to get out of – but that's the point.
4. Will there be a cushion, blanket, sheepskin or other seat cover? Cushions can add 2" or more to the seat height. A sheepskin can add 1" or more.
5. If I am unsure what seat height to use, I'll make it 1" taller than what my gut tells me. Why? You can always trim the legs later to make the seat shorter. Making a seat taller is no fun.

You might be wondering how to determine the seat height for the general populace instead of for a particular person. When I need to do that, I typically use 16-3/4" or 17" for a dining/working chair. And 15" to 16" for a lounging chair. These are on the low side, but they aren't radically low. Tall people will hardly notice. Short people definitely will, and they'll be grateful.



SEAT LIMITS

The smallest seat and the largest seat I use. Smaller or larger seats are possible, but you can quickly run into problems because of the size of the human form.

SEAT DEPTH & WIDTH

A typical seat depth for many chairs is 16". As with a seat that is too high, a seat that is too deep will cut off the sitter's blood flow behind the knees. Surprisingly, shallow seats work pretty well. I have made seats as shallow as 13", and they sit just fine (unless you have an epic backside or the seat is too high; having both is a difficult combination). A shallow and low seat also prevents the blood in your thighs from being constricted.

In general, I don't fiddle much with the seat's depth. If it's between 14" and 16", it will work for most sitters. This slight flexibility allows me to build seats using narrower boards. If I have to glue up my seat from two 7-1/2"-wide boards, I'll do that and call the 15"-deep seat done. I won't glue on an additional 1"-wide strip of wood to get to the magic 16" depth.

The width of an armchair's chair seat is typically about 20" to 24". Side chairs and backstools can be narrower – 17" or 18". I use 20" unless the sitter is quite large or small. Also, another thing to consider: A 20"-wide armchair will ward away sitters who weigh 250 lbs. or more. If you build an armchair so a 300 lb. person can get between the arms, then you damn well better make sure the undercarriage can handle it.

ARMBOW HEIGHT & SEAT TILT

We're not done with the seat quite yet. But to understand the last bit of seat data, we need to understand the chair's armbow.

Biometric data suggests the top of the armrest should be about 7" to 10" from the seat, depending on the sitter. I usually shoot for 8" to 9". Some customers ask for 11" – this height can make some people shrug their shoulders as they sit. Or it creates a "cage" around them, which could be the coziness they seek.

The small of the back – sometimes called the "lumbar" region of the back – is where I do a lot of work to make a chair comfortable. If you build a chair that supports the lumbar spine, you will make friends – as well as chairs. The lumbar is about 7" to 9" above the seat. This is why I keep my armbows located there as much as I can, and I add a "shoe" above it (and occasionally below it) to increase the thickness of the armbow and the support for the lumbar.

Chairs that lack lumbar support can be fatiguing. I squirm to push my lower back against the chair's back, but my shoulders and buttocks prevent it. I guess this is why we have low pillows.

Having too much lumbar support can also be a problem. So always do a test sitting before you glue up a new chair design. You might have to add or remove some material at the back of the chair to fine tune how it sits.

One of the oft-overlooked aspects of chair design – the seat's tilt – can help the lumbar region slide back to its destination, which is the armbow in my chairs.

Most chairs tilt a little toward the back. A seat that is parallel to the floor can feel like you are being thrust forward out of the seat. Adding some additional tilt can encourage the sitter to slide backward and put the lumbar directly on the armbow.

But how much tilt? I like Welsh chairmaker John Brown's method of using his fingers and a spirit level. Put a level on the seat's pommel so it runs from the front to the back of the chair. Raise the spirit level at the rear of the seat until it indicates it is level. If you can get one finger under the level at the back, that's a chair for dining or other proper things – keyboarding etc. Two fingers and you have a chair good for lounging. Use that information to cut the legs down to get the tilt you want. This is covered in detail in the chapter on leveling the legs.

A GOOD SIT

The backrest of a Gibson chair is pitched back at 25° in many cases. That might seem radical – until you sit in it. It's a comfortable chair and doesn't feel like a chaise lounge. This original and stunning Gibson is in the collection of Mark Jenkinson in Slane, Ireland.

BACK ANGLE

For me, this is where the rules get blurry and surprisingly flexible. Many modern chairs have the chair's back sticks tilted back about 5° to 9° or so. That's fine. But adding more tilt can encourage the body to touch the chair's armbow and the shoe.

I tend to tilt the back sticks about 15° to 20°, but I tilt them even more at times. When I first built a copy of an Irish Gibson chair, I was shocked that its back was tilted at 25°. But when I sat in the Gibson, it didn't feel like I was at the dentist. The Gibson was historically used as a chair in the kitchen – even though it looked more like a recliner. Your eyes and expectations can deceive you.

COMB & BACKREST HEIGHT

How high should the comb (aka the crest) or backrest be? It's a trick question. It's somewhat rare that a sitter's head will touch the comb of a typical highback chair. Usually the shoulders rest against the back sticks, then the sitter's neck brings the head forward.

What I prefer in a highback chair is to have the back sticks support the sitter's shoulders without the comb digging into them. This happens about 22" above the seat. With lowback chairs, on the other hand, the backrest does most of the work of supporting the sitter's back. The backrest can be as low as 11" (to support the lumbar) or as high as 17" (to support the sitter at the shoulder blades).

ABOUT THE SADDLE

And then there's the saddle of the seat – the curvy contours that cradle the buttocks. When I started building chairs and examining them closely, I concluded that deeply saddled seats did more for the look of the chair than its comfort.

That's because "sitting" and "sitting still" are not the same thing. We rarely sit still.

Here is a problem with deeply saddled seats. We sit in them and they feel amazing at first – they support and cradle the bottom in a pleasant way. But we can't sit still. Here's why. In a typical chair, the sitter's weight is confined to about four square inches of buttocks. The pressure on that small area requires us to shift our weight, even just a

AN UNTOUCHABLE COMB

In many comfortable comb-backs, your back hits the sticks – not the comb. In armchairs, however, the backrest is integral to the comfort of the chair. Best to make it curved and simple.

FLAT BUT NOT WRONG

Many stick chairs have little or no saddling. A sheepskin or blanket is an easy way to add a lot of comfort. These Irish chairs are in the personal collection of Mark Jenkinson, Slane, Ireland.

little, to remain comfortable.

But a deeply saddled seat doesn't allow us to move much. So, these sorts of seats become agonizing in short order.

I have yet to see an ancient chair seat that is sculpted as dramatically as the contemporary Jell-O molds with legs that we call chairs. I'm sure they are out there, but they've not the dominant form. Instead, many old chairs had shallow saddling (maybe 1/4" to 1/2" deep) or even no saddle whatsoever. A shallow saddle gives you some curve but also allows you to reposition yourself with ease. (Oh, and they are easier to make.)

I also suspect that many all-wood chairs were draped with animal skins, blankets or a cushion. I typically put sheepskins on my chairs and can attest that even the minor cushioning they provide makes a world of difference.

NUDGE THE DESIGN

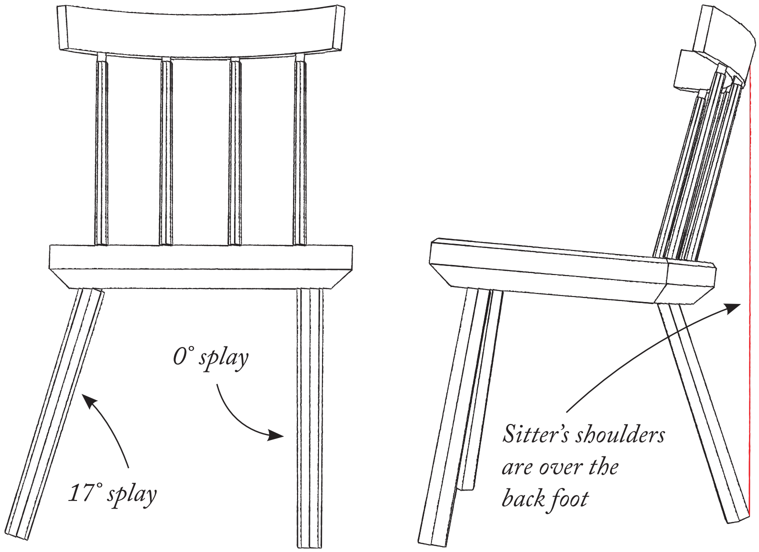
In the blue lowback, the back sticks are pitched back at 15°. When I decided to make the cherry lowback, I added an undercarriage and pitched the sticks back at 20°. Small changes matter.

OVERALL PROPORTIONS & DESIGN

The above numbers and guidelines can help create a functional chair that sits pretty well. But how do you make a chair that looks as good as it sits? What some people call "design." There are entire books on furniture design. This is not one of them. But I would like to get you started thinking like a designer.

I have found that learning to design is like learning a foreign language. At first you learn common and useful phrases from a phrasebook ("Where is the house of Pepe?"). Then you begin to piece phrases together to communicate haltingly ("Is this your hovercraft? Can you sell me three weasels?"). Finally, at some point, you find yourself thinking fluently in Welsh Chair, Irish Chair or Swedish Chair. Then your head is swimming with so many ideas about things to try that you don't think of it as "design."

So where to begin? Like people, I think chairs are born from other



CHANGE THE RAKE & SPLAY

The splay of the front legs changes the entire character of the chair. The rake of the back legs should put the sitter's shoulders directly over the rear foot – for stability

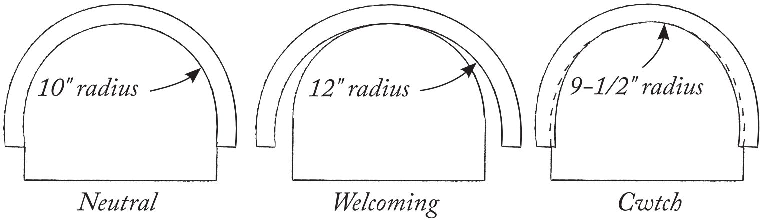
chairs. When I first began designing chairs, I would find two or three old designs that appealed to me. I gathered up all their dimensions and angles that I could measure from photos or (best-case scenario) the real object.

Then I nudged these chairs in a direction I wanted to go. The following are some common examples of how I nudge a design forward.

The sentence begins with: *"I like this chair but …*

1. … the legs need more rake and splay to give it a more animalistic stance."

Many new chairmakers are conservative when it comes to the rake and splay of the legs. Sometimes that conservatism is called for. Many English Forest chairs have front legs that are nearly vertical – no rake or splay. That's a design choice. Also, you might need to cram a bunch of chairs around a table, so conservative rake and splay will reduce the



WHAT DOES YOUR CHAIR SAY?

Small alterations to the radius of your arms will affect how people view your chairs. The radius of the seat is 10".

chair's overall footprint.

When you look at lots of old chairs, you'll encounter some radical rake and splay in surviving examples. It can make you wonder: What is the outer limit to a chair's rake and splay before it collapses? (I don't know the answer to this question.) The simple answer is that if the half-scale model or drawing of your chair looks stable and strong, then it probably is. And if you are uneasy, then add an undercarriage.

Personally, I like a fair amount of rake and splay. On a typical comb-back I'll splay the front legs 17° and rake them 17°. For some chairmakers, those are shocking numbers. But I know from the historical record that I can push even farther out. With that sort of rake and splay, I'll add an undercarriage if the wood is a weaker species, such as cherry or walnut. You might need an undercarriage if the chair is oak.

For the back legs, the goal is to get the feet raked backward so the sitter's shoulder blades are over the chair's back feet. That ensures the chair won't be tippy. In a comb-back, that could be 15° to 20° of rake. For splay, some chairmakers make the back legs match the front legs. I don't think that's necessary. Sometimes I do that and sometimes I don't. Usually I like the back-leg splay to be less than the front-leg splay. It looks better. A typical splay for back legs of my comb-back is 7°.

2. … the arms should have more/less curve and smaller/bigger hands."

Finding an armbow with a natural curve is a real trick in our local forests. So usually I get to determine how much curve the arms have when I make a pieced armbow or a bent one. Typically, I make the inside curve of the arm so it matches the outside curve of the seat. That's a good place to start.

Let's say the back of my D-shaped seat is a 10" radius. I'll make the interior curve of the arm a 10" radius and the exterior curve of the arm a 12" radius (the arm is 2" wide in this case). This makes a chair that I call "neutral." If I increase the radius of the arm – let's say the inside curve is 11" or 12", then the arms will begin to open up, especially at the hands. This makes a chair that I call "welcoming."

In a few cases I have tightened the arm's radius slightly to bring the hands inward. This makes a *cwtch* chair (the Welsh word for hug). It's not unpleasant (if not overdone).

Note that the arm shape doesn't have to mimic the seat's shape. The arm can have an elliptical curve. Or have a flattened section at the back (this makes more room for large sitters). If the difference between the seat and arm isn't shocking, most people won't notice.

3. … the backrest should be curved."

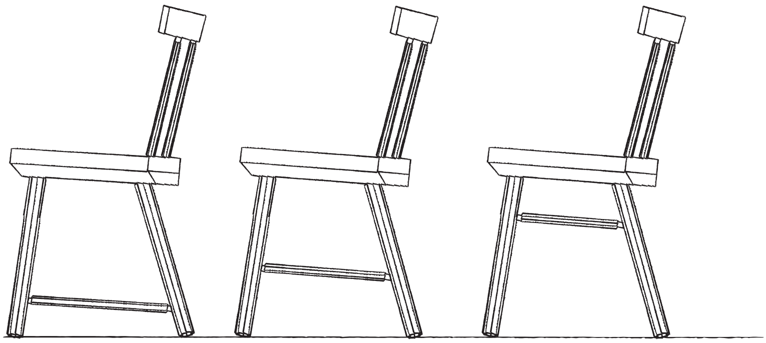
Adding a little curve to the backrest or comb will add a great deal of comfort to the chair because our backs are curved. The amount of curve is determined in part by how long the backrest or comb is. If the comb is short – 12" to 14" long – then the radius can be as tight as 10" or wide as 20". For longer backrests, I use a wide radius, such as 20".

In some instances, a flat backrest is warranted, usually when making a reproduction.

4. … it needs an undercarriage so it can accommodate heavier sitters."

Some customers ask me how heavy a person can sit in my chairs. I've had a lot of people try out my chairs here in the shop, so I have a gut feeling about it. For a chair without an undercarriage, I estimate that a 275 lb. person is a safe upper limit. For these chairs, I keep the arms at a "neutral" position (see No. 2 above) to discourage large people from plopping down.

For an oak or hickory chair with an undercarriage, I think 300-350 lbs. is a safe upper limit. Again, I'll try to design the arms to suit how stout the chair is. In an oak chair with an undercarriage, I might make



OLD SCHOOL OR NEW?

Low stretchers are more common on old chairs. High stretchers are more common on modern chairs. Somewhere between is a position that looks neutral.

the arms a little more "welcoming."

All the estimates above are conservative. Other chairmakers have told me tales of people destroying chairs – snapping sticks and legs – so I err on the low side when it comes to weight limits on sitters.

5. … I want to remove the stretchers to make the chair look older in form."

I am continually surprised by how many older chairs have no stretchers and have survived just fine. If you want to take this path, I recommend straight-grained oak legs, plus robust tenons. For me, a robust tenon is about 1" or 1-1/4" in diameter where it enters the seat. The joints can be either cylindrical or tapered.

If I have any trepidation about a chair's design, I will first make just the seat and legs. I then cut the joinery and drive the legs into the seat dry. I sit on the seat and bounce on top to see if the legs flex. If the legs flex, I add stretchers. If they don't flex, I skip them.

6. … I want to lower/raise the stretchers so the chair looks more ancient/ modern."

Lowering the stretchers likely makes the chair stronger. Visually, it makes the chair look like an older form. Raising the stretchers looks modern. If you are not trying to make a statement either way, try putting the stretchers about 9" off the floor (as measured from the front legs). When I install low stretchers, I'll put them 3-1/2" to 4" off the floor. High stretchers look good if they're about 5"-6" below the seat.

7. … its round legs look like dowels, so I will make them faceted."

Lots of old chairs have legs that were shaved round. This makes them look more like turnings, which might have been why they were shaved round (turnings are fancier). Older chairs have legs that are hexagons or octagons. Sometimes they were shaved at the top of the leg to blend in with the tenon. This is a purely aesthetic choice. I prefer faceted legs because I like the way each facet catches the light as you walk around the chair. But round legs were a common sight on old vernacular chairs.

8. … the seat is a bit chunky so I will add an underbevel to it."

With many stick chairs, the seat and the arms were the most difficult pieces of wood for the builder to find. Big chunks of wood were rare in countries that once tightly regulated their forests. As a result, many makers of stick chairs used whatever they could get their hands on. Sometimes this chunk would be too thin or thick.

With a thick seat, you could plane it to thickness (which is a bit arduous). Or you could shave a bevel on the underside of the seat to fool the eye into thinking the seat was thinner. Many chairmakers call this the seat's "underbevel."

Some makers of stick chairs skipped the underbevel, so chunky seats are common on old chairs. Relieving the underside of a seat makes a huge difference to the appearance of the chair. My underbevels usually start about halfway through the thickness of the seat. For a 2"-thick seat, the bevel is 1" high. Usually a 30° to 45° bevel is enough to hide the seat's bulk. Shallower bevels (20° to 25°) don't make much of a difference.

9. … the comb is too high/low."

The position of the comb has an oversized role in the look and comfort of a comb-back chair. If the comb is too low, it might hit the sit-

FEWER BUT THICKER

This chair has sticks that are a bit more than 1" in diameter. When sticks get thicker, you can use fewer of them.

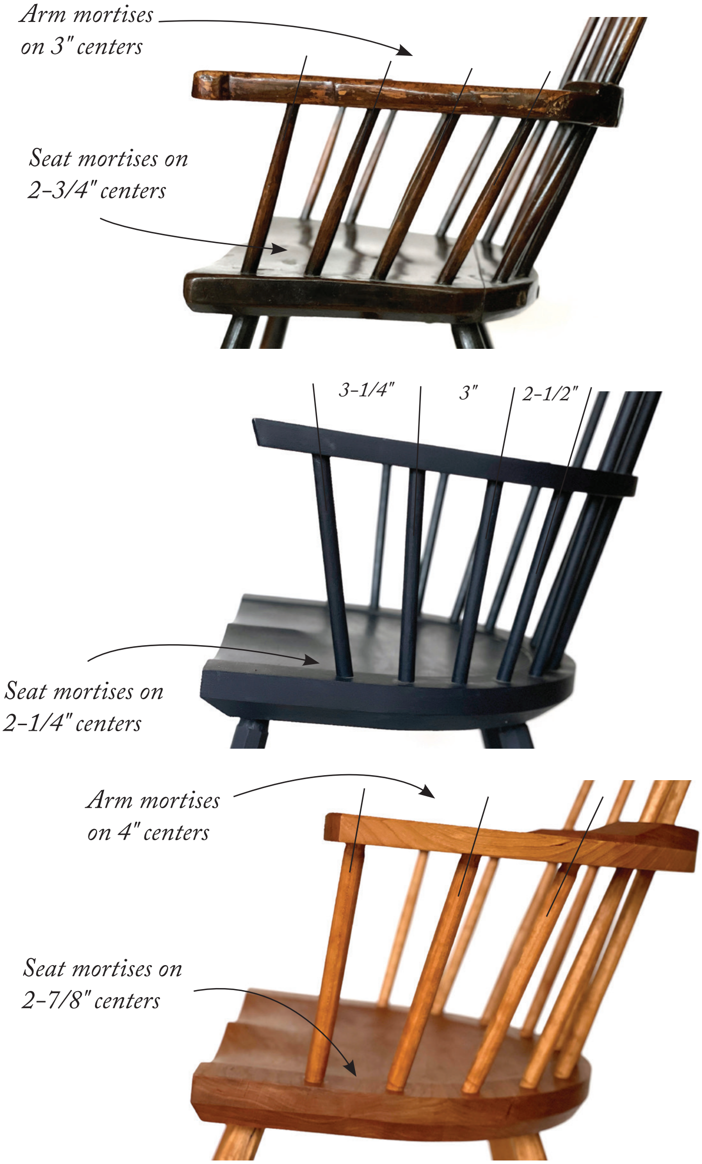
ter's shoulder blades wrong. Or the corners of the comb might dig into your back meat. If the comb is too high, the chair looks out of balance.

When making a comb-back, especially a new design, I'll make the back sticks over-long so I can decide where the comb goes after the chair is assembled. Once I have everything assembled except the comb, I can sit in the chair and see where my back encounters the back sticks. Then I can put the comb slightly higher than my shoulders. Or, if the chair is supposed to have a backrest instead, and it is curved, I might move it lower, right above the shoulder blades.

10. … the back angle needs to be increased/decreased."

As mentioned earlier, the back angle can be greater than what is typical in modern chairs. If a 20° lean seems too much, first try 15°. After I ventured past 15°, there was no turning back for me.

You might think that chairs with a 20° back would be unsuitable for



DIFFERENT STICKS

Spacing the short sticks is one of the ways you can change how the chair looks overall.

the dining room. I have not found that to be the case. People like being able to lean back after a nice meal.

11. … it needs more/fewer sticks."

The number of sticks and their spacing will change the look of the piece. The more sticks you have, the stouter the chair looks, but it also makes the top half of the chair look heavier, which is neither good nor bad. Having fewer sticks lightens the look of the chair. But if they get too spaced out, the chair looks weak (and it might be weak).

In general, when you use smaller-diameter sticks (5/8"), you should space them closer. Larger sticks (1" or more) can be spaced farther apart without looking weak.

In my chairs, I space small-diameter sticks on 1-1/2" to 3" centers in the seat. Large-diameter sticks get spaced on 4-1/2" to 6" centers in the seat. As you'll see shortly, changing the stick spacing in the arm can also alter the chair's appearance.

In some cases, I will "skip" a stick in a chair. That is, I leave a gap between the chair's short sticks and the long sticks. The negative space separates the chair's back from its sides and can look nice. The gap can also hide some awkward math problems when spacing the sticks in the seat. Sometimes you need that gap to make the sticks work.

12. … the short sticks should lean backward so the chair looks laid back and at ease."

13. … the short sticks should lean forward to make the chair look like it wants a hug."

14. … the short sticks should be perfectly vertical to give the chair some formality."

I like to keep the stick spacing in the seat consistent. In other words, every mortise in the spindle deck is spaced equally.

But the stick spacing in the armbow can vary. This is where you need to sharpen up your dividers and start mocking things up with bamboo skewers and sticky putty.

On some old chairs, the lean of the short sticks matches the lean of the back sticks. If the back leans 20°, then the short sticks lean 20°. Plus the spacing of the mortises in the seat comes close to matching the spacing of the mortises in the arm. When you do this, the short

FAN THE BACK

Small changes in the spacing of the back sticks changes the character and comfort of the chair's back.

sticks lean back. This gives the chair a laid-back appearance. Or, in extreme cases, it can give the chair a sense of forward motion, like it is in a wind tunnel.

Other chairs have the short sticks gradually raking forward. This can give the chair the appearance of reaching out give you a hug. (You can combine this with making open arms to add to the effect.) Mocking up the sticks' positions is the best way to figure out the spacing in the arm. But an example might help. In one of my chairs, the mortises in the seat are on 2-1/4" centers. In the arm, however, each mortise is spaced a little more forward. First 2-1/2", then 3", then 3-1/4". In the end, the front stick is raked forward about 12°.

Still other chairs have the short sticks spaced so the front sticks end up perfectly vertical, which gives a formal appearance to the chair. This is done by accelerating the spacing of the mortises in the armbow. An example: One of my chairs has the mortises in the seat spaced on 2-7/8" centers. In the armbow, the back sticks are spaced on 2-7/8" centers, but the short sticks are spaced on 4" centers. This spacing gradually brings the sticks to vertical at the front of the chair.

Mocking things up before you drill into an arm is a good idea.

15. … the back sticks should fan out to make the chair look welcoming."

This is similar to accelerating the mortise spacing in the arms, but it is done mostly in the comb. It doesn't take much to fan out the back sticks. When I do this, I keep the mortise spacing consistent in the seat. For example, 2" centers. In the arm, I keep the spacing for the back sticks on 2" centers – except for the two outer back sticks. Those are on 2-1/4" centers.

In the comb, the spacing is 2-1/2" from the center stick, then 2-5/8", then 2-3/4". In other words, the spacing increases by 1/8" with each mortise. You'll have to bend the sticks a little to get them into their mortises. But if your sticks have straight grain, you'll be OK.

NOTHING NEW

A lot of beginners worry that their changes will push things too far, and the chair will be a failure, either design-wise or pile-of-broken-splinters-wise. But if you stay within the guardrails of typical part sizes and typical dimensions for your chairs, you are unlikely to fail structurally. (There is a graphic of common diameters and thicknesses in the chapter "Wood for Stick Chairs" to get you started.)

Most of all, I try to not create something new. Instead, I seek to make a chair that is plausible. I ask myself: Would this chair look right in a 19th-century cottage?

How do I know the answer to that question? By looking at lots and lots of chairs. Some vernacular stick chairs turn up in museums, but the easiest way to learn about them is to haunt the websites of antique dealers. Read the dealer's description of the chair, but don't take it as gospel. Some dealers specialize in vernacular furniture. Most do not.

When you find a chair you like, grab the images and save them in a folder on your computer. I keep a folder for each country I am interested in: Wales, Germany, Sweden etc.

These visual libraries will help you navigate forward. You'll get it in your bones that Irish and German chairs are more likely to have rectangular seats than chairs from other countries. Welsh chairs have more angularity in the uppercarriage than many other cultures. Comb-backs are uncommon in Germany. And so on.

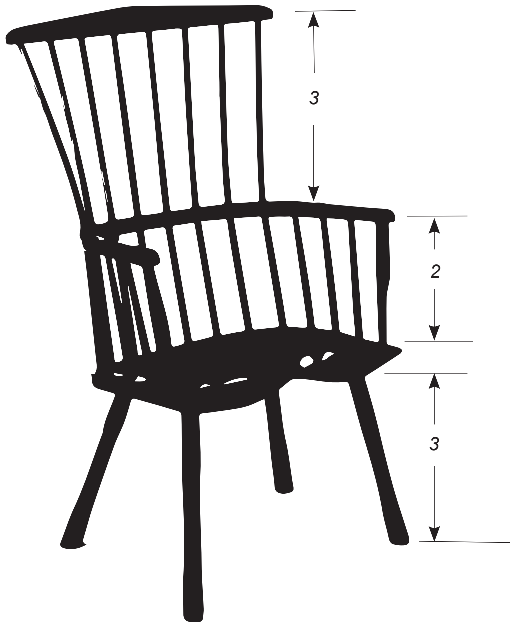
Also, looking at lots of other chairs helps you see the internal balance that's present in beautiful chairs. Nothing is too thick, thin, wide or weird. The chair's decorative details, angles and curves complement one another. Once you hear this song played over and over, you will be able to sing it yourself.

A MAGIC FORMULA

As I drift off to sleep each night, my mind often crawls over the images of chairs that I've seen that day. How did they drill that angle? How did they make those blind mortises in the arms? Stuff like that. One night after looking at a bunch of early chairs from Lincolnshire, my mind fixated on why these early chairs looked so harmonious compared to John Brown's early comb-back chairs.

Without thinking, the answer came to me: these early chairs look better because the height of the arms in relation to the height of the combs is 2:3. Then I realized that a typical chair seat (16" x 20") is 4:5, and the seat of the Forest chair (16" x 24") is 2:3.

Now, I don't subscribe much to the "Golden Ratio is the answer to all things" school (the Golden Ratio is 1.618 to 1, or about 3:5). But I



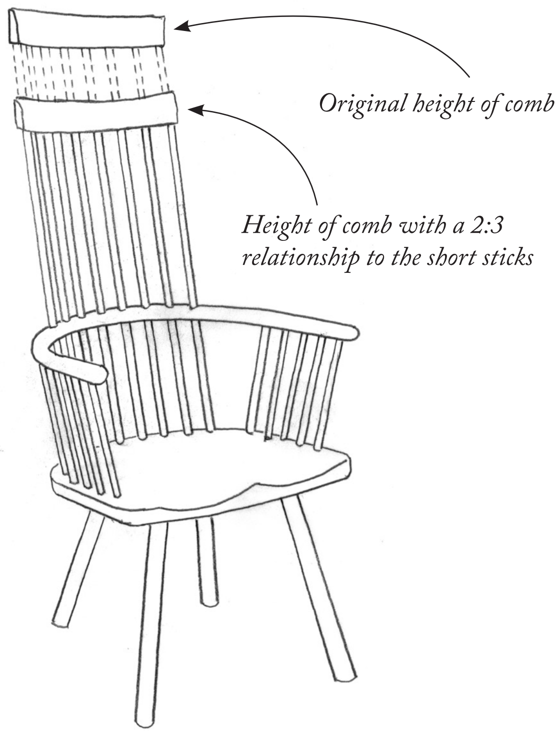
WHOLE-NUMBER RATIOS

Many of the chairs I find beautiful tend to have whole-number ratios embedded in them. This early Forest chair uses a 2:3 ratio for the arm height to the back height. And the seat's depth and width are also 2:3.

do find lots of whole-number ratios in old work. And this little discovery was enough to get me out of bed in my underwear and down to the workshop.

I started looking at photos of old comb-back chairs, and it struck me how often the 2:3 ratio appeared in the vertical axis of the chair. The top of the arm is about 10" above the seat. The comb is 15" to 16" above the arm. And the legs hold the seat 16" off the floor. That's about 3:2:3.

Then I opened my copy of "Welsh Stick Chairs" and looked at John Brown's early comb-back, what he called his Cardigan chair. That chair's arm-height to comb-height is close to 1:2 – like a sheet of mod-



LOWER THE COMB

This drawing shows an early John Brown chair where I lowered the comb so the ratio between the arm height and comb height is 2:3. I think it looks better. John Brown's later chairs were gorgeously proportioned.

ern plywood. I always thought the back of this chair was too high. So I sketched John Brown's chair with a 2:3 relationship between the arm height and comb height, and it looked better to my eye.

Still in my underwear, I examined the stretchers on the second Welsh chair I built. The stretchers were 6" off the floor with another 9" to the seat – 2:3 again. I looked at some Irish armchairs. The arms are

10" off the seat. The backrest is 15"-16" off the seat. Another 2:3 ratio.

What about the overall dimensions of the chairs? Is there anything there? My comb-backs are usually about 42" tall overall and 26" wide. That is 1.615 to 1, which is the Golden Ratio, dammit. My Irish armchairs usually end up 30" tall x 24" wide – a 5:4 ratio.

What does this all mean? I take it as evidence that whole-number ratios flow through old work, which is not news. What is helpful is knowing that 2:3 and 4:5 are good places to start when I ask myself: How high should the comb be? Or more importantly, when something is wrong with a design and I cannot figure out why, I'll see if applying 2:3 or 4:5 will improve things.

I am not a slave to ratios or formulas. But I do think they resonate through our culture and economy. The 3:2 ratio, for example, is a harmonic fifth in music. And 4:5 shows up a lot in video and photography (4" x 5", 8" x 10" and 16" x 20" photographic prints, for example).

Whole-number ratios are just one tool in your kit. Don't abuse it. If you try to build a cabinet with only an awl, you'll encounter a road with a lot of potholes. Years ago, I tried to design a cabinet entirely with Golden Section ratios. As you probably can guess, my design was a mess and stays safely imprisoned in a sketchbook.

Other tools in your kit include:

• The constraints of the body – chairs are an exoskeleton for people, so there are lines you shouldn't cross (a 24"-high seat, for example).

• Common furniture thicknesses and widths, which control the rough size of your lumber.

• The species of wood available, and the mechanical constraints of wood as a building material.

• The joinery that you and your tools can reliably make.

Finally, you have the entire history of chairmaking under your feet and butt. We sit on an enormous mountain of chair designs that go back to the ancient Egyptians at least. Every chair out there has lessons to share about what you should and should not do.

"New" designs are incredibly rare and seem to come about as the result of new technology – think Ray and Charles Eames, or Michael Thonet. So if you are making stick chairs for normal humans, using wood and traditional tools, then your design mantra should probably be the same as mine: Invent nothing.


JEFF TWEEDY
HOW TO WRITE ONE SONG
WORLD WITHIN A SONG
JEFF TWEEDY
LARRY
CHIEF MOUSERY

STICK STOOL

Whenever you find stick chairs in their original environment, you'll also likely find these low footstools. Unlike modern 16"-tall stools, these stools are the ideal companion for a stick chair.

They occupy a small space – about 8" tall x 8" wide x 12" long. So they are easily stored under the seat of a chair, right in front of its medial stretcher. Pull the stool out, put it in front of the chair and stretch out your feet on it. This keeps your feet off a cold floor and increases blood flow to your legs.

Or pull the footstool to the side of the chair. Now it's the perfect place to put a drink, a book or your glasses.

And if you have an old cat, it will appreciate the stool to help jump into your lap.

These little footstools often escape the notice of antique dealers, but I can't get enough of them. They are easy to build with scraps left over from chairmaking, plus the same kit of tools. And they take only an hour or two to make.

I'm including the plan for these stools in this book for two reasons.

1. They are an excellent introduction to the principles of building a chair's seat and undercarriage. You'll employ sightlines and resultants to drill the mortises in the seat. Plus a tenon cutter and a jack plane to make the legs.

2. Everyone should have at least one of these stools.

CUTTING LIST & NOTES

Here are the parts required to build the stool, along with notes on how the parts are shaped and joined.

ONE ANGLE

Drill all the mortises with a 27° resultant angle. If you have a laser, it's a help. But by no means necessary equipment.

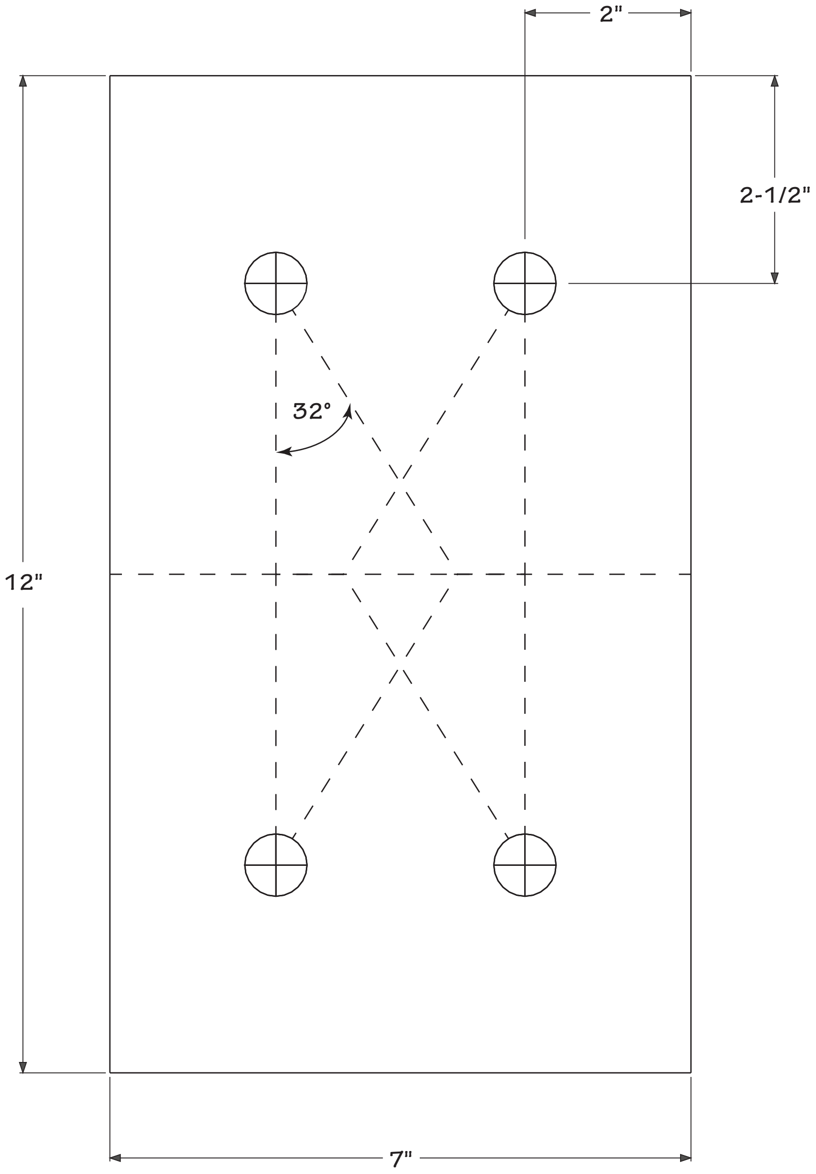
4 Legs: 1" x 1" x 11" (over-long and cut to final length after assembly)
• Legs are tapered octagons. They taper to the tenon. No shoulder.
• Tenons are 3/4" x 2-1/2" cylinders. After assembly, the tops of the tenons are cut flush and the seat is cleaned up.

1 Seat: 1" x 7" x 12"
• All edges are beveled at 27°, with a 3/8" flat on the edge. (The bevel is 5/8" x 1-1/4")

MAKE THE SEAT & DRILL THE MORTISES

The seat can be any species of wood that is difficult to split. I typically use stock left over from making the arms of a chair (that stock is typically 1" thick). First cut the seat to size, then lay out the sightlines and mortise locations on the underside of the seat using the pattern at right.

Prepare to drill the mortises in the seat. Clamp a backing piece to



Seat pattern

BEVEL THE UNDERSIDE

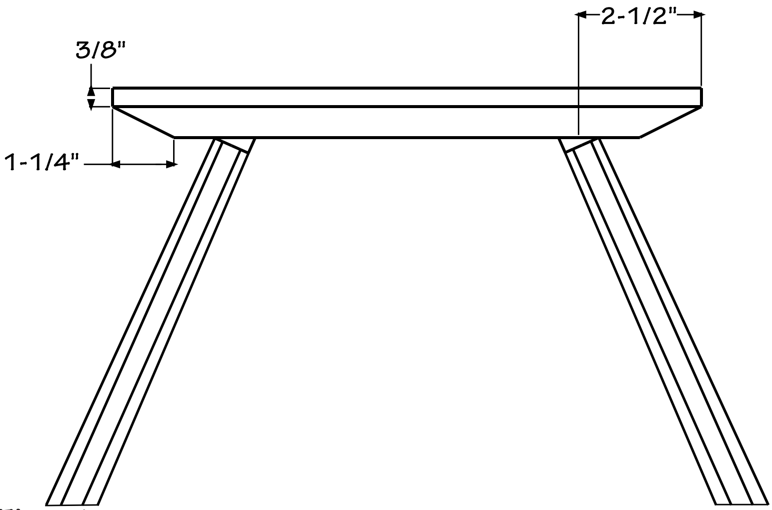
After jack planing the bevel, clean up the work with a smooth plane.

the topside of the seat to reduce splintering on the exit holes. Clamp the seat and backing board to your bench. Set a sliding bevel to 27°, which is the resultant angle (sometimes called the drilling angle) for the mortises. Use a 3/4" auger to drill the four mortises through the seat board.

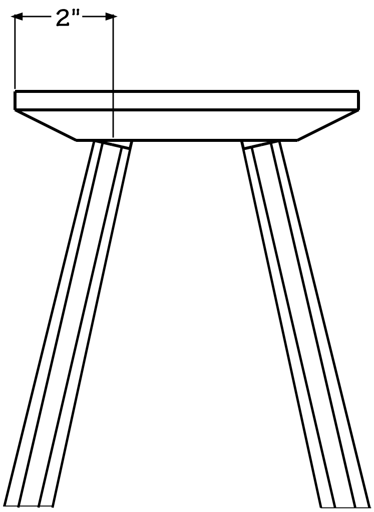
Now cut the bevel on the underside of the seat. You can lay out the bevel using pencil lines. It is 5/8" tall x 1-1/4" wide. Plane down to both lines using a jack plane.

MAKE & TENON THE LEGS

Plane the four leg pieces into octagons using a jack plane. Then cut a 3/4" x 2-1/2"-long tenon on one end of each leg. I used a power tenon cutter in a drill.



Elevation



Profile

TENON ONE END

A 3/4" power tenon cutter makes short work of this operation.

TAPER TO THE SHOULDER

Jack plane each facet so the tapers end right where the tenon begins.

RAISE THE WORK

Because the tenons are over-long, you'll need to raise up the seat on scraps during assembly.

Then taper all the facets of the octagons down to the tenon shoulder. I used a jack plane.

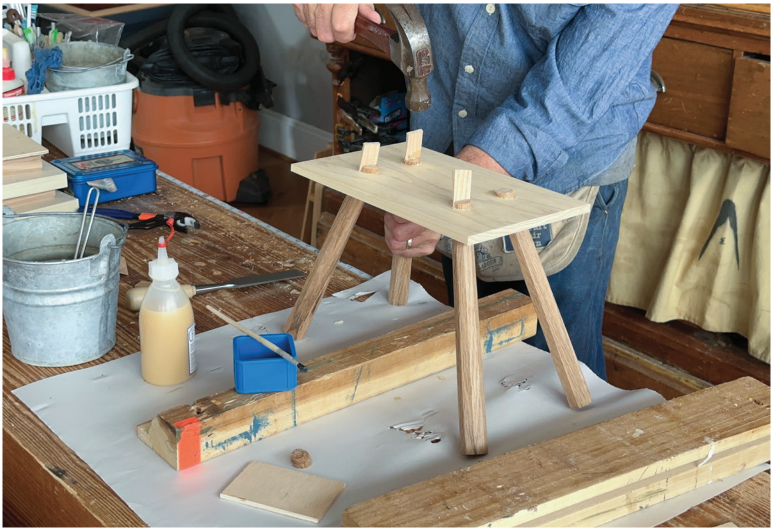
Cut a kerf down each tenon to receive the wedge with a tenon saw. The kerf should be about 2" deep.

WEDGES & ASSEMBLY

Make 3/4"-wide wedges to assemble the stool; use the chapter on wedges as a guide. Before assembling the stool, use a plane to clean up any errant toolmarks on the seat and legs. Get out the glue.

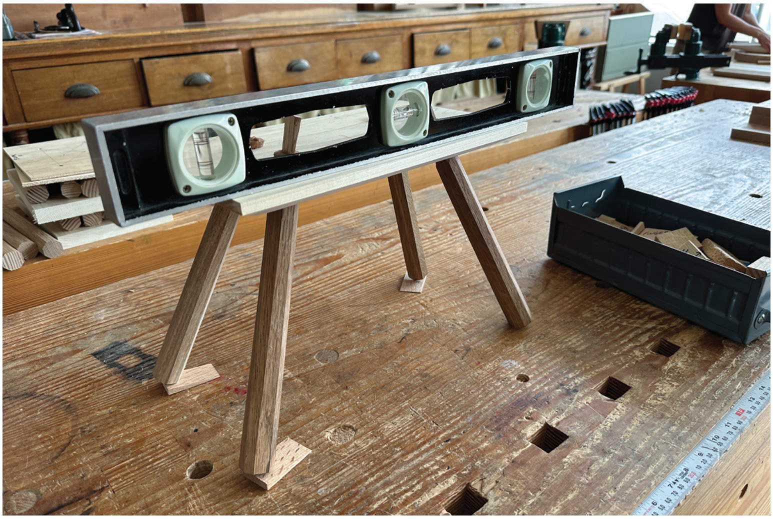
Paint glue in one mortise. Then paint a thin coat of glue on its mating tenon. Insert the tenon so the kerf is perpendicular to the grain of the seat. Drive in the leg until it won't go in any more. Repeat this process for the other three legs.

Set the stool on its feet. The tenons are over-long. Trim them close to the seat with a saw. I shoot for about 1/8" above the seat. Paint a thin coat of glue on a wedge and drive it into the kerf until the wedge won't



WEDGING

Hold the leg with your off hand while you drive the tenon into the kerf.



LEVEL BOTH WAYS

Level the seat on a flat and level place in your workshop.

TRIM THE LEGS

The tricky part of trimming the legs is holding the stool at a convenient height for sawing.

go in any more. (Troubleshooting tip: If the kerf is closed and you can't get a wedge in it, open up the kerf by driving the tip of a 3/4" chisel into the closed kerf.)

Repeat this process for the other three tenons.

After the glue has dried, cut the tenons flush to the seat and level the legs. I usually make these stools about 8-1/2" tall. Finish as desired.

A HANDFUL OF STICKS

This simple armchair is a good introduction to the geometry and shapes that are common in stick chairs. Despite the chair's simplicity, it is pretty comfortable.

SIMPLE IRISH-Y ARMCHAIR

A note on the plans: The five chairs in this book were built using the construction principles discussed in the previous chapters. The following plans focus on aspects of each chair that were not covered earlier, such as how to drill the mortises for the back sticks in an armchair. If you've read the earlier chapters, you'll find these plans easy to follow. If you skipped all that stuff and started reading the book here, good luck.

If you've never built an armchair, this compact Irish-esque example is a good place to begin. There are just a few parts, none of the components is curved and the seat is flat – no saddle. Yet, with the help of a sheepskin and geometry, this chair is a nice place to sit.

Like all the chairs in this book, this chair is not a copy of an antique. Instead, this chair is a composite of dozens of Irish armchairs I've studied. What makes the chair Irish-y? For the most part, it's the overall form: straight arms that are joined to the back sticks. Straight backrest. Rectangular seat with no saddling. Stout sticks. Simple legs with no undercarriage.

If you build one of these chairs and try to pass it off as an antique, the buyer will (I hope) laugh at you. The crisply faceted legs, the rake and splay of the legs and the chamfers on the arms are dead giveaways that this is a modern interpretation.

I built this chair using oak throughout. The sticks, legs and arms were split from 8/4 kiln-dried stock, then dressed with planes. The seat and backrest were all sawn from 8/4 kiln-dried stock. Some of the following photos show components in species other than oak – these were prototypes built using scraps of maple and other woods.

CUTTING LIST & NOTES

Here are the sizes of the parts with notes on how they are shaped.

4 Legs: 1-5/8" x 1-5/8" x 19" (over-long and cut to final length after assembly)

• Legs are tapered octagons, 1-5/8" at foot and 1" at tenon shoulder, directly below the seat.
• Tenons are 1"-diameter cylinders x 2-1/2" long (wedged and trimmed after assembly).

1 Seat: 1-5/8" x 16" x 20"
• Grain runs from left to right in seat.
• All four edges of seat, top and bottom, are chamfered (1/8" x 1/8").

2 Front posts: 1-1/8" diameter x 12-1/2" long
• Front posts are shaved with entasis to blend into tenons. Top tenons: 1" diameter x 2" long. Bottom tenons: 1" diameter x 2-1/4" long.
• Top tenon, which passes through the arm, is wedged and trimmed after assembly.
• Bottom tenon, which passes through the seat, is left long and not wedged.

2 Arms: 1" x 2-1/4" x 21"
• Four long edges are chamfered (1/8" x 1/8").
• Back stick passing through arm is pinned with a peg (5/32" x 2").

4 Back sticks: 1-1/8" diameter x 17-1/2"
• Back sticks are shaved and tapered: 1" diameter at seat and 3/4" diameter at top tenon shoulder.
• Tenon on the bottom of the back sticks is 1" diameter x 2-1/4" long. This tenon passes through the seat and is left long and not wedged.
• Tenon on the top of the back sticks is 5/8" diameter x 1-1/2" long.
• Shoulder at the top of the stick is shaved to blend into the tenon.
• Two back sticks that pass through an arm tilt 6° out (and 20° back). The two center back sticks are vertical in elevation and tilt back 20°.
• The back sticks that pass through the arms are tapered to 1" at the location of the arm and pass through a 1" hole in the arm.

1 Backrest: 1" x 3" x 25"
• Front face of backrest is slightly rounded so it is 1/2" thick at top.
• Ends of backrest are cut at 6°.
• Four tenons are mortised into the backrest and pegged.

THANKS, NIKOLA TESLA

I like using a brace and auger bit whenever possible. But when it comes to 1"-diameter mortises in maple or oak, a 10"-sweep brace is not going to do it (not with my stick-bug arms).

MAKE THE SEAT

If necessary, glue up the seat from two or more boards. Use three loose tenons in each seam to make the seat more durable should your glue ever fail. Pin each tenon on the underside of the seat.

Lay out the locations of the mortises and sightlines on the underside of the seat. The mortises are straight 1"-diameter holes. I used a 1"-diameter auger powered by a corded drill. Pushing 1" through oak with a brace is no joke. The resultant angle for the front legs is 25°; the resultant for the rear legs is 28°.

Because the seat isn't saddled, place a backing board where each mortise exits the seat to prevent the auger from ripping up the show surface. I use scrap plywood and clamp it to the seat.

MAKE THE LEGS

The legs are tapered octagons. Saw them to size. Then, before tapering the legs, use a power tenon cutter to cut the 1" x 2-1/2"-long tenons on the top of each leg. Cutting the tenons before tapering them makes it easier to level the legs in your vise.

Now taper the legs' facets with planes. The taper is slight – from 1-5/8" at the foot to 1-1/4" at the tenon shoulder.

(If you don't have a power tenon cutter, taper the legs first and make the tenons with a jack plane or drawknife.)

Saw a kerf in each tenon for a wedge and assign each leg to a particular mortise in the seat. Mark everything so you can get the legs in the correct mortises at glue-up. If the tenons are too tight, compress them with soft-jaw pliers or (as a last resort) shave them with a block plane or scraper.

Because the seat isn't saddled, you can glue the legs into the seat at this time. Glue the mortises and tenons, drive the legs into the seat and wedge the tenons. When the glue is dry, saw the tenons flush with the seat and plane the seat flat.

You can cut the legs to their final length now, or you can do it at the end of the construction process.

TENON & SHAVE THE STICKS/POSTS

The back sticks and front posts all start out their lives as octagons. I first cut the tenons on the ends of the parts. Then I shave the sticks so they are round and taper to the diameter of the tenons.

After you have shaved all the sticks and posts, set aside two back sticks that will pass through the arms. Those need some additional tapering after you drill the mortises through the arms and the seat.

DRILL MORTISES FOR THE STICKS

The arms are 8" off the seat, just like the other chairs in this book. So you can (mostly) use the same jigs for the comb-back chairs in this book to hold the arms over the seat of this armchair. The longer drilling jig works great, but the smaller jig (which holds up the back of a comb-back's armbow) isn't much help. So rip a 2x10 x 24" to 8" to help prop up both arms over the seat.

Positioning the arms over the seat is pretty simple using the drawing

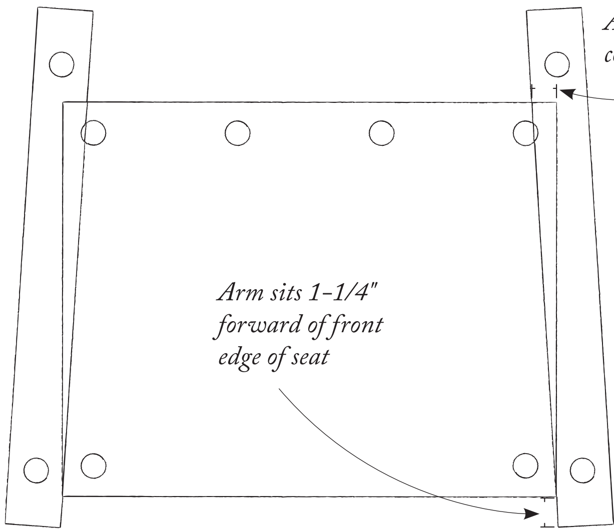
EASIER THAN THE MORTISES

Cutting the tenons by hand is easy with a hollow auger and a brace. The hollow auger's cutter slices across the grain of the leg, which makes the cut almost effortless. The leg shown here is round (not octagonal) because it was for an earlier iteration of this chair.

on the next page and a 12" combination square. The arms should hang over the front edge of the seat by 1-1/4". And the arm should be tangent to the front corner of the seat.

At the back edge of the seat, the arm should be tangent to a mark that is 1" from the end of the seat. Confused? See the construction drawing. It's pretty straightforward when drawn out. Basically, the arms angle in about 3.6° from front to back.

Once you get the two arms positioned in the correct place over the seat, clamp them in place on the jigs. Chuck a 1" bit in your drill or brace with a bit extender (if needed). If necessary, use a spotter to help you drill through the arm and the seat. The 1" holes should pass through both the arm and the seat, so it's best to use a backing block to prevent spelching on the exit holes.



POSITION THE ARMS

The position of the arm over the seat determines the pitch of the back and the splay of the front post.

TAPER TWO BACK STICKS

The only tricky part of this armchair is fitting the back sticks that pass through the arms. They need to fit tightly on the back sticks so the entasis holds the arm at the right position, which is 8" above the seat. And they need to fit (somewhat) nicely on the back sticks.

Here's how I deal with it. The arms are 8" off the seat, so I mark the back sticks about 2" below the arm. From there, I plane the two back sticks to get to 1" in diameter so the sticks pass through the mortise in the arm and jam in the right place to hold the arm up 8" off the seat.

The goal is to get the two front posts and two back sticks planed up so the arms are 8" off the seat and the sticks are dry-fit into the seat. Take your time if this is your first time. It's easy to get frustrated and overshoot the target. If you own a tapered reamer, you can lightly ream the underside of the hole through the arm to help things fit.

A HELPFUL SPOTTER

Here I can see if my bit is correctly placed left-to-right. My spotter, Megan, can see if I am positioned correctly forward-and-back. She has a laser in her hands to help guide us. Honestly, after you build a few chairs, your spotter will say: "You don't really need me, do you?" Don't answer them.

DRILL THE BACKREST MORTISES

Boring the mortises for the two remaining back sticks is simple work. With the arms dry-fit, use a sliding bevel to measure the backward pitch of the two exterior back sticks. It should be about 20°, but that number could be off depending on human error. Measure the actual pitch on both back sticks and average them if they are different. Set your sliding bevel to that pitch.

The two remaining back sticks are simply pitched backward at this angle. They don't angle left or right. Tape the sliding bevel to the seat and drill the through-mortises in the seat for these back sticks.

With the mortises cut, drive the two interior back sticks in place. Decide where the backrest should end up by sitting in the chair. Cut the back sticks to final length (I do it with the sticks in place and use a Dozuki). Then use a 5/8" tenon cutter to make the 1-1/2"-long tenons on the back sticks.

PLANE TO FIT THE ARM

The back sticks that pass through the arm are a little tricky. Plane them until they pass through the arm and wedge so that about 10" of the stick is below the arm (8" of stick plus the tenon). Then plane a little more – removing any facets – so that you have a little forgiveness and slop at assembly time.

Clamp the backrest in place on the tenons on the back sticks. You can make small corrections to the angles of the sticks at this point. The outside sticks should pitch out about 6°. The two inner sticks should be at 0°. You can hold the sticks and backrest together using spring clamps. Once everything is in place, trace the angles of the tenons onto the backrest. Then drill the mortises in the backrest.

FINAL STEPS

Now it's up to you to shape things to please yourself. I planed chamfers on the seat and arms. And I rounded the front face of the backrest. Kerf the two front posts at the top for wedges. And remove any offending tool marks.

BACKREST TENONS

Use a 5/8" tenon cutter to shave the top of the back sticks so they each have a 5/8"-diameter x 1-1/2"-long tenon. Then drive them in place. This is a manual one.

Glue up the chair. I do this one arm at a time. Glue the back sticks in place. Then slide the arm plus its post over its mating back stick. Drive the post into its mortise in the seat. Knock the arms up and down on the back sticks until the arms are dead parallel. Then wedge the tenons on the front posts.

Take a breath. Glue the backrest on. Make sure the backrest is parallel to the seat. Then peg the arms to the back sticks. Peg the backrest to the tenons on the back sticks.

After the glue is dry, saw all the pegs and tenons flush. Level the legs (if you haven't already) and clean up the entire chair.

The chair shown here is painted with two coats of General Finishes Milk Paint in basil.

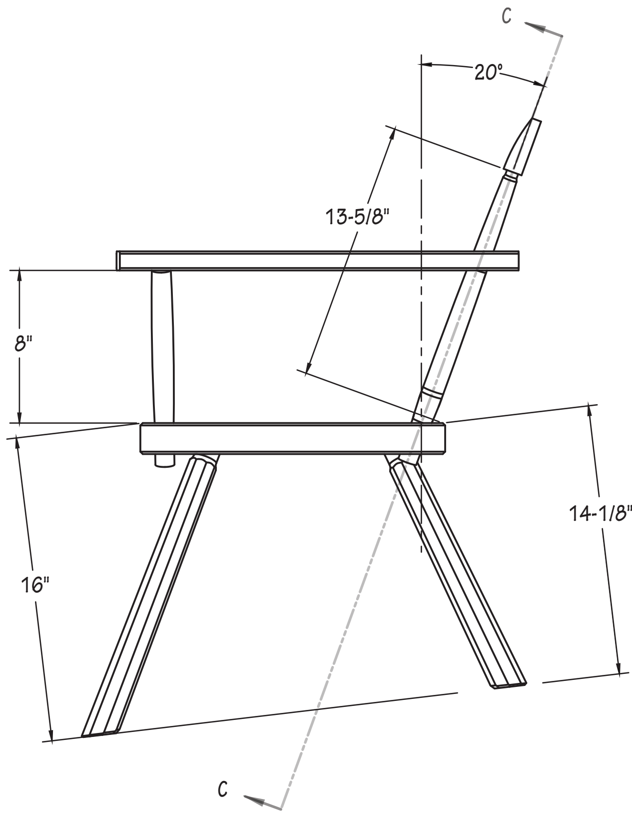
DRILL THE BACKREST MORTISES

Drill the four 5/8" x 1-1/2"-deep mortises in the backrest. Follow the pencil lines you drew. Then dry-fit the backrest on the tenons on the back sticks.

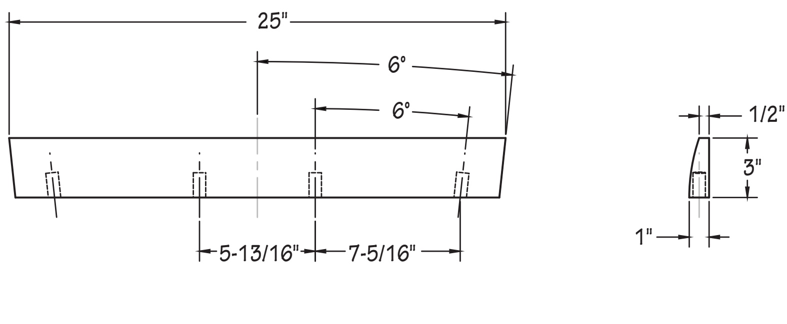
•••

A note on the construction drawings: The following construction drawings show a lot of precise measurements. Drafting a stick chair, however, is like trying to make a construction drawing of a jellyfish. Handmade stick chairs have an organic quality. As a result, use these drawings as guidelines, not gospel. If the drawings say all the back sticks are 5-53/64" apart, realize that we are trying to tell you the sticks are equally spaced (use your dividers). In the end, your stick chair will be different, anyway. Embrace that.

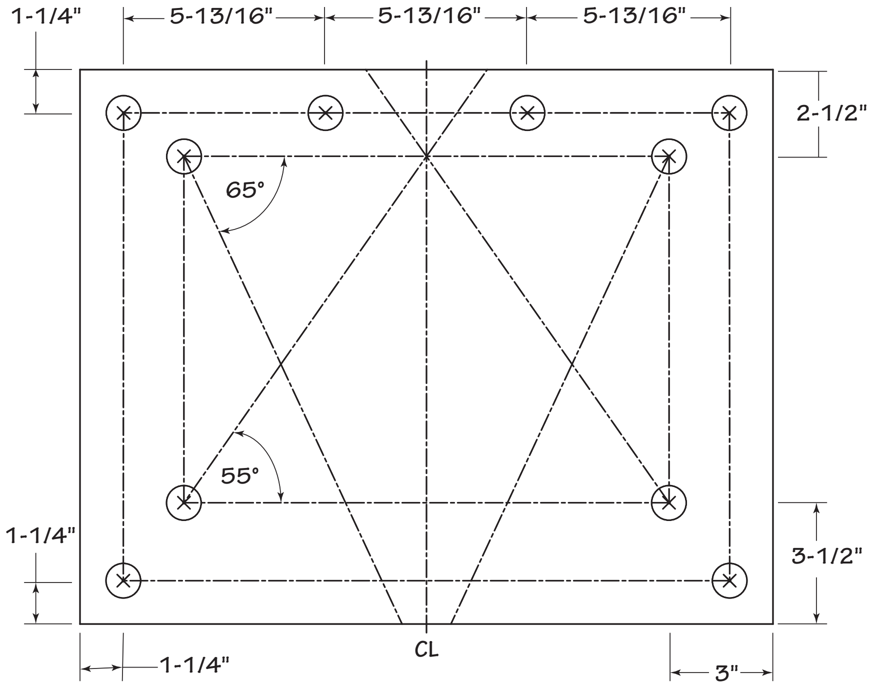
SIMPLE IRISH-Y ARMCHAIR



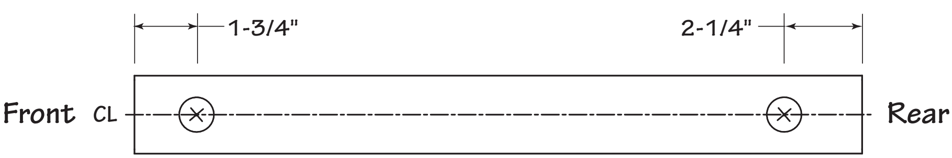
Profile



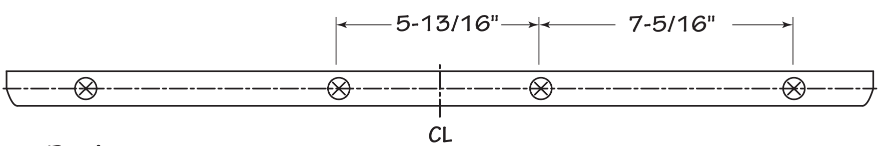
Elevation of backrest



Seat pattern



Arm pattern



Backrest pattern

IRISH-AMERICAN

Irish armchairs are one of my favorite stick chair forms. For this chair, I took the basic structure of an Irish chair and pushed it forward in terms of comfort, curvature and detailing.

IRISH-AMERICAN ARMCHAIR

After making many armchairs by following historical Irish examples, I decided to design an armchair without worrying about what was Irish, Welsh, Scottish, Scandinavian or German. The result here is a bit of a mutt. But I take comfort that modifying styles from the mother country is a traditional American trait.

This design began with an Irish skeleton – an armchair with a rectangular seat. But its details have been pushed in different directions.

The legs are double-tapered octagons. These legs have the rake and splay of Irish Gibson chairs I've measured, so they don't look too foreign. The double tapers are a contemporary touch, I know. But after trying many leg profiles on this form, I have landed on this leg shape.

The seat is saddled, which is rare among Irish chairs. The arms are quite curved and have tiny hands. I wanted the chair to look like it was reaching out to you. I'm not sure why I drew baby hands for this chair, but I like the effect. I also gave the backrest a dramatic sweep with a 3"-diameter arc on its ends.

Like all my stick chairs, I build them using humble woods that are ideal for chairmaking. The seat and backrest are American sycamore, a species that isn't used much in cabinetmaking. It warps a lot as it dries, and its color and figure tend to vary wildly. But sycamore has the redeeming quality of being difficult to split. So it's a fine seat material.

The rest of the chair is red elm. Elm is my favorite chair wood, but it can be difficult to make smooth because of its interlocked grain.

Most of all, this chair is compact, low and comfortable. It's a perfect chair for the fireplace. It's also easy to build. All the curved parts are cut from solid material, so there's no wood to bend.

For reference, all the components were sawn out on the band saw. Splitting out elm is possible but not fun.

NICE FROM BEHIND

I think this chair looks its best from behind, where the angle of the back is more obvious. This chair features traditional "socks" – a painted-on detail that absorbs scuffs to the feet.

CUTTING LIST & NOTES

Here are the parts required to build this armchair, along with notes on how the parts are shaped and joined.

4 Legs: 1-3/4" x 1-3/4" x 19" (over-long and cut to length after assembly)

- Legs are double-tapered octagons. The taper at the foot is about 6" from the floor and tapers in about 1/8" on each facet.
- Tenons are 1"-diameter cylinders that are 2-1/2" long. The facets of the octagonal section act as a small tenon shoulder, so leave the

facets a little proud of the tenon when tapering them.

1 Seat: 1-3/4" x 16" x 20"
• Grain runs from left to right in seat.
• Seat shape consists of a 13-1/2" x 20" rectangle with a 21-1/4"-radius arc added to the back of the rectangle.
• Seat is saddled. The spindle deck is 2-1/2" wide. Saddle is 3/8" deep with a pommel.
• As built, the front edge of the seat (at the pommel) is 16-3/4" from the floor. Rear edge of seat is 14-3/4" from the floor (measured from the top of the spindle deck). So the seat tilts 2" from front to back.

4 Short sticks: 1-1/8" diameter x 12-1/2"
• The short sticks are shaved with entasis to blend into 3/4"-diameter x 2-1/4"-long tenons on both ends.
• Top tenons, which pass through the arms, are wedged and trimmed after assembly.
• Bottom tenons, which pass through the seat, are sawn flush to the underside of the seat (or left a little proud). Wedges are optional as there is a lot of surface area in these joints for glue.

2 Arms: 1" x 5" x 20" (curved arms cut from solid)
• All the edges of arms are shaved with spokeshaves and then rasped. The goal is have the entire arm be pleasant to grip.
• The notch at the hands is cut with a fine rasp.

3 Back sticks: 1-1/8" diameter x 19-1/2" (overlong; trimmed to length)
• Back sticks are shaved and tapered: 3/4" diameter at seat and 3/4" diameter at the shoulder of the top tenon.
• Tenons on the bottom of the back sticks are 3/4" diameter x 2-1/4" long. These tenons pass through the seat. No wedges – though some old chairs are wedged from below.
• Tenons on the top of the back sticks are 3/4" diameter x 2-1/4" long and wedged at assembly.
• Shoulders at the tops of the sticks are shaved to blend into the tenons.
• All back sticks tilt 25° back with a 0° sightline.

2 Posts: 7/8" x 7/8" x 19-1/2"

• The tenons on the posts are as follows: 3/4" x 2-1/4" on one end, and 5/8" x 2-1/4" at the other.

• The posts pass through the arms and are tapered to 3/4" at the location of the arm to pass through a tapered 3/4" hole in each arm.

1 Backrest: 1-1/4" x 4" x 24" (backrest sawn from solid)

• Interior radius of curve is 21-1/4"; exterior radius is 22-1/2".

• Ends of backrest are cut with a 3"-radius arc.

• The tenons of the two posts are pegged. The holes are 3/8" up from the bottom edge of the backrest.

MAKE THE SEAT

You likely will have to glue up the seat from two boards. I recommend you add three loose tenons to the edge joint and peg them on the underside of the seat.

Cut the seat to size and lay out the locations of the leg mortises and the sightlines. The resultant angle for the front legs is 25°. The resultant for the rear legs is 28°.

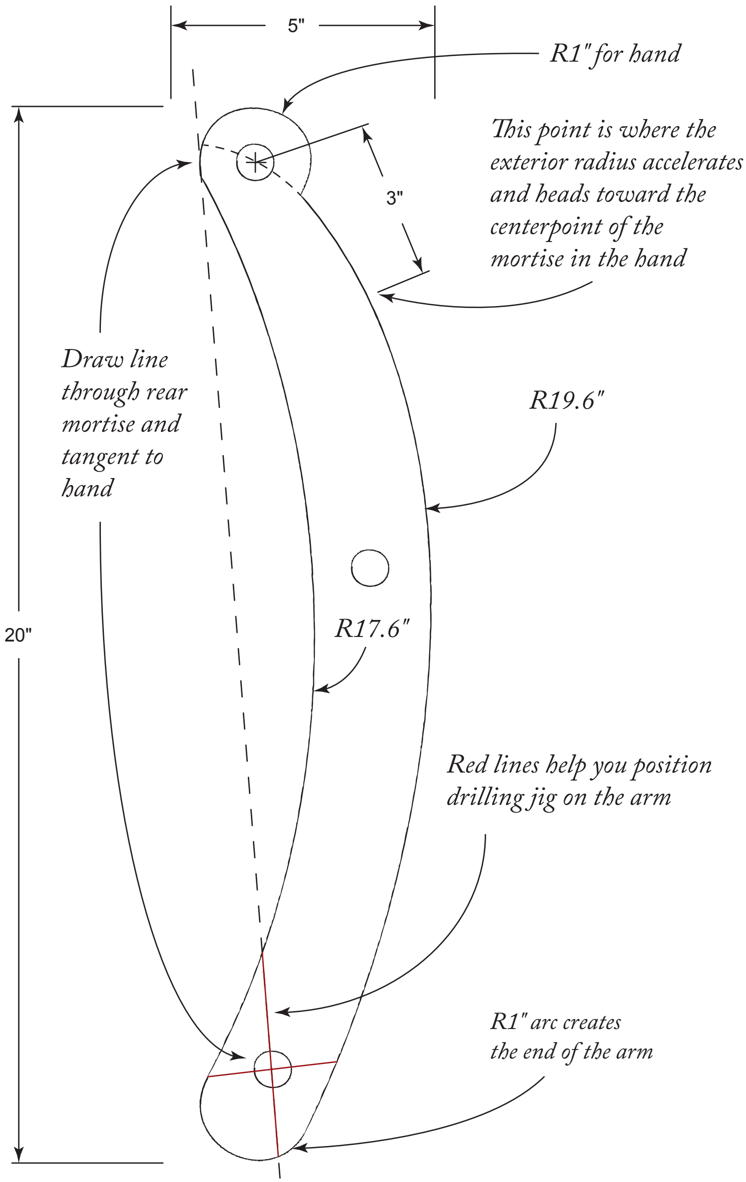
Drill the 1"-diameter mortises through the seat. Use a backing board to prevent (or reduce) spelching on the show surface of the seat.

MAKE THE LEGS

The legs are octagons. Using a jack plane, taper the top of the legs to a 1" octagon. Taper the bottom of the legs to a 1-1/2" octagon (the tapers meet about 6" from the floor). The 1"-diameter tenon on the top of each leg is made with a tenon cutter and is about 2-1/2" long. After cutting the tenons, plane the facets of each leg to make a small and consistent shoulder all around.

Test the fit of the legs in the seat. Assign a leg to each mortise, then saw a kerf in each tenon for a wedge.

While you have the tenon cutters out, cut all the tenons on the sticks. The short sticks have 3/4"-diameter x 2-1/4"-long tenons on both ends. For the back sticks and posts, cut a 3/4"-diameter x 2-1/4"-long tenon on one end. On the posts, add 5/8" x 2-1/2" to the untenoned end.


5"
R1" for hand
This point is where the exterior radius accelerates and heads toward the centerpoint of the mortise in the hand
3"
Draw line through rear mortise and tangent to hand
R19.6"
20"
R17.6"
Red lines help you position drilling jig on the arm
R1" arc creates the end of the arm

ARM PATTERN

DRILL MORTISES FOR THE POSTS & BACK STICKS

Though I try to avoid jigs, a simple shop-made drilling jig makes this chair easier to build. The jig clamps to the seat and guides a 3/4" drill bit to make the 25° mortises for the back sticks and the posts. It also clamps to the arms to help you drill the 25° mortise on the rear of the arms.

The jig is shown at right. It's a piece of plywood glued to a block of hardwood. You drill a hole at 25° through the jig and draw guide lines on the jig to center the hole on your parts. If treated with care, you can make dozens of chairs without wearing out the jig.

Lay out the locations of all the mortises for the sticks and posts on the top of the seat. Use a square to draw horizontal and vertical lines through each mortise location. These lines help you place the jig.

Clamp the jig to the seat, aligning the lines on the seat and the jig to center the jig. Drill all the 3/4" mortises using the jig to guide you. Important tip: Do everything you can to keep the drill bit from touching the walls of the hole in the jig. Many students tend let the jig guide the bit. The result is that the walls of the jig get chewed up after a hole or two. And then the jig is inaccurate and worthless.

So here's how to do it right: Start the bit slowly while it's in the jig's hole, making sure the bit isn't touching the walls of the jig. Increase your speed and focus on keeping the bit centered.

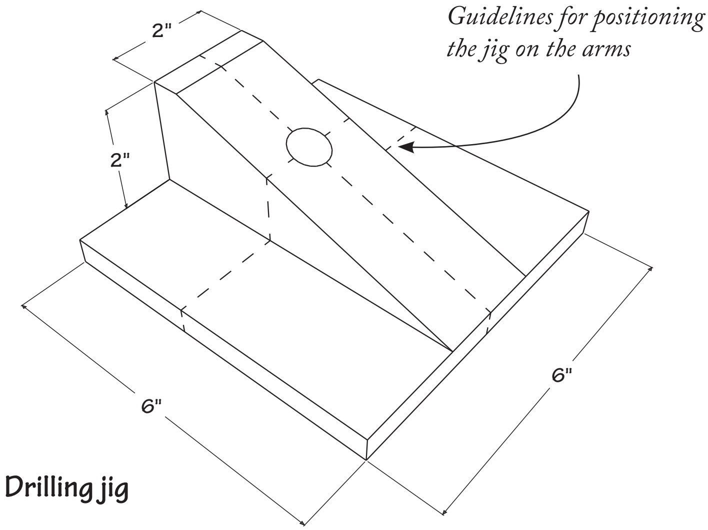
Drill all five holes for the back sticks and posts. The holes should go through the seat.

MAKE & DRILL THE ARMS

The arms are sawn from solid stock. Because of their curve, you will have some short grain. If you take care during assembly, the arms will survive just fine. If you prefer, you can hunt up a curved branch from the woods instead.

Cut the arms to rough shape, but don't refine them further until you have drilled the mortises through them and into the seat. There's still a 20-percent chance of firewood in the forecast. Lay out the locations of the mortises on the arms and the seat.

The first step is to use the drilling jig discussed above to drill the 25° mortise at the rear of the arm. Use the lines on the jig and on the draw-

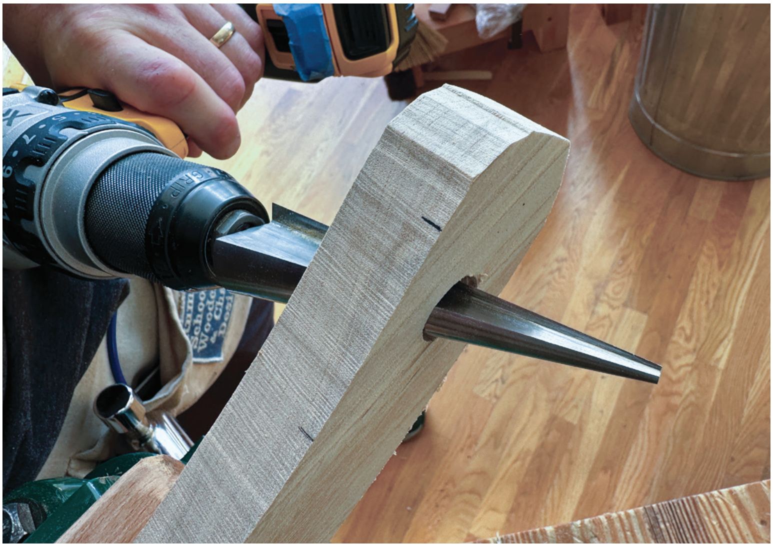


MORTISES FOR THE BACK STICKS AND POSTS

The simple mortising jig makes it easy to drill the holes for the posts and the long back sticks. Use the jig to help improve your drilling. Don't expect the jig to do all the work.

THE JIG & THE ARM

Transfer the lines on the arm pattern to the arm. Line up the jig's centerlines with the lines on the arm. Clamp things tight. Drill with care.



REAM THE HOLE FOR THE POST

Ream the mortise in the arm to make it easier to fit the post onto the arm.

ing to position the jig on the arm. Yes, it's awkward.

Clamp the jig and arm into a vise. Drill the 3/4"-diameter mortise. Now ream the underside of the mortise with a tapered reamer. Center the reamer in the 3/4" hole. Ream until the taper just reaches the 3/4"-diameter rim of the mortise. Then stop reaming.

SHAVE THE POSTS

After building this chair 50 times or so, I've found a better way to drill the mortises for the short sticks. First you shave the posts to fit the tapered holes in the arms. Then you dry-fit the posts and arms into the seat. The posts take over the job of the rear drilling jig. Finally, you add the front drilling jig to hold up the front of the arms. Then you drill the mortises for the short sticks as per normal.

So the first step is to shave each post so it fits the tapered hole in the arm. Also, the post needs to support the arm so the arm will hover 8" above the seat while you drill the short sticks.

SET THE HEIGHT OF THE ARM

Shave the post until the arm wedges on it as shown. The underside of the arm should be at least 8" from the post's tenon shoulder.

This isn't difficult. It's just a little time consuming to get right.

The goal is shown in the photo at right. The shaved post supports the arm. And when the mortise is driven into the seat, the arm will be 8" above it.

After you get the posts and arms playing together nicely, add the front drilling jig to the dry assembly. Rotate each arm so its hand is tangent to the front corner of the seat (the photo at right shows how to

READY TO DRILL

With the post in place, the arm is tangent to the front corner of the seat. And the arm is clamped 8" off the seat.

do this with a combination square). Now clamp everything down and drill the 3/4"-diameter mortises for the short sticks.

FINISH THE STICKS

Finish shaping all the sticks. I tend to leave them faceted because I like the texture. Once you have finished planing and fitting all the sticks, cut a kerf in the tops of the tenons of the short sticks. Then dry-fit the chair's legs, seat, sticks and arms. Be sure to seat the sticks fully.

TRIM THE BACK STICKS

Now trim the back sticks to their final length. Place a yardstick on top of the posts' tenons as shown in the photo on the next page. Use the yardstick to mark the finished length of the back sticks. Cut them to length, then add a 3/4"-diameter x 2-1/4"-long tenon to the ends of the back sticks.

TRIM THE BACK STICKS

Rest a yardstick on top of the tenons on the posts. Use a yardstick and the Half Pencil to mark the (approximate) length of the back sticks. Saw them to length.

A SADDLE NEVER HURTS

Though most Irish chairs are unsaddled, a little curve helps sell the chair.

MAKE THE BACKREST

The backrest is cut from solid stock. I first glue two layers of thick stock face-to-face to make a block that is thick enough to make a backrest that is 4" high. Saw the backrest to shape, then lay out and drill the mortises. The mortises for the posts are 5/8"; the mortises for the back sticks are 3/4". All the mortises are 2-1/4" deep. These holes are vertical.

SADDLE THE SEAT

Lay out the 2-1/2"-wide spindle deck on the seat. Use a scorp or adze to remove as much waste as possible, making the saddle about 3/8" deep. Once the seat is saddled, you can glue and wedge the legs in place. After the glue has dried, saw the tenons flush to the saddle and clean up any errant tool marks.

MAKE PRETTY & ASSEMBLY

Shape the arms with spokeshaves, rasps, scrapers and sanding. Ease all the top edges of the arms.

BEFORE & AFTER
When heavily shaping arms, I first shave a big chamfer to remove the bulk of the material, then I round things over with the shaves.

Assembly goes like this. Glue the posts into the seat, then glue the short sticks into the arms. Slide the arms over the posts and tap the short sticks into their mortises. Don't be too aggressive, or you will crack the arm. Tap things down until the underside of the arm is 8" off the seat. Wedge the short sticks into the arm.

Glue the back sticks into the seat. Place the chair on its back on the workbench. Put glue in the mortises in the backrest and knock it onto the posts and back sticks. Make sure the backrest is level from side to

RASPS TO FINISH

Rasps can cut in any direction without tear-out, which makes them the ideal tool for shaping the arms after the spokeshaves.

DON'T CRACK AN ARM

First glue the posts into the seat. Then glue the short sticks into the arm. Finally, slide the arm over the post and tap the tenons into place in the seat.

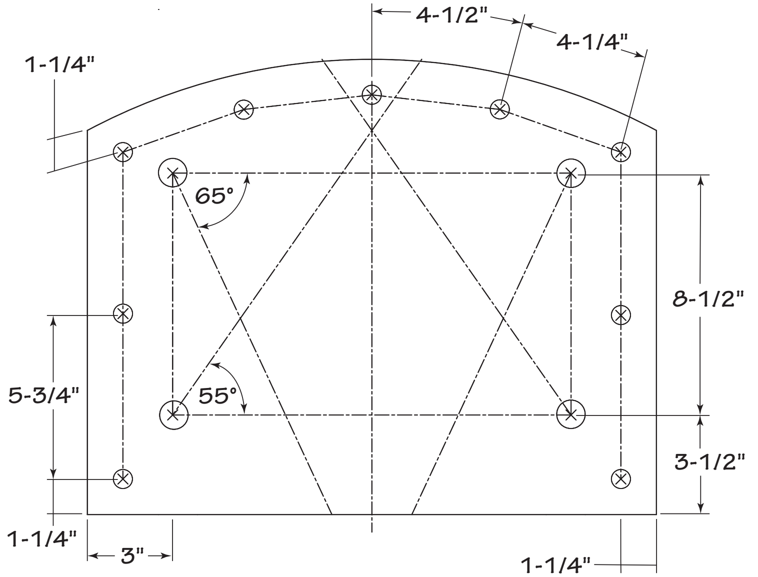
side. Pin the backrest in place with some hardwood pins. I usually pin only the posts. And the holes for the pins are blind (that is, they do not pass all the way through the backrest).

Finally, level the legs. I have experimented with a lot of seat tilts with this chair. I like a seat that drops 2" from the front to back.

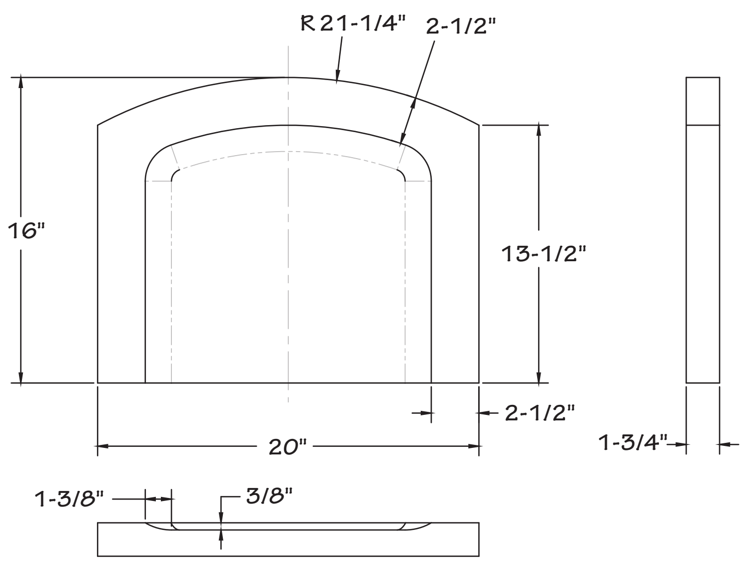
After the glue is dry, trim all the protruding tenons, wedges and pegs flush (including the tenons on the underside of the seat). Clean up any tool marks and finish the chair. If you are going to paint on the "socks," do it before you add the topcoat finish to the chair. When I paint on the socks, I use whatever paint is on hand. Masking tape keeps my lines crisp. I used a linseed oil/wax finish as the topcoat. I apply the goop with a 3M woven gray pad then buff the chair dry with a huck towel. This finish will last many years, even with heavy use. If the chair gets scuffed in the meantime, you can erase the scuff by applying a little more finish and buffing it off.

WITHOUT SOCKS

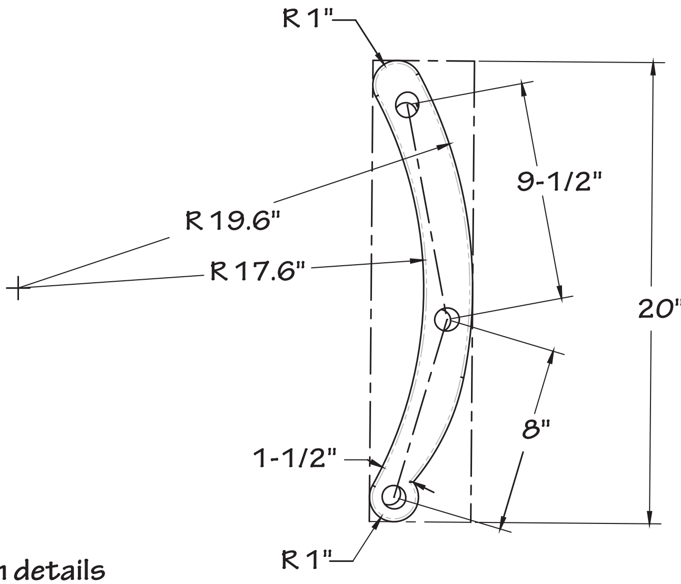
The Irish-American armchair in red oak with a soft wax finish.



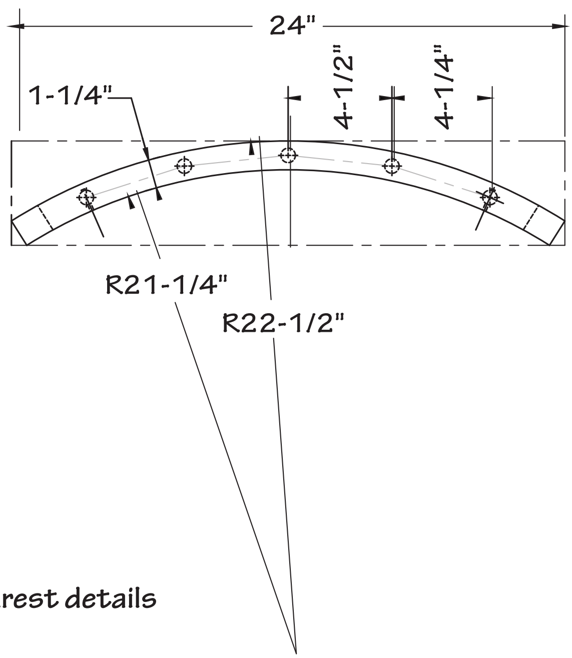
Seat pattern



Seat details



Arm details



Backrest details

SANS TARTAR SAUCE

Most commercial lowback chairs are uncomfortable and clunky. They don't have to be that way. By stealing some geometry and curves from other chairs, a lowback can rise above its traditional place in seafood restaurants.

LOWBACK STICK CHAIR

Lowbacks are a difficult chair form to pull off. Part of the problem is aesthetic. Lowback Forest chairs – sometimes called "captain's chairs" or "firehouse Windsors" – seem to lurk in every sketchy seafood restaurant in the U.S. These mass-produced chairs feature lifeless turnings, a dark and glossy finish and questionable comfort. The sooner you finish chewing the chum, the sooner the next diners can be seated.

When made by hand, this chair form doesn't sell well, either. Even Welsh chairmaker John Brown had difficulty getting rid of his lowbacks, which he called a "smoker's bow." The problem might be that chair customers expect a lowback to cost less than a comb-back, even though a lowback is almost as much work.

Despite these shortcomings, however, I think lowbacks are worth studying and building. So for this book, I set out to design one that is both comfortable and attractive.

Now, whenever I create a new piece, I first examine beautiful historical examples for inspiration. And while I'm sure there are gorgeous old lowbacks out there, I haven't yet encountered them.

That's why I turned my attention to the geometry and curves on other chairs I admire.

After building many Irish Gibson armchairs and living with them, I am comfortable with extreme angles for chair backs. The 20°-25° slope of the Gibson's back sticks makes the chair look like a recliner, but its slope feels like nothing of the sort. Instead, they are simply comfortable chairs you could have in a kitchen, library or living room.

One of the other compact chairs I admire is the Jennie Alexander chair. It's not even what I call a stick chair. But it contains some geometry that is almost identical to a Gibson. The top splat of the Jennie chairs is about 25° to the seat. It hits the human spine in the same place as a Gibson. And its back has a similar curve, as well.

GEOMETRY DONORS

The back support offered by the Gibson and Jennie chairs can be grafted successfully onto the lowback form. The result is a better place to sit for longer periods.

With these numbers in mind, I designed a chair with a tilt and curvature similar to those two chairs. Plus – and I think this is key – I made the backrest taller than I wanted it to be. In the end, this chair has about 4-1/2" of wood sweeping around to support the sitter's back. That's more support than a typical lowback, and it makes a difference.

One more thing: You will see the seat and undercarriage of this chair several times in this book. Both of the comb-back chairs in subsequent chapters and this chair are nearly identical from the seat down. That's not because of a lack of imagination on my part. Instead, I wanted you to be able to use many of the same templates for seats and arms to easily explore other chair forms.

CUTTING LIST & NOTES

Here are the parts required to build this chair, along with notes on how the parts are shaped and joined.

4 Legs: 1-3/4" x 1-3/4" x 20" (over-long and cut to final length after assembly)
• Legs are tapered octagons. They taper to the tenon. No shoulder.
• Tenons are 1" x 2-1/2" cylinders. After assembly, the tops of the tenons are cut flush and the seat is cleaned up.

1 Seat: 1-3/4" x 16" x 20"
• Grain runs from left to right in seat.
• Seat shape consists of a 6" x 20" rectangle with a 10"-radius arc added to the back of the rectangle.
• Seat is saddled. The spindle deck is 2" wide. The saddle is 7/16" deep at its deepest. The pommel is 1" long from the front edge. The cups are an 11" radius (about 3/4" high).
• Seat has an underbevel that is 3/4" tall at 45°.
• Front edge of seat (at pommel) is 17" from the floor. Rear edge of seat is 16-1/2" from the floor (measured from the top of the spindle deck). So, the seat tilts 1/2" from front to back.

2 Arm segments: cut from 7/8" x 5-1/2" x 16" blanks
• Arm segments are joined to the mid-arm.
• The assembled arm is then covered with the "backrest."

1 Mid-arm: cut from 7/8" x 4" x 15" blank
• Mid-arm is joined to the arms with pocket screws.

1 Backrest: cut from 3-1/4" x 6" x 20" blank
• Curved front edge is cut at 30° off 0°.
• Ends have a cove that ends with a 3/8"-tall flat at the ends of the backrest.
• Create the backrest's shape using the assembled arm.

10 Short sticks: 3/4" diameter x 12-1/2"
• Sticks are shaved with entasis. Each end has a 5/8" x 2-1/4" tenon.
• Tenons into the seat are glued into through-mortises.
• Tenons into the backrest/arm are glued into blind mortises.
• Four through-tenons in front of the backrest are wedged and cut flush after assembly.

DIRECT DRILLING

To get my drill bit 11" off the seat, I put a 2"-thick block under the drill's battery.

3 Stretchers: 7/8" x 1-1/8" x 24" (overlong and cut to fit)

- Stretchers have 5/8"-diameter x 2-1/4"-long tenons on both ends.
- Stretchers are octagons. They taper down to the tenon shoulders.
- Stretcher assembly is 11" below the seat and parallel to the seat.

MAKE THE SEAT

You likely will have to glue up the seat from at least two boards. I recommend you add three loose tenons to each edge joint and peg them on the underside of the seat.

Cut the seat to shape and lay out the locations of the leg mortises and the sightlines using the construction drawings. Drill the 1"-diameter mortises for all four legs with a 23° resultant angle.

Shape the underbevel on the bottom of the seat.

STRETCHER STUFF

Put your vise on the corner of your bench so you can drill both ends of a stick without moving it. Also, I have tapered the stretchers a bit so they are square in section at the ends. This makes tenoning easier.

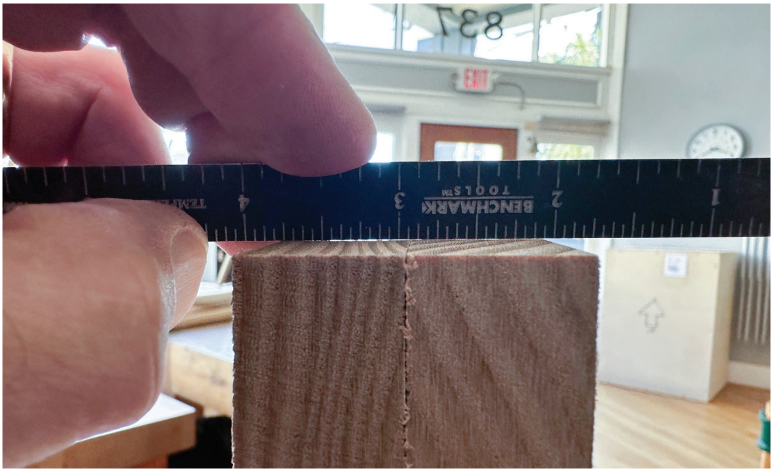
MAKE THE LEGS & STRETCHERS

The legs are tapered octagons that blend into the tenons. Begin by tapering the legs from 1-3/4" square at the floor to 1" square at the top. I use a jack plane. Then cut a 1" x 2-1/2" tenon on the end of each leg.

Assign each leg to a mortise in the seat and cut a kerf in the top of each tenon.

Mark the legs for the mortises for the side stretchers. Drill the 5/8" mortises for the stretchers. Then measure to determine the length of each side stretcher. Make the side stretchers and their tenons and install them between the front and back legs.

Determine the location of the medial stretcher. Drill its mortises in the side stretchers, measure between the mortises and make the medial stretcher to fit. Dry-fit the undercarriage.

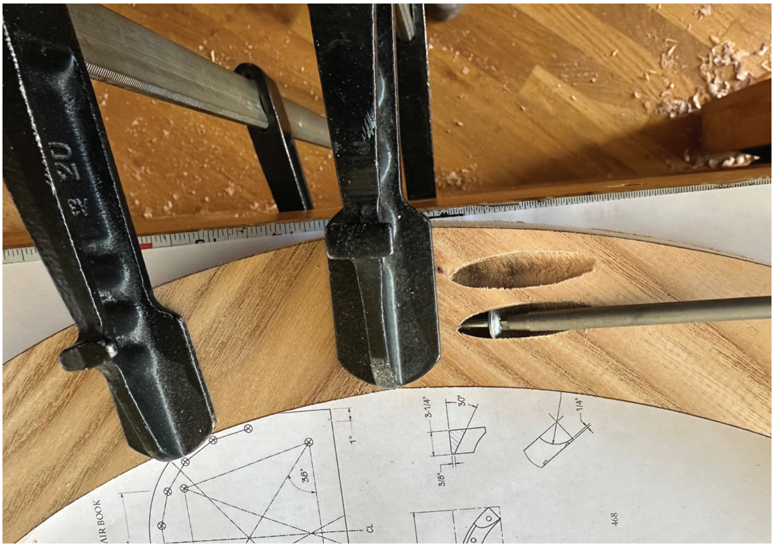


SEE A LITTLE LIGHT

Plane the ends of the arms and mid-arm simultaneously. The goal is to get the surface light-tight in all directions. This joint needs work.

POCKET SCREWS AS CLAMPS

Drill pocket holes in the mid-arm to clamp it to the arms. Right before you add the backrest, remove the screws.



SPIRAL CLAMPS

Pocket screws are an excellent way to join the two arm segments to the mid-arm. The left clamp holds the mid-arm. The right one is over the joint's seam.

MAKE THE ARMS

Here's an overview of the construction and drilling process. First, I saw out the two arm segments and the mid-arm and join them with pocket screws. Then I clamp the arm assembly 8" above the seat using the drilling rigs and bore all the mortises for the sticks in the arm and seat. You can remove the pocket screws at this point if you like. No one will see them as they are covered by the backrest.

Trace the backrest's shape on your stock using the assembled arm. Then shape the backrest and glue it to the arm. Once the glue is dry, deepen the mortises in the backrest from the underside of the arms.

Begin making the arms and mid-arm by using the patterns to saw the pieces to shape. Drill pocket holes in the mid-arm. Apply glue to the joints and screw the arms and mid-arm together.

Once the glue is dry, position the arm assembly on the drilling jigs over the seat. Position it 1-1/8" behind the back end of the seat (about 20° off vertical).

BEFORE THE BACKREST

Drill the mortises in the arm and seat before gluing the backrest to the arm.

Drill the through-mortises through the arms and the seat. After drilling the arms, remove any tool marks. Don't mess too much with the edges of the arms because you will shape those up after gluing the backrest on top of the arms.

THE BACKREST

Unless you have giant chunks of wood sitting around for the backrest, laminate two chunks of 8/4 face to face. The backrest is sawn from that thick blank. After cutting out its rough shape, set your band saw's table to 30° and saw a curve on the front edge of the backrest.

Lay out the cove cuts on the ends. The exact radius isn't important – I shoot for a 1/4" flat on each end of the backrest. Make relief cuts in the waste to make the curve easier to navigate with your band saw.

Remove most of the band saw marks from the backrest using rasps. Don't go too far, however, because you will need to blend the backrest into the arm after you glue them together.

Glue the backrest to the arm. After the glue is dry, blend the back-

TRACE THE ARM

Use the arm as a pattern to lay out the backrest pieces. Then cut a little outside the line.

TOP TO THE TABLE

Saw the 30° angle on the front of the backrest. Note that the top of the backrest is on the saw's table. Don't throw away the waste piece.

A TIGHT CURVE

The relief cuts help you make a sharp turn, even with a 1/2"-wide blade. As you cut this curve, you will have to rock the backrest slowly on the table to keep the work on the saw's table right where the cut is happening. This helps keep the cut under control.

rest and arm pieces together using shaves, rasps and sandpaper. The last big operation on the arm assembly is to deepen the arm mortises into the backrest. I do this with a Forstner bit. Deepen all the mortises to 1-5/8", except for the two mortises under the cove detail on the ends of the backrest.

MAKE THE STICKS

The 10 short sticks are all made the same way. Cut the 5/8" x 2-1/4" tenons on the ends first. Then shape the rest of the sticks with planes.

Fit your sticks into the arm and the seat and designate which stick goes where. The sticks that enter the backrest don't need any wedges. The ones that pass through the arm do – so don't forget to kerf those tenons. Loosely dry-fit the seat, sticks and arm to ensure the chair will go together (the preflight procedure mentioned earlier in the book).

WASTE MAKES HASTE

Use the waste from cutting the bevel on the backrest is a great sanding block. Wrap #80-grit sandpaper around it to remove the band saw marks.

Some of the tenons might have to be trimmed so the chair fits together. Take everything apart.

SADDLE THE SEAT

Draw the 2"-wide spindle deck on the seat and draw the 11"-radius cups that join the pommel with the spindle deck. Rough out the seat with a scorp. Use a scorp to cut the cups using with-the-grain cuts.

Clean up the chair's saddle with a travisher, scraping and sanding. Clean up all errant tool marks on the legs, stretchers and seat.

ASSEMBLY & FINISH

Glue the stretcher assembly together. Glue this to the legs. Then glue the legs into the seat. Wedge the tenons and let the glue sit over-

CLAMP INSIDE & OUT

When clamping the backrest to the arm, alternate the clamps' bars on the inside and outside of the arm. This reduces gaps at the seam.

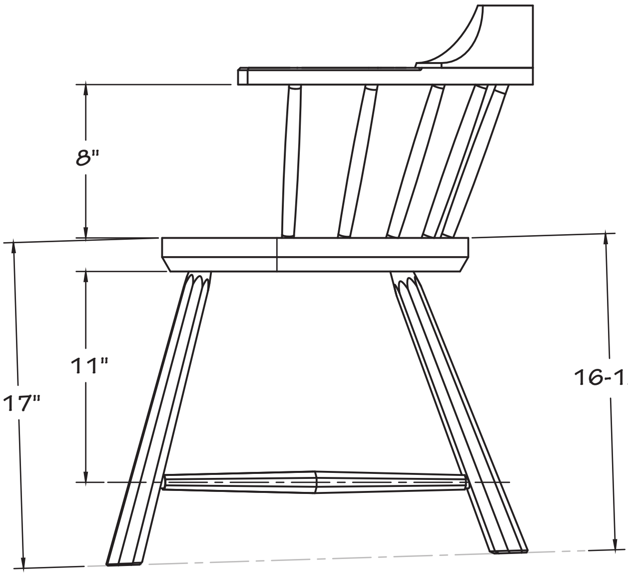
night. The next day, saw the tenons flush and nibble away any waste with your inshave/scorp.

Cut the legs to their final length and set the pitch of the seat. Lowbacks seem to sit best with only a little tilt – about 1/2" from front to back. An extreme tilt is not comfortable. Clean up the saddle again and get the chair ready for the final assembly steps.

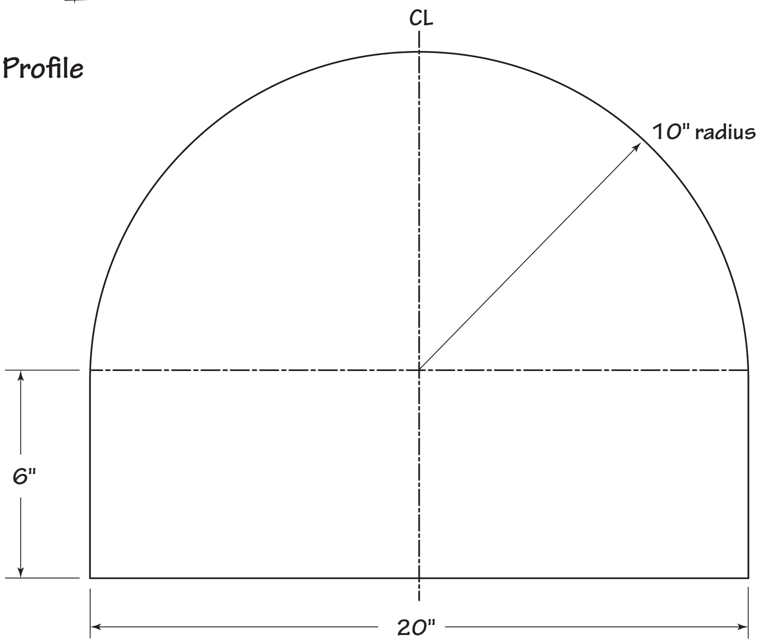
Now glue the rest of the chair together. Glue the sticks into the arms. Then paint glue into the mortises in the seat. Push the sticks into their mortises in the seat. Then tap the arm in place so it is 8" off the seat and level from left to right. Wedge the tenons in the arms and let the glue sit overnight.

The next day, saw the tenons flush and do the final cleanup.

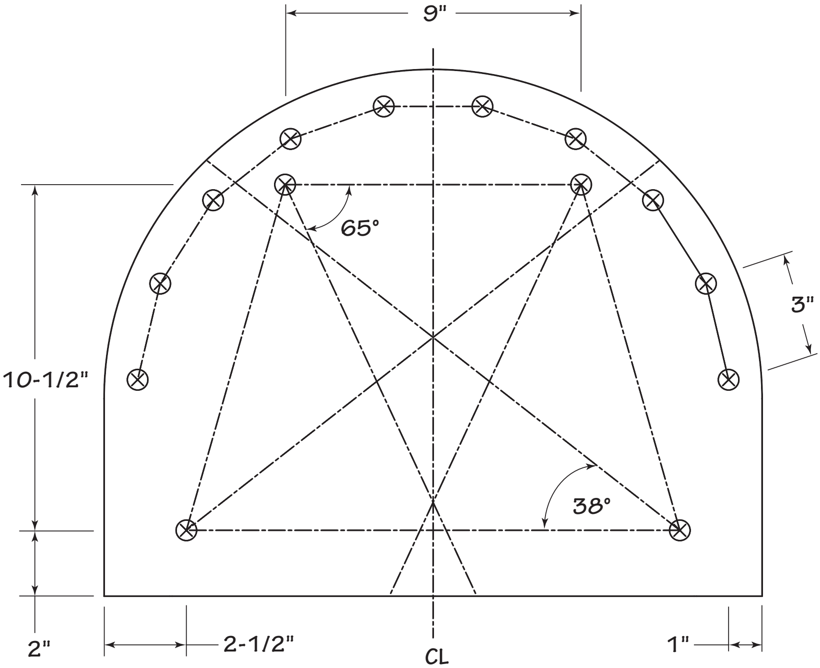
LOWBACK STICK CHAIR



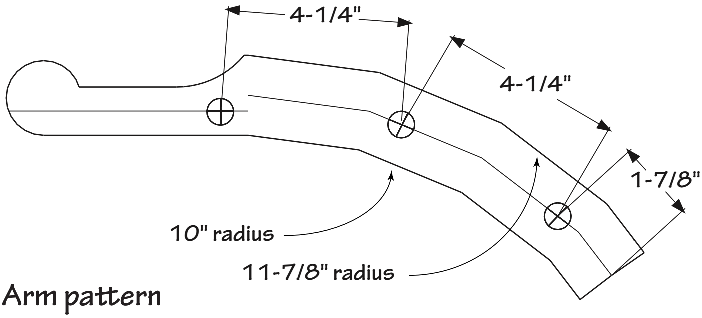
Profile



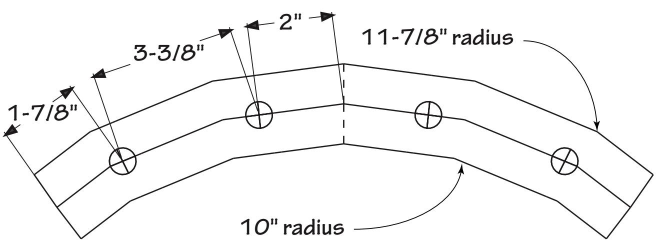
D-shape seat



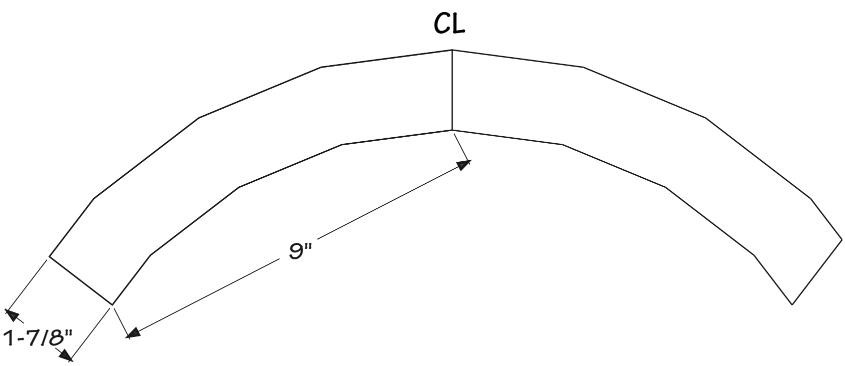
Seat pattern



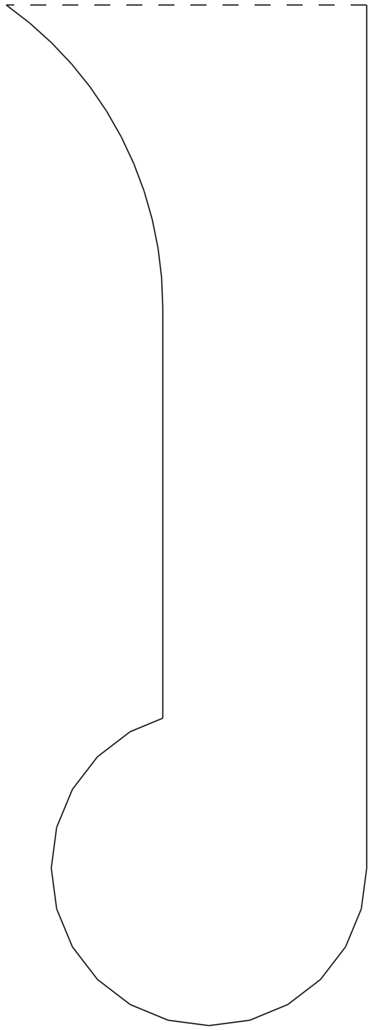
Arm pattern



Mid-arm pattern



Backrest



Hand (full-size pattern)

FROM ALL ANGLES

It's tough to make a chair look good from all angles.

SEVEN-STICK COMB-BACK

Most of the chairs I make for sale are comb-backs. And that's probably because people are more willing to pay for a tall comb-back than a lowback or armchair.

Because customers like comb-back chairs, I put a lot of effort into making them comfortable. When designed to fit the human body, a comb-back is a fine chair for eating a good meal, writing a letter or just talking with friends around a fire.

I should know. I spend several hours of each day sitting in one. And I think about them a lot. Would a slightly longer arm be more comfortable? Should I rake the back legs more to change the chair's tipping point? Can I shape the comb to better reflect other design elements of the chair? That kind of stuff. As a result of that thinking, I am constantly tinkering with the design of my comb-backs.

It's been a long journey. The first stick chair I made in 2003 was a comb-back, the most recent chair I built was a comb-back and I suspect the last chair I make will be a comb-back as well.

Here's what I think is important when you build one.

1. Don't put the comb too high. It can look ridiculous and doesn't make the chair more comfortable. Many beginners assume the comb cradles the head when you sit. I thought this, too, at one time. The truth is the sticks (and occasionally the comb), support the shoulder blades. And that's what makes the chair comfortable.

2. The position of the comb can vary based on the sitter's torso. During the last few years I've developed a "dummy comb" from pine that allows me to try out a range of heights. You'll see this dummy comb later in the chapter.

3. All surfaces that touch the sitter should be relieved, chamfered or rounded. But your chair doesn't have to look like pudding. Many beginners go crazy with a rasp and round over every surface so the entire chair looks like a leggy pile of melted Gouda. Other beginners

SEVERE BUT STILL NICE

I make a lot of four-stick comb-backs for customers. They like the basic look. Adding more sticks adds comfort. However, I sit in a four-stick chair every morning for a couple hours.

leave edges dead square. I like things somewhere in the middle.

4. The height of the seat should be slightly lower than the modern standard of 18". For most comb-backs, I shoot for 16-3/4" to 17" high at the front. This height takes a little weight off the sitter's thighs, but it doesn't make the chair difficult to get out of. Of course, shorter sitters need even lower seats.

5. The seat should pitch back about 1" to 1-1/2" from front to back.

This pitch encourages the sitter to slide back to the armbow and the long back sticks.

7. Four back sticks are OK. Six to 11 are even better. I love the severe look of a four-stick chair – it's a bit like a bass guitar in chair form. But a wider spread of sticks that support the entire width of the sitter's shoulders is ideal.

7. The default pitch for the back sticks is 15°-20° in my comb-backs. I will do less (10°) if the customer insists, but 15°-20° is hard to beat.

All in all, it might seem like I am talking out of both sides of my mouth here. In the first 400 pages of this book, I begged you to try different shapes, radii and angles. And here I'm laying down Old Testament, stone-tablet stuff. After you build a few chairs, I hope you'll see how both approaches co-exist.

CUTTING LIST & NOTES

Here are the parts required to build this chair, along with notes on how the parts are shaped and joined.

4 Legs: 1-3/4" x 1-3/4" x 20" (over-long and cut to length after assembly)
• Legs are tapered octagons. They taper to the tenon. No shoulder.
• Tenons are 1" x 2-1/2" cylinders. After assembly, the tops of the tenons are cut flush and the seat is cleaned up.

1 Seat: 1-3/4" x 16" x 20"
• Grain runs left to right in seat.
• Seat shape consists of a 6" x 20" rectangle with a 10"-radius half-circle added to the back of the rectangle.
• Seat is saddled. The spindle deck is 2" wide. The saddle is 7/16" deep at its deepest. The pommel is 1" long from the front edge of the seat, measured back. The cups are an 11" radius (about 3/4" high).
• The seat has an underbevel that is 3/4" tall and cut at 45°.

2 Arm segments: cut from 7/8" x 5-1/2" x 16" blanks
• Arm segments are joined to the mid-arm.
• The assembled arm is then covered with the shoe.

1 Mid-arm: cut from 7/8" x 4" x 15" blank

• Mid-arm is joined to the arms with pocket screws.

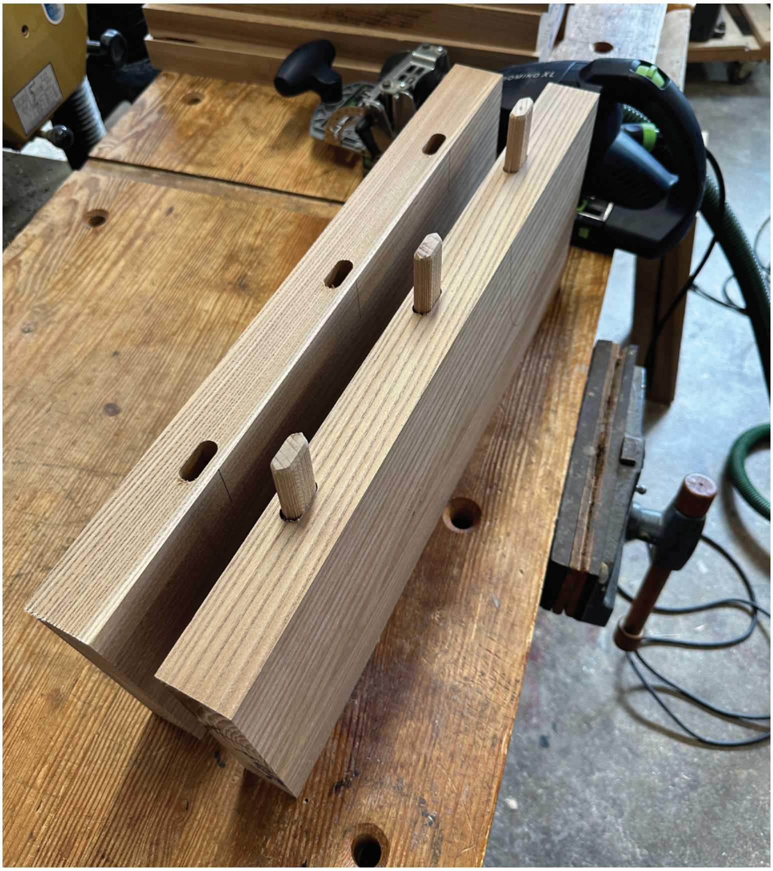
1 Shoe: cut from 5/8" x 7" x 20" blank
• The shape of the shoe is traced from the assembled arm – not a pattern.
• Front edge of the shoe is beveled or rounded for comfort.
• Shoe is glued to arm assembly, centered on the arm.

6 Short sticks: 3/4" diameter x 12-1/2" (they start out as 3/4" octagons and are shaved. Sticks are over-long and trimmed to fit).
• Sticks are shaved with entasis. Each end has a 5/8" x 2-1/4" tenon. The tenons into the arms are wedged and cut flush after assembly. The tenons into the seat are in through-mortises and are trimmed after assembly.

7 Long sticks: 3/4" diameter x 27" (they start out as 3/4" octagons and are shaved. They can be trimmed to lower the comb).
• Sticks are shaved with entasis below the arm. Then they taper to 5/8" diameter at the top.
• Tenons at the bottom of the long sticks are 5/8" diameter x 2-1/4"; tenons at the top of the long sticks are 5/8" diameter x 1" long.
• Long sticks are 5/8" in diameter where they pass through the arm and shoe.
• Back sticks tilt back 20°.

1 Comb: cut from 1-7/8" x 4" x 19" blank
• Front edge of comb is cut at 20°.
• Ends of comb are angled at 10° or curved (your call).
• Mortises in comb drilled at 20° off 90°.
• Tenons for the back sticks are pegged.

2 Side stretchers: 7/8" x 1-1/8" x 24" (rough length)
• Stretchers have 5/8"-diameter x 2-1/4"-long tenons on both ends.
• Stretchers are octagons. They taper to the tenon shoulders.
• Tenon shoulders are not blended into the tenons.
• Stretcher assembly is 11" below the seat.



CHEATED DOWN

The location of these three loose tenons in this seat are shifted toward the underside of the seat. This ensures I won't encounter the tenons when I saddle the seat.

1 Medial stretcher: 7/8" x 1-1/8" x 24" (rough length)

• Medial stretcher has 5/8"-diameter x 2-1/4"-long tenons on both ends.

• Facets of the medial stretcher are tapered down to the tenons.

MAKE THE SEAT

Unless you are lucky, the seat is glued up from two or more boards. I recommend adding three loose tenons to each of your edge joints. Then peg the tenons from the underside of the seat.

Lay out the locations of the mortises for the legs, plus the sightlines, on the underside of the seat. The resultant angle for both the front legs and back legs is 23°. Check your angles as you drill the 1"-diameter mortises through the seat. Saw or shave the underbevel on the seat.

MAKE THE LEGS & STRETCHERS

The legs are tapered octagons. After planing or sawing the legs to octagonal, taper them using a jack plane so they are about 1-3/4" at the foot and 1" at the top. Then cut a 1" x 2-1/2" tenon using a power tenon cutter on the top of each leg.

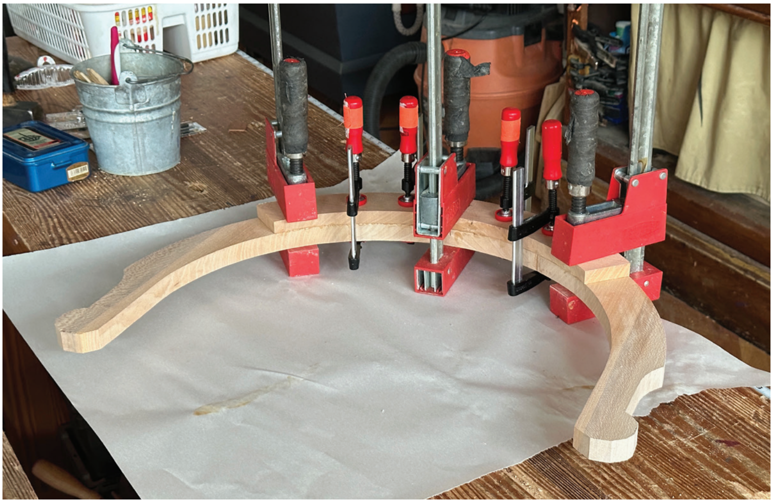
Assign each leg to a mortise in the seat, saw a kerf in each tenon for a wedge and drive the legs into their mortises. Now mark mortise locations for the side stretchers on the legs – 11" from the underside of the seat. Drill 5/8" through-mortises in the legs for the stretchers. Measure between the mortises to determine the length of each side stretcher. Tenon and fit the side stretchers into their mortises.

Now mark the location of the mortises for the medial stretcher. Drill the 5/8" through-mortises and determine the overall length of the medial stretcher. Make and fit the medial stretcher. Dry-fit all the undercarriage parts and the seat.

MAKE & DRILL THE ARM

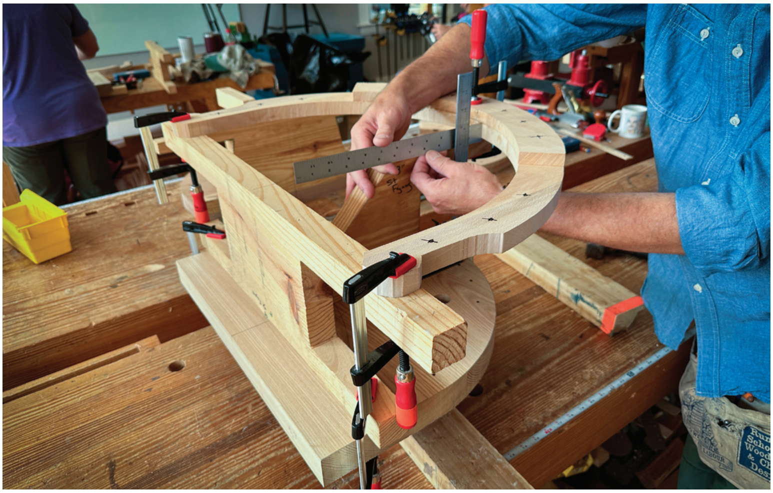
The arm for this comb-back is a "pieced armbow." It is made by gluing and screwing two arm segments to a mid-arm. Then the assembled arm is covered with a shoe. Saw out the two arm segments and mid-arm; avoid putting any short grain in the hands. Plane the joints between the three arm components so they fit tight. Join the arm segments to the mid-arm with pocket screws and glue. After the glue is dry, remove the screws.

Use the assembled arm as a pattern to make the shoe. Then saw out the shoe. Glue the shoe to the arm. Then rough in any decorative details on the assembled armbow.



LAMINATING FOR STRENGTH

Note the shoe is thinner than the arm. This makes it easier to clamp the shoe to the assembled arm with fewer gaps (because the thinner shoe is more flexible).



SET THE LEAN

The location of the arm in relation to the back edge of the seat determines the way the back sticks will lean. Here I'm setting the arm 1-1/8" back from the seat.

A BIT MUCH

The hard line that I carve between the saddle and the spindle deck isn't common on older chairs. They would have saddles that flowed gently to the spindle deck.

Lay out the locations of all the mortises in the seat and the armbow. Position the assembled armbow 8" over the seat, using the drilling jigs to hold the armbow. The armbow needs to be about 1-1/8" back from the back edge of the seat so the sticks lean 20°.

Clamp the armbow in place over the seat. Drill the 5/8" through-mortises through the armbow and the seat.

SADDLE THE SEAT

The spindle deck is 2" wide. Draw that out on the seat. Also draw in the cups on the front edge of the chair and the pommel.

Use a scorp or adze to remove as much material as possible in the bowl of the seat, in the area adjacent to the pommel and in the cups. Then refine all the surfaces of the saddle with a travisher, a scraper and sandpaper. But don't take the saddle all the way to its finished surface. Assembling the chair will usually mar the saddle a bit.

MAKE THE STICKS FIT
Clamp the armbow upside down to your bench. Plane the long sticks until they fit perfectly into the armbow.

MAKE THE STICKS

The sticks for this chair start out as 3/4" square stock. For the short sticks, cut 5/8" x 2-1/4" tenons on both ends of the short sticks. Shave the sticks octagonal, then taper them down to the tenons.

The long sticks have to pass through the armbow, with the right amount of stick below the armbow. I drive all the long sticks through a 5/8" dowel cutter, except for the bottom 10" of each stick. I then cut the 5/8" x 2-1/4" tenons on the bottom of the long sticks. Finally, I octagonalize and shape the square section that is left.

After that, it's a matter of blending the octagonal section with the section that is a 5/8" cylinder. And removing any machine marks from the sticks.

Kerf the tenons of the short sticks that will be wedged into the arms. Then designate each stick to a mortise in the seat and dry-fit the chair.

DO YOU LIKE THIS HEIGHT?
I make a scrap "dummy" comb from pine with oversized holes drilled through it. This allows me to try different comb heights for different sitters.

ASSEMBLE THE CHAIR

Clean up all the chair's parts, removing any toolmarks from the legs, arms, stretchers and sticks. Glue up the undercarriage. Begin by gluing the medial stretcher(s) into the side stretchers. Glue the stretchers into the legs. Put glue on the legs' tenons and mortises, then drive the legs in with a mallet. Flip the chair over and wedge all the tenons. Let the glue dry overnight.

The next day, level the tenons. I saw them close to the saddle, then finish the job by nibbling at them with a scorp. Then I finish the saddle with scraping and sanding to a fine grit. Level the legs and set the pitch of the seat.

Now add the arms and sticks. Put glue in all the mortises in the seat. Glue the short sticks into the arm. Push the long sticks into place in

DUMMY BONUS

The dummy comb also helps me mark where the tenons begin on the long sticks. No math or geometry required.

the armbow. Take this constellation of arm and sticks and pull the sticks into their mortises in the seat. Tap the arm and short sticks gently but swiftly into place. Then drive the long sticks home with a mallet. Make sure the armbow is 8" off the seat in several places. Wedge the short sticks and let the glue dry.

The next day cut the tenons on the short sticks flush to the arms and clean up any bruising from the assembly process.

MAKE & FIT THE COMB

Saw the comb from solid material. Drill the 5/8" mortises for the long sticks in the underside of the comb. These mortises angle 20° back. Now cut a 20° bevel on the front edge of the comb. Trim both ends of the comb and add any decorative detail (such as an arc or angle). Clean off all the saw blade marks.

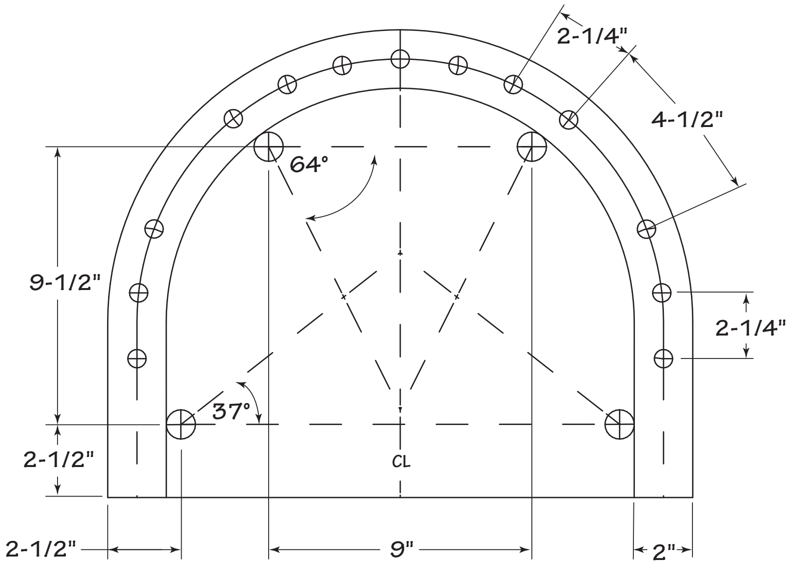
TRIM THE STICKS

Press the sticks against the workbench to immobilize them. Then saw them to length.

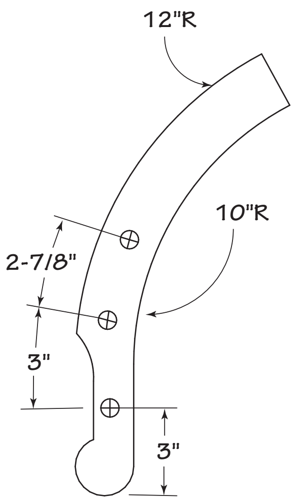
Fit the comb onto the back sticks and adjust the tenons on the back sticks if necessary. Glue the comb onto the back sticks and peg the tenons. When the glue is dry, saw the pegs flush to the surface.

FINISH

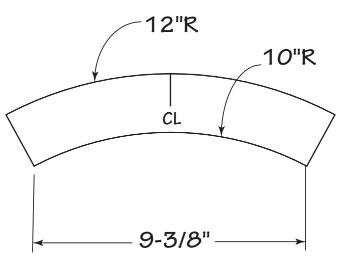
If the chair is made from mixed species of wood, or ugly wood, I paint it. If the chair is worthy of a clear finish, I usually use a linseed oil/wax blend. I wipe on a coat with a 3M gray pad. Then remove all the excess with a huck towel. It should be dry enough for a sit in a couple hours. If it's not, rub the chair again to remove the excess this time.



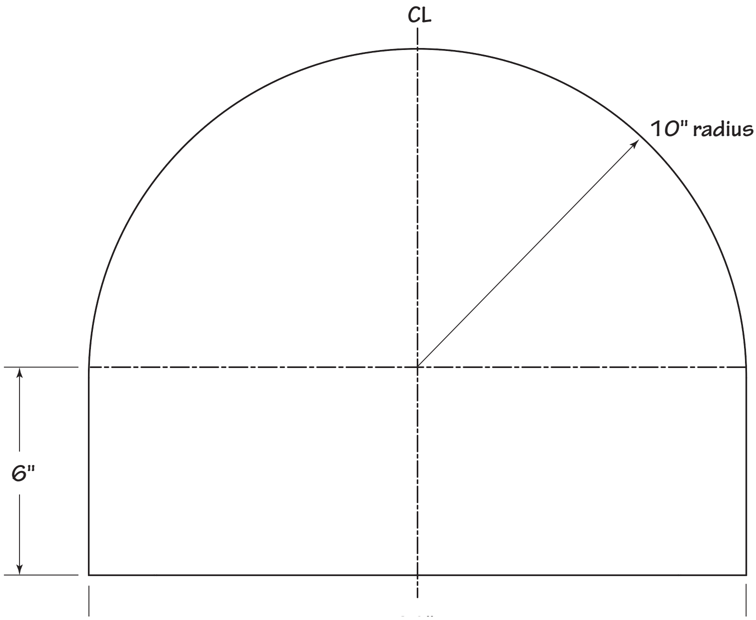
Seat shape



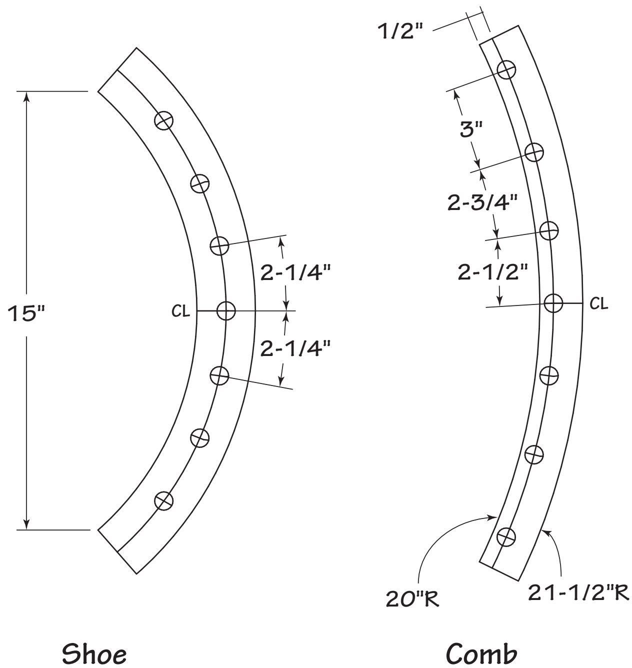
Arm



Mid-arm



Seat shape


15"
CL
2-1/4"
2-1/4"
Shoe
1/2"
3"
2-3/4"
2-1/2"
CL
20"R
21-1/2"R
Comb

AT HOME

The bent-arm comb-back in fresh milk paint with a saffron pigment.

COMB-BACK WITH BENT ARMBOW

This chair is the most expensive one I make. The reason it is expensive is because of the bent armbow and comb. Bending wood requires an investment in tools and skill. And there are times when bent parts split, delaminate or crack across the grain.

So I need some help paying for that firewood.

Failure when bending wood is normal. Anyone who tells you otherwise is selling something.

So, if bending parts is such a pain, why do it? I think it looks fantastic and it is satisfying when things go well. It also uses less material (in theory) and creates strong chair parts. A bent armbow is much smaller and lighter than a pieced one. And a bent crest is stronger than one sawn from a solid chunk of timber.

Bending wood is not a new thing. People have been doing it for centuries to make ship components, bentwood storage containers and parts for carriages. So of course you can do it, too.

In my workshop, I bend wood using several different methods. For chairs, I use steambending, boiling and cold-bend hardwood. Other than the bent components, this chair is a close cousin of the six-stick comb-back. The seat and undercarriage are the same.

CUTTING LIST & NOTES ON THE PARTS

4 Legs: 1-3/4" x 1-3/4" x 20" (over-long and cut to final length after assembly)

• Legs are tapered octagons. They taper to 1-1/8" where they transition into round. No shoulder.

• Tenons are 1" x 2-1/2" cylinders.

1 Seat: 1-3/4" x 16" x 20"

• Grain runs from left to right in seat.

• Seat shape consists of a 6" x 20" rectangle with a 10"-radius

half-circle added to the back of the rectangle.
• Seat is saddled. The spindle deck is 2" wide. The saddle is 7/16" deep at its deepest. The pommel is 1" long. The front curves are an 11" radius (about 3/4" high). Seat has a small bevel on top edge.
• The seat has an underbevel that is 3/4" tall and cut at 30° off 90°.
• Front edge of seat (at pommel) is 17" from the floor. Rear edge of seat is 15-3/4" from the floor (measured from the top of the spindle deck).

1 Arm: 1" x 1-3/8" x 48" (trimmed to 46" after bending and assembly)
• Arm is bent over a form that mimics the seat shape – a 10" radius curve joined by a 5" x 20" rectangle.
• Front of hand is cut at a 20° bevel off 90°.
• Arm is 8" off seat.

6 or 8 Short sticks: 5/8" diameter x 12-1/2" (over-long and trimmed)
• Sticks are shaved with entasis. Each end has a 5/8" x 2-1/4" tenon. The tenons into the arms are wedged and cut flush after assembly. The tenons into the seat are in through-mortises and are trimmed after assembly.

7 Long sticks: 3/4" diameter x 27".
• Sticks are shaved with entasis below the arm. Then they taper to 5/8" diameter at the top.
• Tenons at the bottom of the long sticks are 5/8" diameter x 2-1/4"; tenons at the top of the long sticks are 5/8" diameter x 1" long.
• Long sticks are 5/8" in diameter where they pass through the arm and shoe.
• Back sticks tilt back 20°.

1 Comb: 7/8" x 1-7/8" x 20"
• Comb can be bent over a form (20" radius arc) or cut from solid. If cut from solid, the blank should be 2" x 3" x 21".
• Ends of comb are angled at 10° off 90° (or curved).
• Tenons for the back sticks are pegged.

2 Side stretchers: 7/8" x 1-1/8" x 24" (rough length)

• Stretchers have 5/8"-diameter x 2-1/4"-long tenons on both ends.
• Stretchers are octagons. They taper to the tenon shoulders.
• Tenon shoulders are not blended into the tenons.
• Stretcher assembly is 11" below the seat.

1 Medial stretcher: 7/8" x 1-1/8" x 24" (rough length)
• Medial stretcher has 5/8”-diameter x 2-1/4”-long tenons on both ends.
• Facets of the medial stretcher are tapered down to the tenons.

AN INTRO TO STEAMBENDING

I've been bending wood since I started chairmaking. But I can guarantee you there are monkeys who know more about the topic than me.

I'm about to tell you everything I know about steambending, but you might've noticed there aren't many pages left in this book. So, if you want to make steambending an essential part of your chair designs, I recommend you check out some books at the library on the topic.

I bend only two chair components for my designs: the comb (which is easy to bend) and the armbow (which isn't). I don't use fancy equipment. To make steam, I have a plywood-and-drywall screw steambox plus a wallpaper steamer. Sometimes I'll use a metal boiling tank plus an induction cooktop to heat the water in the tank. I also have an adjustable metal compression strap to reduce failure during bending. And a PVC pipe to soak my wood.

Here are the important principles:

1. Heat makes the wood bend, not the water. Water is important to steambending because it is an efficient way to carry the heat into the wood. And it prevents the wood from drying out and cracking. If you are wondering how steambending works, here's the abbreviated version. Wood has cellulose, which makes up the cell walls, and lignin, which is the glue between them. Heat plasticizes the lignin and allows the cellulose to move. When the lignin cools, the wood keeps its new shape (mostly).

2. Air-dried wood and green wood are the easiest woods to bend. You can bend kiln-dried stuff after a week of soaking. No matter what, the grain needs to be as straight as possible through the entire stick of wood. You can get there by riving, sawing or a combination of the two.

BOIL IT

This welded tray holds about six arms. The heat is provided by an induction cooktop.

READY TO DRY

After the arm has cooled you can screw it to a stick of wood or tie the ends together with string or wire. Then take it off the form to dry.

If you want to practice on some scrap, buy a bundle of firewood at the gas station. It's air-dried wood that has been split for you.

3. A compression strap greatly reduces splits. The metal strap supports the outside of the bend and keeps the ends of the board compressed. This greatly reduces the tendency of the wood to burst.

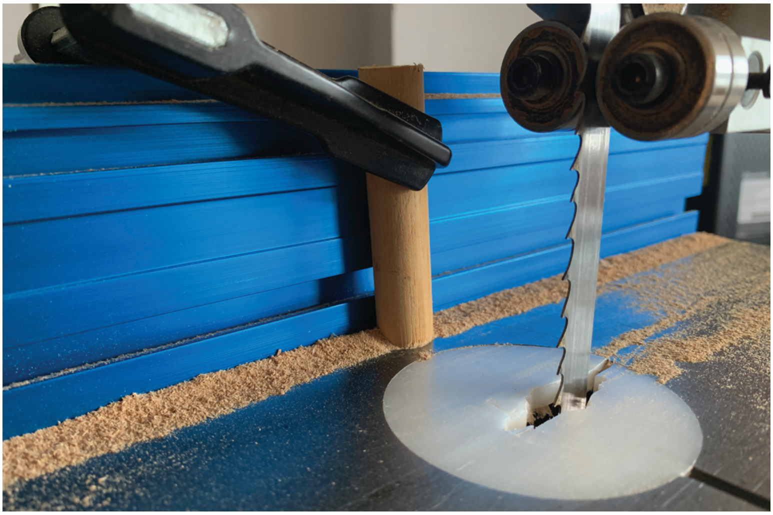
4. You have to dry the wood gently after a bend. I put it in a cardboard box with a light bulb (you can call it a kiln, but it's really just a cheap fire hazard). Keep the box at 125° (F) overnight. Or if that is too much trouble, just let the piece sit around for a week or so.

5. The wood might change shape after it comes off the form. The bend might tighten up or expand a bit as it dries. I refuse to get worked up about this. All my chairs are different, and this is one way they express themselves. Embrace it.

6. Steambending is risky. I've seen a fair number of old chairs with

CHEAP TRICKS

You can spend a lot of time and money setting up a steambending operation. And if you are a professional chairmaker, you should. However, steambent components are only a small part of my chairmaking, so I have inexpensive (but reliable) gear.



JUST A DOWEL

I don't use the fence when making long rips for armbows. Instead, I take a short length of dowel and plane a flat on it. Then clamp it to my saw's fence. Then I can follow my line and do a little steering if necessary. A long rived edge isn't always perfectly straight.

steambent components that have come apart – usually because of some short-grain problems.

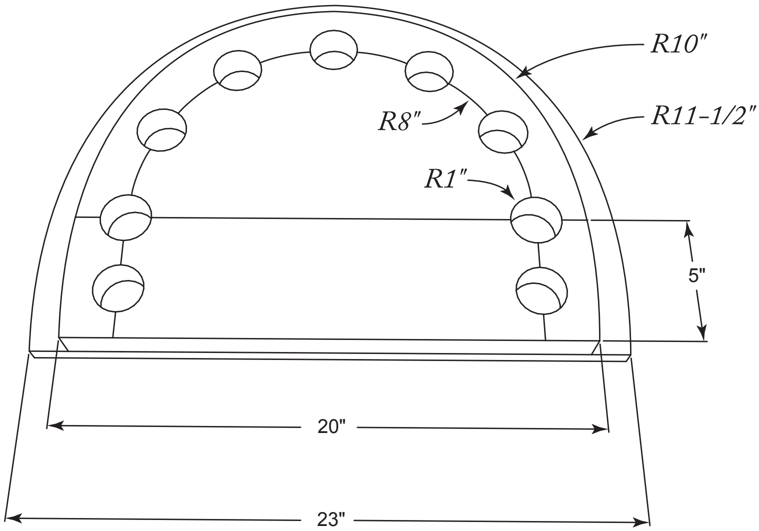
7. You will fail. Sometimes when I bend 10 arms, every one bends like a dream. The next time, nine of them crack or look like crap in the end. Don't take it personally. Just remember: The wood hates you and wants you to die.

Here is the gear I use:

Wallpaper steamer: This is a safe way to make steam. You can buy a steambending kit that includes a wallpaper steamer with a hose and a fitting for the steambox. It works OK and shuts itself off if you run out of water. I wish it put out more steam.

Other people use a propane burner and a giant metal tank of water, also known as a homemade bomb.

Steambox: It's a cheap plywood box that is screwed together. I have installed some dowels in it to hold the pieces up so the steam can get



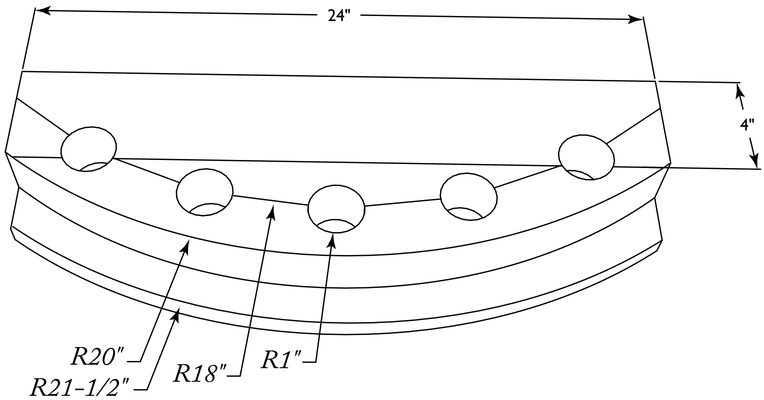
BENDING FORM FOR ARMS

My bending form for arms. The base is 3/4" plywood. The form itself is two layers of 3/4" plywood that are glued and screwed together.

all around them. One end of the box has some holes (so the water can drain out). The other end has a hinged door that allows me to get pieces in and out. It took me 30 minutes (tops) to make it. Don't try to make it airtight because that's also a homemade bomb. Steam must be able to escape.

Boil tank: Mine was made by a sheet-metal fabricator. You can also buy a trough for feeding chickens (I've seen them at farm supply stores for $25). The heat is provided by an induction cooktop. Some people use more than one cooktop.

Compression strap: If you make one or two kinds of arms, I suggest you make your own from the metal strapping used to hold boxes on pallets. You can find an unlimited supply in the dumpsters of warehouses. I screwed wooden blocks to the ends of the straps to hold my work. Years ago I bought an adjustable Veritas Strap Clamp, which allows me to have one adjustable strap (instead of a whole pile of them



BENDING FORM FOR COMBS

Like the form for arms, this form is made from cheap layers of plywood. The base is one layer of plywood. The form itself is three layers of MDF or plywood.

shop-made ones). This is heavy-duty and adjustable. But it can be unwieldy for smaller bends.

PVC pipe: When I bend kiln-dried wood, I soak it for a week or two (or whatever) before bending it. For soaking, I have a 3" PVC pipe. One end is capped. The other end has a clean-out cap on it that acts as a screw-top lid. I first saw this setup used by Bern Chandley. It's genius.

Forms: I have a few forms for the different arms and combs I make. These are made from cheap plywood and last for decades. I wedge my work to the forms with 1" dowels and hardwood wedges.

Thermometer: A cheap meat thermometer is handy at first.

Heavy gloves: These protect your hands from burns. You'll forget to put them on only once.

A cardboard box and a light bulb: This is your kiln.

HOW TO DO IT

If this is your first time steambending, plan to make four blanks and hope to get one that looks good enough for your chair. As mentioned earlier, do everything possible to get the grain running straight

PLAYING WITH FIRE

I have sawn out two armbows and one blank for a comb. Normally I would saw out five extra pieces, but I was short on wood.

through the blank. Select straight-grained wood at the lumberyard. Rive or saw the wood so that the grain is arrow-straight through the blank. I also cut my blank 2" over-long to the finished size. Sometimes the ends of a bend look pretty rough when it's all over.

If the wood is kiln dried, you'll need to soak it in your pipe. If it's air-dried, it can go right into the steambox or boil tank.

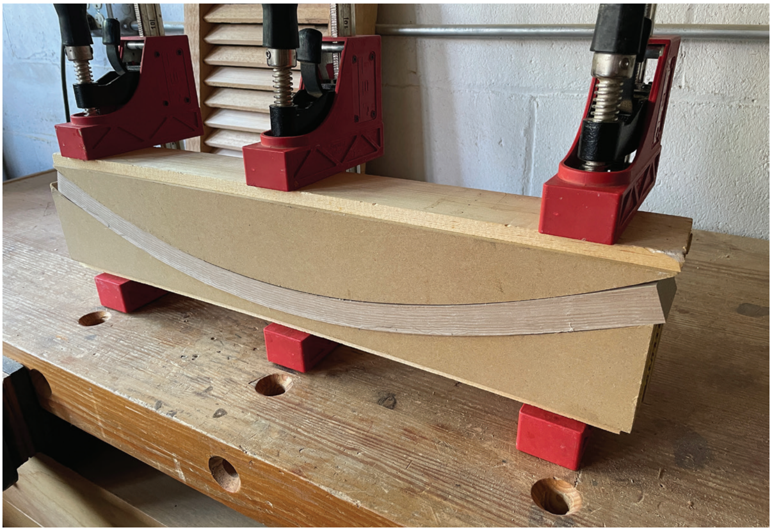
Set up the steambox and crank up the steamer. Check the box with a meat thermometer near the opening of the box and let the temperature rise to the boiling point before putting anything in.

While the box heats up, set up your form. Clamp it to the bench and get your clamps out. Position the compression strap so the blank can go right from the steambox into the compression strap. Mark a pencil line at the midpoint of the blank that is on all four faces.

When the box has been at the boiling point for 30 minutes or so, put the first blank in and quickly shut the door. After 45 minutes, don the gloves and pull the blank out. Hold one end in your gloved hand and

TAKING ITS TEMPERATURE

After 45 minutes of steaming, the blank should be able to flex a bit in the middle. This allows me to see how limber it has become – and which direction the blank wants to bend. You can learn a lot from this quick step.



A COMB IN THE COLD

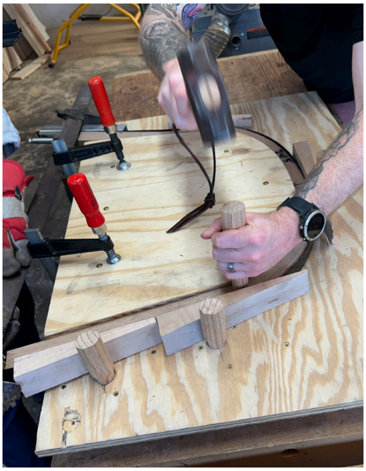
With cold-bend hardwood, you can have a simple form such as this. Place the wood between the forms and clamp it tight.

let the other end hit the floor. Push the middle of the blank with your other gloved hand to see how limber it is. It should be more flexible than dried wood. Push it a few times then put it back in the steambox for 20 minutes.

When the time is up, pull the blank out – quickly and smoothly – and put it in the compression strap. Wedge the pair to the center of the form. Pull one side around the form, wedging as you go. Then pull the other side around and do the same pull-and-wedge routine. If you have a shop helper, you can work together and faster.

Let the blank cool for an hour on the form. Then you can remove it from the form. I screw a stick between the two ends of the blank to hold them at a consistent distance while drying. Dry the blank for overnight in a cardboard box warmed with a light bulb. Shoot for 125°-130° (F). Poke holes in the box to let moisture escape. Or you can let the bend sit around for a couple weeks.

You can get technical about all this. Or you can just do it. For the last



IT TAKES PRACTICE

The first bend of a batch is always awkward for me, even though I've been doing this for many years. Pull the stick out of the steambox, place it in the strap and wedge it to the center of the form. Pull the stick around the form, wedging as you go.

18 years I have resisted becoming a steam engineer.

After its time in the kiln, you can treat the bent wood like regular stock. Plane it, drill it, sand it, finish it.

COLD-BEND HARDWOOD

I have been using cold-bend hardwood almost as long as I have been steambending. Furniture maker Jeff Miller introduced me to it, and I have learned a lot about the stuff in the last 15 years or so.

Using cold-bend hardwood is similar to using steambent wood. But there's no heat. You simply unwrap the wood from its plastic wrap, cut it to size and bend it over your form. Put the form and the blank in the kiln and let it dry for a day or two. Then remove it from the form.

Cold-bend hardwood is expensive, but it has failed me only once in all the years I've used it. Here are some of its peculiarities.

1. Rip it with a band saw only. Don't use a table saw, jointer, planer or handsaw. It will tear-out or bind the blade horribly. I am not kidding or exaggerating. Don't worry about surfacing it. It's flexible, and most crooks or bows can be pulled out on the form. You can crosscut it however you like.

2. If you have a drum sander, you can smooth the wet blank before it goes on the form. This will save you some work later. After the blank is dry, you can work it with edge tools and machine tools. But honestly: Abrasive sanding seems to work best.

3. Usually the grain in the blanks is pretty darn straight. I don't try to straighten it out with sawing or riving. I just rip it, crosscut it then bend it.

4. Read the directions from the manufacturer. They are written by people who use the stuff for a living (not personal injury lawyers).

Bending wood is a lot like whitewater rafting. You can read every word written about it. Watch all the videos. And talk to everyone who has ever done it. But the real education begins when you do it yourself. I learned more about bending wood on my first try than I had learned during three years of reading about it beforehand.

BEGIN WITH BENDING

Because your armbow and comb will need to dry before you can use them, I recommend you bend those components first and build the rest of the chair while the parts dry. When I am in production mode, I try to keep a pile of bent arms and combs on hand at all times. That means that even when I am not building chairs, I am bending parts in the background of whatever else I'm doing.

MAKE & MORTISE THE SEAT

I always strive to find wide boards so I can make a one-board seat. When I can't get my hands on affordable wide stock, I glue up my seats from two boards. Join them with loose tenons in case the glue ever fails. Once the seat is assembled, peg the loose tenons from the underside of the seat.

Saw the seat to shape, then cut the underbevel on the seat's underside. Draw out all the mortise locations and sightlines for the legs.

The mortises and tenons are cylindrical Check your work as you drill against a sliding bevel set to the resultant angle (23°).

MAKE & TENON THE LEGS

The legs are tapered octagons with a cylindrical tenon on top of each. Begin by sawing out the legs to 1-3/4" square, then sawing or planing them octagonal. To taper them, pencil a 1" octagon on the top of the legs. Taper the eight sides to the pencil line with a jack plane.

Make the tenon with a power tenon cutter, rounding plane, plug cutter or a block plane.

Assign each leg to a mortise in the seat. Mark the top of each tenon for a kerf to accept a wedge. Saw a kerf in each leg. Then drive all four legs into the seat.

MAKE & INSTALL THE STRETCHERS

Use a thick block of wood that's 11" long and a Half Pencil to mark the locations of the mortises for the side stretchers. Drill 5/8"-diameter through mortises in each leg. Use a skinny stick to determine the length of each stretcher. They likely will be different lengths.

Make the side stretchers and cut the 5/8"-diameter tenons on the ends. Taper the stretchers so they are thick in the middle and skinny by the tenons. Install the side stretchers in the legs.

Now lay out the location of the medial stretcher. These stretchers are centered on the side stretchers from front to back. Drill 5/8"-diameter

POSITION THE ARM

Note the combination square. It tells me that the arm is 1" behind the back edge of the seat. This gives you a 20° lean to the back sticks.

through-mortises in the side stretchers. Measure between the mortises to determine the lengths of the medial stretcher. Make the stretcher, tenon its ends and install it between the side stretchers.

DRILL THE MORTISES IN THE ARM & SEAT

Lay out the locations of the mortises in the arm and the seat. Use your drilling jigs to clamp the armbow in place over the seat, using the illustrations as a guide. Now drill 5/8" holes through the armbow (don't forget a backing block) and the seat.

SADDLE THE SEAT

Mark the 2"-wide spindle deck on the seat. Then use a scorp, inshave or adze to hog out as much material as you can in the bowl at the back of the seat and up to the leg cups, which are beside the pommel. Then

THE FINAL TOUCH

This card scraper has a few different curves to deal with different parts of the saddle. I shape my scrapers on a belt sander.

use the scorp to scoop out the wood in the cups on the front edge of the seat. Scorp the back of the pommel and blend all the areas of the seat together.

Use a travisher to clean up the rough furrows left by the scorp. Scrape and sand the saddle so it is smooth but not completely finished.

ASSEMBLE THE UNDERCARRIAGE

Set up all your parts on the bench. Glue the medial stretchers to the side stretchers. Then glue the stretchers to the chair's legs. Paint glue on both the mortises in the seat and on the legs' tenons, then drive the legs into the seat firmly. Flip the chair over. Paint glue on each wedge and drive it into a leg tenon. Clean up all errant glue drips and let the glue dry overnight.

The next day, saw off the wedges and level the protruding tenons to

SLIGHT ADJUSTMENTS

Because the sticks fan out a bit, the mortises for the exterior back sticks need to be drilled at a slight angle. Drill the two center mortises at 90°. Then drive the comb onto the sticks. You can then use the sticks to determine and mark the slight angles. Drill the mortises by eye.

the saddle. I use a scorp to nibble away the proud tenons. Scrape and sand the saddle to its finished grit.

MAKE THE STICKS

The sticks are made with the Veritas Dowel Maker, plus planes. Prepare the wood with care and ensure the grain is arrow straight. Then use a drill to drive the top part of the 3/4" x 3/4" blanks through the dowel maker. Tenon the bottom of the stick so it goes into the seat. Then blend everything into a nice long stick.

Kerf the tops of the short sticks for wedges. Scrape the long sticks until they slide easily into their holes in the armbow. Check the fit of all the tenons in the seat. Compress any that are too tight.

ASSEMBLE THE UPPERCARRIAGE

Plane any tool marks off the spindle deck and armbow. Put glue in all the seat mortises. Then glue the short sticks into the armbow. Now take the assembled armbow and wrangle the sticks into the mortises in the seat.

Tap the long sticks home. Tap the short sticks and armbow until the armbow is 8" off the seat. Check this measurement in several places.

Wedge the short sticks with some glue. Clean off any excess glue and let the chair sit overnight. The next day, saw the short sticks flush with the arm and clean off any bruising or denting on the armbow.

MAKE & INSTALL THE COMB

The comb can be either bent wood or sawn from solid. Once you get it to rough shape, mark out the locations of the mortises in the comb. Trim the long sticks to their final length.

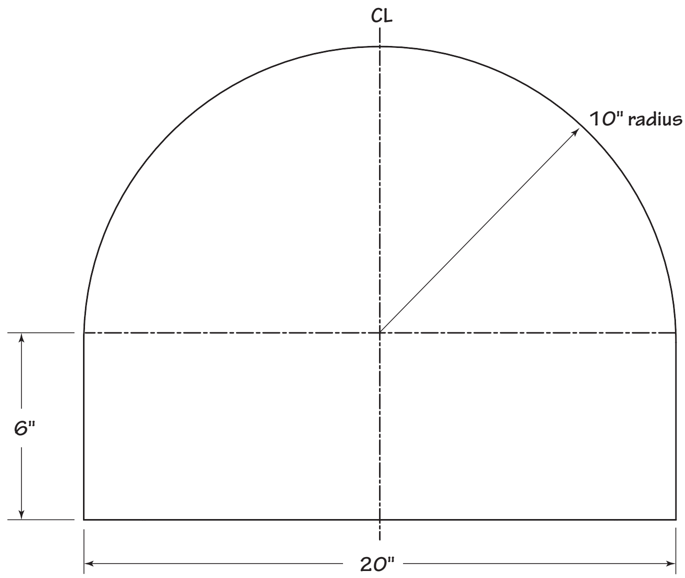
Sometimes I drill 1/2" mortises in the comb and shave the long sticks down to fit. Other times I drill 5/8" mortises into the comb and fit the sticks in the mortises without shaving. The first approach is more work; the second has a little risk if your drill bit wanders. Either way, the mortises are 1-1/4" deep.

Clean up any ugly tool marks on the comb and cut a bevel on the ends. Glue the comb onto the long sticks and peg the tenons.

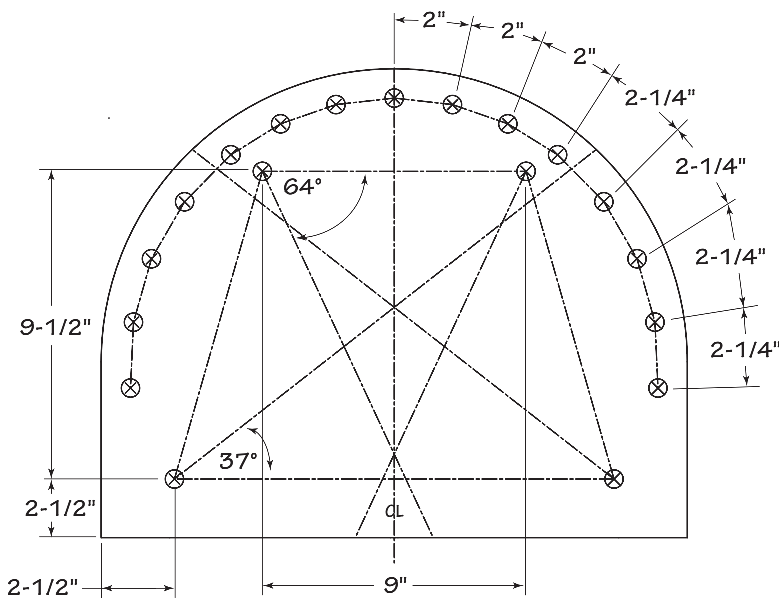
Level the legs and set the pitch of the seat. Trim the arms to their finished length and angle. Go over all the surfaces of the chair to prepare it for finishing.

FINISHING

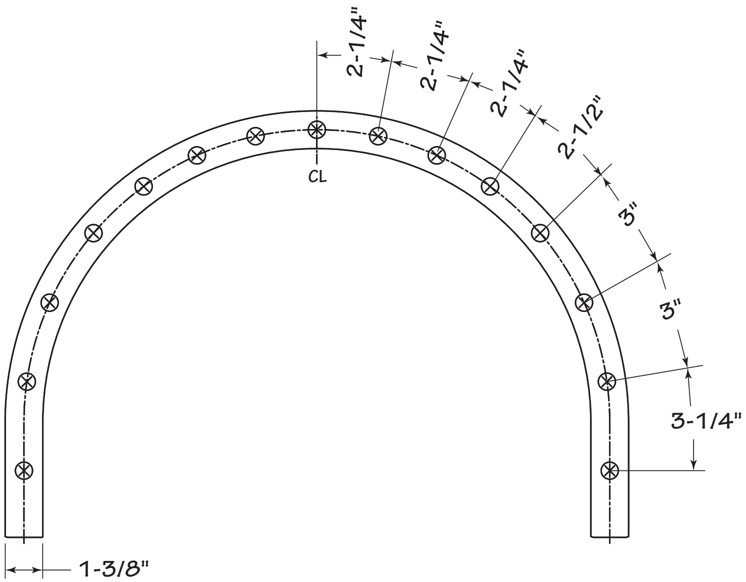
These chairs are typically painted, though occasionally I'll make one with a clear finish. For a clear finish, I use a mixture of beeswax and linseed oil.



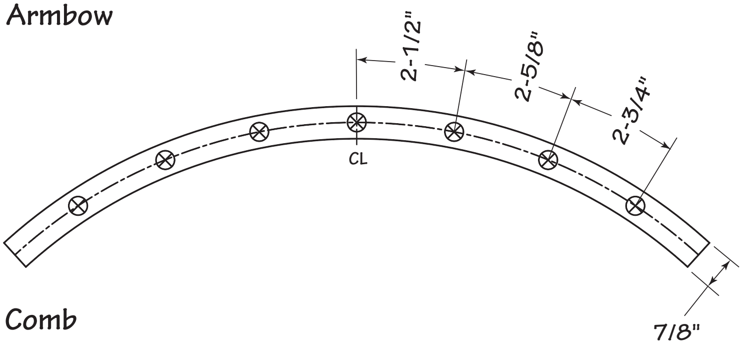
Seat shape



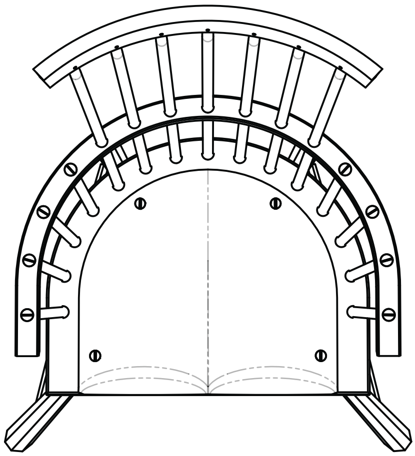
Seat pattern

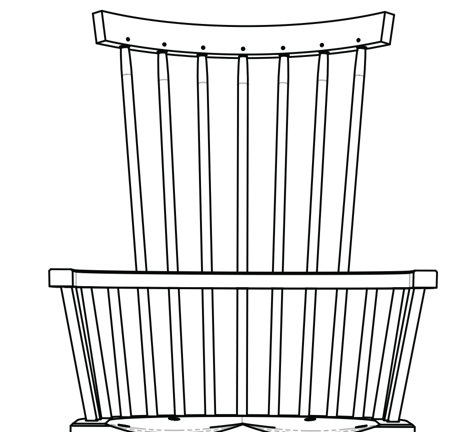


Armbow



Comb





COMB-BACK WITH BENT ARMBOW

ST FAGANS ROOT-BACK CHAIR

I adore this sublime root-back chair from Wales. If there is a high-style equivalent to this chair, I am unaware of it. Many vernacular chairs are their own thing.

CHAIRS & THE CWTCH

If there is one thing we can agree on, it's probably this: Factory-made wooden chairs are some of the biggest hunks of garbage on the market today. With rare exception, their parts are joined with dowels or (worse) flimsy mechanical fasteners.

These chairs are designed to fail after a certain number of uses. And then you are supposed to buy a new chair with the same limited lifespan. Furniture manufacturers don't tell you this, of course. Who would buy a chair that was advertised to be good for 2,000 sits?

But we all know it. And we accept the fact without complaint. As soon as a wooden chair starts to sway, you better throw it to the curb lest you end up in the ER with a new stick implant. (Plus a new and unfortunate nickname.)

Here's the other maddening thing: This is not a new problem.

I own a gorgeous Morris chair made by the Shop of the Crafters, circa 1905. It's built from thick quartersawn oak and looks like a tank. The truth, however, is the chair isn't what it seems. After I owned it for six years, its base became loose. I decided to take it apart and reglue the mortise-and-tenon joints with hide glue.

I injected alcohol into the joints, and the whole thing popped apart. It was completely joined with dowels. Dowels. And not that many dowels. I have no idea how the thing survived as long as it did.

The Arts & Crafts movement was supposed to be a reaction to this shoddy type of work. It was supposed to embrace mortise-and-tenon joints and solid construction principles.

What can we do about this problem? Burn down the chair factories? Petition Congress to ban dowel joinery?

Nah. If you can't beat them, join them – the chair parts, that is. Long ago, I chose to make my own chairs with joinery that will last way past my lifetime.

In many ways, we are in the same situation as the people who made stick chairs in the 18th and 19th centuries. Back then, well-built chairs that were made by professionals were far too expensive for a farmer or day-laborer to own. In other words, good chairs were unobtainable.

So, the solution was to make chairs yourself. With the tools you had on the farm and the wood around you.

There isn't much written about these amateur chairmakers. Most of the academic research on old furniture is focused on high-style pieces made for the wealthy. When the research does mention vernacular work, the broad assumption is that these farmers were imitating the high styles from the cities. And because vernacular makers didn't have the skills to copy the high styles, they produced simple items that were shadows of Forest chairs, highboys or secretaries.

These assumptions and declarations make me sour. While we don't have a written history of stick chairs, we do have a wooden one. And it is clear.

Thanks to a few furniture historians and open-minded museums, we still have collections of the old chairs that weren't burnt for heat when the farmers could finally afford tubular steel chairs with plastic cushions. And if you spend some time with these chairs, you will see that these makers spoke their own language.

Stick chairs are their own weird and wonderful thing. Most of the forms have no analog to high-style pieces. They have unusual forms. Unexpected shapes. And a lot of knots, bark and splits.

Because of these unusual features, many people are repulsed or confused when they encounter stick chairs for the first time. They don't look like any sort of chair they've encountered. Stick chairs aren't something you see on television, in furniture stores, or in magazines about interior design (yet).

It's like visiting a foreign country where they eat fermented fish for breakfast. It takes some getting used to.

When I first started making stick chairs with three legs, none of my family or friends would sit in them. It was like having a live tiger at the dinner table. A three-legged chair seemed a wild and unpredictable thing that could throw you to the floor at a moment's notice.

After a few months with no injuries, however, the three-legged chairs became a normal part of the household. And when I gave my last one away to a family member, our kids howled in protest.

The best way to make the people around you appreciate (or even

MEN SHOVELING CHAIRS (SCUPSTOEL)
This drawing is from 1444–50. Drawn by Rogier van der Weyden, or possibly Vranke van der Stockt of Brussels. From the Robert Lehman Collection.

accept) stick chairs is to build some and put them in your home. Well, that's what I did.

Every stick chair around our dinner table is unique. They aren't a matched set. They're made from different woods. Some are painted and some aren't. They all have different forms. None of the chairs looks more important than another.

All of them are scratched, stained and dented from years of daily use, thanks to thousands of meals, homework sessions, family budget talks and late-night games of Uno. And while I feel sorry for the abuse we've heaped on the chairs, I occasionally wonder if the chairs have, in turn, affected my family.

When my daughters were ages 4 and 9, I built them each a stick chair that was based on chairs in the background of the film "The Fellowship of the Ring." (We are a nerdy J.R.R. Tolkien family.)

These chairs were rough and quick work. I was employed full-time as an editor and didn't have time to fuss over a couple chairs. We needed them for the girls, and I built them in a week or so. Even though they are the ugliest chairs I've made (yet), the chairs were built to last, using all the principles that I now use to build chairs for customers. And they are pretty comfortable.

When our oldest daughter left for college years ago, she packed up her car. Then she plucked her "Hobbit chair" from the dining room and packed it with her things.

I wasn't expecting that.

The chair followed her from Ohio to Connecticut then Pennsylvania. She eats dinner in it every night. It is her chair, and no one else's. Her younger sister has the same plan for her red Hobbit chair.

When I made those ugly red chairs, I had no idea that they could become personal totems. Now I know better. Stick chairs, like three-legged stray cats, tend to imprint on you.

You can abuse them, and they won't fall to bits. They get better looking with age. And if made truly well, they will never leave you.

There are days when I think about the red chair that my eldest daughter snatched on her way out. I wonder if she's worn through the red paint on its hands. Or if the through-tenons on the seat have begun to show through after almost two decades of use.

And on a few nights, I wonder if she's ever realized that I made that chair to hold her when I wasn't around – because I was out of town teaching, working late at the shop or (someday) had left this world.

Some chairs, no matter how wide their arm spans, will always be *cwtch* chairs.

ANOTHER CWTCH CHAIR

The Irish armchairs always look like they want to give you a hug. And they tend to deliver on the promise.

MAKE YOUR OWN

Making your own finishes can be as easy as heating up a burrito. You will save an astonishing amount of money, and you can avoid harmful chemicals in the process.

3 FINISH RECIPES

Making your own finish can be as easy as cooking up a batch of macaroni and cheese from a box mix. In fact, the process uses mostly the same gear.

I make my own finishes because it's shockingly cheaper. And it gives me control over how the finish works and exactly what's in it. The following finish recipes are easy to make and are safe to apply without gloves or a respirator.

SOAP FINISH FOR CHAIRS

I've used soap finish for many years on chairs and tables, including the desk in our office. Soap adds little or no protection, but it is easy to apply and easy to both repair and renew (just add more soap). Soap leaves a matte surface that is soft to the touch.

People have a lot of questions about soap finish. Here are a handful:

• If I put a wet glass on a soap finish, will it foam up? No. Not unless you applied a goo-thick coat of the finish.

• How do I remove a soap finish if I don't like it? Water.

• How long does it last? It depends on how much you use the object. Some Hans Wegner chairs from the 20th century still sport their original coat of soap finish.

• Does it make the wood feel slippery or greasy? No.

• Will it protect against red wine? No. But you can clean stains away with household bleach.

• Why would you use soap on wood? It's safe. After many applications, the object gets a slightly bleached look. I love the way the finished surface feels and looks.

• Why can't I just rub liquid soap on my project? Liquid soap has detergents, scents and other chemicals that aren't ideal for a wood finish. But feel free to give it a try if you don't believe me.

• Can I apply soap over a film finish or milk paint? You can, but it might look odd. Try a test board first.

SOAP FLAKES

Pure soap doesn't lather up like the liquid soap at the gas station. The flakes are combined with hot water to produce a low-sheen finish that leaves a white cast on most woods.

• If I don't like a soap finish, can I apply another finish over it? Rinse the object with hot water first to remove the soap, and you will be fine.

• What woods should I use it on? I prefer it on light-colored woods; maple, ash and beech look great. I also like it on gray pieces of white oak. It fills in the pores and looks nice. I'm not wild about soap on darker woods, such as cherry or walnut. But make a few test boards, and you can make up your own mind.

• Where can I buy the right soap? I use pure soap flakes, which are available from many suppliers by mail. In flake form, soap is about $16 per pound (16 ounces by weight). You also can buy a bar of unscented Castile soap from the grocery, shred it with a cheese grater and give the recipe a try. Each batch of this finish costs about $4 to make.

JUST ADD WATER

Pour boiling water over the soap flakes and immediately stir the solution. The flakes will clump up, then they should dissolve in a minute or two. Stir until the solution is free of clumps. Or until the clumps stop getting smaller. Then allow the solution to cool.

Soap Finish Recipe

4 ounces of soap flakes (by weight, not volume)
4 ounces of boiling water (by volume)

Heat the water using an electric kettle or on a stove. Put the soap flakes in a Mason jar or other container that can be sealed. When the water boils, pour it over the soap flakes and immediately stir the solution with a stick. The flakes should dissolve within a minute or two. Allow the solution to cool with the lid off. Within an hour or two, the solution should firm into a soupy paste. You can use it immediately or seal it for later use. I have kept unused soap finish sealed for a couple years with no problems. Readers report that different brands of soap

A NICE PASTE

This linseed oil and wax finish is the thickness of peanut butter. It's easy to apply and to wipe off. It buffs to a nice low sheen.

require more flakes. So if your solution is too runny, heat it back up and add more flakes. If you end up with a waxy block of soap finish, that will work, too. Simply wrap a towel around it, squeeze it and then rub it all against the wood.

APPLY A SOAP FINISH

Apply the finish directly with a rag. Wipe the finish on faily thin. The wood will get wet. Spread the soap evenly on the wood in a thin coat. Let it sit for 10-15 minutes, then remove the excess with a clean rag. When the excess has been wiped off, allow the water to evaporate.

If the grain has been raised by the water in the finish, sand the wood with a #320-grit sanding sponge. Then apply another thin coat.

LINSEED OIL & WAX

My favorite clear finish for chairs is a combination of raw linseed oil, beeswax and a bit of citrus solvent. It is easy to apply, nearly non-toxic and is a lustrous finish that does not make a film barrier between you

RAW INGREDIENTS

I make the finish in small batches. A little bit goes a long way. Before heating the oil, I measure out the three ingredients so I don't have to think much during the process.

and the chair. It is easily renewed or repaired by adding more finish. This finish works for woods of all colors – from maple to walnut. It will add a yellow/orange cast to light-colored woods. So if you want a whiter finish, use soap instead.

You can buy pre-made linseed oil and wax finish from many suppliers. Some of them are reasonably priced; others are expensive. I make my own because it's easy, cheap, and I'm in control of the process.

I buy beeswax in bulk from a place that sells raw ingredients for people who make personal-care products. A pound of beeswax pellets costs anywhere from $5 to $10, depending on how much you order. A pound of beeswax pellets is about four cups by volume.

You can also get it from beekeepers, which is where I got mine for many years. The upside: it's inexpensive or free. The downside: you might need to heat it and strain it first to get the bug parts out.

The second ingredient is raw linseed oil – not the commercial boiled

READY TO GO

Once the temperature of the oil is above 151° (F), you can add the other ingredients and leave the mixture on the heat as the wax and solvent combine. As soon as the wax melts, turn off the heat and remove the mixture from the burner.

linseed oil (BLO) at hardware stores. BLO has toxic metallic driers and is not what you want for this recipe (though it will work just fine). Raw linseed oil is also available from most hardware stores, but sometimes you have to ask them to order it for you. I pay about $10 for 32 ounces (four cups by volume).

People will tell you that raw linseed oil never dries. They are misinformed. Linseed is a drying oil. It takes time for it to fully cure, but if you apply it correctly (that is, a thin coat) you can sit in your chair after a couple hours.

The third ingredient is a citrus solvent (limonene). The solvent loosens the mixture so it is more of a soft wax (like a lightweight peanut butter) and not a bar of soap. You can buy limonene from a variety of sellers and pay anywhere from $1 per ounce to $13 an ounce. I usually pay about $21 for 16 ounces (32 tablespoons). In total, a batch of this finish costs about $7 to make and will finish more than 10 chairs.

Linseed Oil & Wax (aka Soft Wax) Finish Recipe
2 cups (16 ounces by volume) of raw linseed oil (or tung oil)
3.8 ounces beeswax (by weight)
4 tablespoons limonene

I make this finish in a metal quart paint can. Place the metal can on a hotplate, fill the can with the raw linseed oil and turn on the hotplate to between low and medium. Monitor the temperature with a cooking thermometer. Beeswax melts at 151° (F). As soon as the temperature of the oil reaches 151°, pour the beeswax pellets and limonene into the oil. Stir with a stick until the beeswax melts (it takes less than a minute). Turn off the hotplate and remove the mixture from heat.

Allow it to cool. It will become a paste after about an hour of cooling. Seal. You can use it immediately or keep it indefinitely. If the finish is too difficult to spread, heat up the mixture a bit on a hot plate and add more solvent.

APPLY LINSEED OIL & WAX FINISH

Apply the finish with a gray 3M abrasive pad. The pad will knock down any nibs or raised grain as you apply the finish. Apply it generously and spread it out to a thin coat. After 15 minutes, use a huck-weave towel to remove all the excess.

Huck-weave towels are typically sold as surgical towels or wiping cloths for automotive waxing.

This is the point where people mess up. They leave some (or a lot) of the finish on the surface. Then it gets gummy, sticky and nasty. Don't make this mistake. Rub the entire chair until it is dry to the touch. After a couple hours you can sit in the chair. The oil isn't fully cured, but it is dry enough.

It might take a couple weeks for the finish to fully cure. After that happens, evaluate the chair. Do you like the matte look? Then leave it alone for now. Do you want more luster? Add another coat of finish. And wipe it just as dry as you did the first coat.

Caution: Whenever you deal with linseed oil, spread the rags outside to dry before throwing them away. Never bunch up oily rags and throw them away. Linseed oil generates heat as it cures. This can cause a fire. Other people dispose of the rags by burning them. Others put them in plastic bags with water and throw them away.

NICK KROLL'S FRESH MILK PAINT

In July 2025, woodworker Nick Kroll introduced me to his recipe for fresh milk paint. It is so easy, inexpensive and superior to all other paints, that I now use it all the time. Nick wrote a book about the paint. This is a short summary.

Fresh Milk Paint Recipe
8 or 9 ounces (250 grams) of quark, a fresh cheese
6 tablespoons (90 ml) tap water
1 ounce (30 grams) hydrated lime
1 ounce (30 grams) of pigment

North American readers might wonder what quark is. It's a fresh cheese found in Europe that has had the fat removed. Look for quark (aka Farmer's Cheese) at fancy groceries, cheese shops or health food stores. You can make your own quark. Instructions are easily found on the internet.

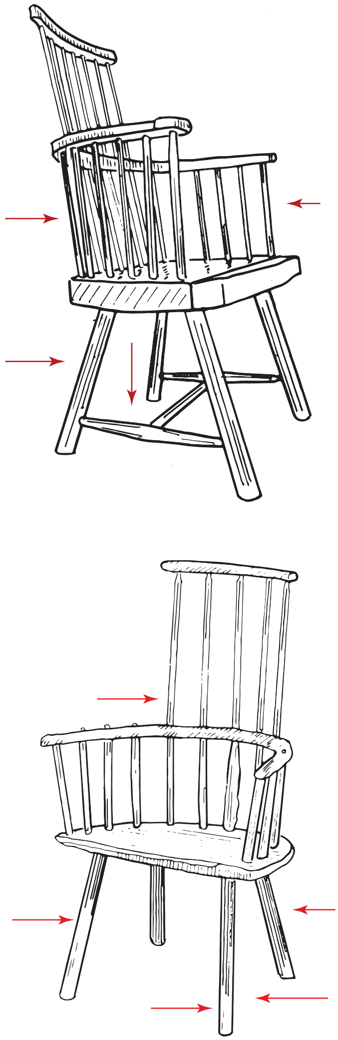
Once you have some quark, here's how to mix the paint. First mix the water and the pigment. You can use natural or synthetic pigments from artists' stores. Then carefully add the lime (protect your eyes with goggles). Spoon in the quark and any moisture in the container. Mix the paint with an immersion blender or in a blender for smoothies. Blend it until it looks like heavy cream. Add a little water if you like a thinner paint.

Brush it on thin with a synthetic brush. The first coat will look terrible (as with most paints). It dries quickly, less than 30 minutes. Sand with a #320-grit sanding sponge to remove any raised grain or nibs. Dust off the chair. Continue to add coats until you are happy. Happy is usually about three or four coats.

You can add a topcoat, such as wax, soft wax or linseed oil after the final coat dries overnight. But the paint has a nice sheen as-is, like a low-luster acrylic. The paint is durable and can be any color you desire (welcome to the world of pigments).

MAKE YOUR OWN MILK PAINT

We make our milk paint in an appliance intended to make smoothies and energy drinks (above). The result is a beautiful paint that applies like a quality acrylic.



TWO FORMULAS

Modulus of Rupture forces (top) occur when a stick is affixed or supported at both ends. Shear forces (parallel to the grain) are against a part that is affixed at one end (bottom).

WOOD STRENGTH FORMULAS

The chapter titled "Wood for Stick Chairs" provides a lot of data on how much force is required to break a part via the "modulus of rupture" and through shear forces. However, if you want to calculate these forces for woods or part sizes I didn't cover in that chapter, here is what you need to do the calculations yourself.

The first formula calculates how much force is required to break a stick that is supported on both of its ends with the force occurring in the middle of the stick. This calculates the stick's modulus of rupture. Here are the elements of that equation. The formula and statistics are from the "Wood Handbook: Wood as an Engineering Material" (Forest Products Laboratory).

A: The modulus of rupture (lb.f. in.$^{-2}$) Table 5-3b from the "Wood Handbook"
B: Width of the stick in decimal inches
C: Thickness of the stick in decimal inches
D: Length of the stick in decimal inches

Pounds-force per square inch to break stick = A x B x C^2/D

The second formula calculates the shear strength (parallel to the grain) of a stick. Shear forces occur against a stick that is secured at one end, such as a chair leg without stretchers.

E: Shear force parallel to grain (lb.f. in.$^{-2}$) Table 5-3b from the "Wood Handbook"
F: Spindle diameter in decimal inches
G: If it's a round spindle, this number should be 1.33. If it's square, 1.5

Pound-force per square inch to break stick = E x F^2/G

For your convenience, here are the published statistics for the modulus of rupture and shear force parallel to the grain for some commercial species in the U.S. at 12-percent moisture content.

Species	**MoR (lb.f .in^{-2})**	**Shear (lb.f. in^{-2})**
Alder, red	9,800	1,080
Ash, black	12,600	1,570
Beech	14,900	2,010
Birch, yellow	16,600	1,880
Cherry, black	12,300	1,700
Elm, American	11,800	1,510
Pecan	13,700	2,080
Hickory	20,200	2,430
Locust, black	19,400	2,480
Maple, silver	8,900	1,480
Maple, sugar	15,800	2,330
Oak, red (northern)	14,300	1,780
Oak, red (southern)	10,800	1,390
Oak, white	15,200	2,000
Walnut, black	14,600	1,370
Willow	7,800	1,250
Yellow poplar	10,100	1,190
Douglas fir	12,400	1,130
Hemlock (eastern)	8,900	1,060
Pine (E. white)	8,600	900
Pine, loblolly	12,800	1,390
Pine, longleaf	14,500	1,510
Pine, sugar	8,200	1,130
Redwood	7,900	1,110
Spruce, black	10,800	1,230
Tamarack	11,600	1,280

ANOTHER UNUSUAL WOOD

After doing the math, I decided that I could make a stick chair from mahogany (this was stuff left over from my book "Campaign Furniture"). I'm glad I did.

BY HAND OR POWER

Sharpening curved tools isn't terribly difficult. I use basic equipment: sharpening stones, dowels wrapped with an abrasive and ....

SHARPEN CHAIRMAKING TOOLS

Sharpening chairmaking tools intimidates many beginners. Every time I teach a class in chairmaking, students request to see how to sharpen a scorp, a travisher and a curved card scraper. When I show them how I do it, they say:

"Wait, that's it?"

Sharpening tools with curved edges isn't much different than sharpening straight-edged tools. A cutting edge is the intersection of two intersecting surfaces. When those two surfaces intersect at the smallest point possible – called a zero-radius intersection – the edge is sharp. After the edge is at a zero-radius intersection, you can polish the two surfaces to make the edge more durable. That's all sharpening is: abrading and polishing two intersecting planes.

The only complication with chairmaking tools is that the edges of the tools are typically curved. So you have to wield your sharpening tools a little differently.

I don't like to give people sharpening advice. But I'll make an exception here to say: Before you buy a bunch of commercial jigs that promise to ease your sharpening chores, first try to work with what you have on hand. I worked for many years with my existing abrasives before I broke down and bought special gear.

And now that I've broken my personal rule once, here's another unsolicited piece of sharpening advice: With chairmaking tools, do everything you can to avoid grinding them. Focus instead on touching up your edges as you work so the edges never degrade to the point where you have to grind them.

SHARPEN SCORPS & TRAVISHERS

For years, I sharpened my scorp and travisher using my existing sharpening stones (waterstones of #1,000, #5,000 and #8,000 grit) plus a #5,000-grit slipstone that I also used to touch up my moulding planes.

Now I have some dedicated tools for sharpening these tools.

INSIDE CURVES

A diamond cone (top) and dowel-like oilstones are great for sharpening inside curves, such as this blade for a travisher.

OUTSIDE CURVES

Polish the outside curve of the travisher on a flat polishing stone (shown is an #8,000-grit stone).

For travishers, I first use a large DMT diamond cone in fine grit (this is about 25 micron, which removes metal about like a #1,000-grit waterstone). The cone is ideal for sharpening a travisher's blade. You put a finger inside the cone as you stroke the tool's bevel. This gives you more feedback than a slipstone. The feedback (it's like you are touching the bevel) makes it easy to keep the diamond cone flat on the tool's bevel.

I use camellia oil as a lubricant, though any light oil or water will do. We always have camellia on hand, and it's non-toxic.

I hold the tool with my left hand and hone the bevel flat with my right. No micro-bevel. I just keep the cone flat on the bevel, and I stroke it back and forth until I turn a slight burr on the backside of the blade. When that happens, I am done with the cone. I wipe off the oil and put the cone away.

To polish the bevel, I use two natural oilstones that are shaped like dowels. I use a "hard Arkansas" and a "true hard Arkansas." The exact dimensions of the oilstones aren't important. Buy what you can afford.

POWER SHARPENING

A $20 disc converts my table saw to a scorp-sharpening station. One face of the disc has #220-grit sandpaper (for grinding). The other face has MDF and polishing compound (for polishing).

They are all fine for this job.

I keep these soaking in some oil in a metal box, which has a seamless bottom that won't leak, plus a tight-fitting lid that prevents the oil from drying out. As a result, the oilstones are always ready to go.

I polish the bevel first with the hard Arkansas. This stone has a little bite to it – not enough to turn a burr (that I can feel). But you can feel the stone removing metal.

I polish the bevel until the scratches from the diamond cone are gone. This takes less than five minutes. Then I repeat the process with the true hard Arkansas. It glides over the bevel and polishes things up nicely. Again, less than five minutes of work is all it takes to get the edge polished.

The last step is to polish the flat back of the blade. I do this on my #8,000-grit waterstone that is used for my bench tools. It takes only a dozen strokes or so on this fine stone to remove the burr from the back and give it some polish. I then wipe off the blade with an oily rag and put the blade back in the travisher.

SHARPEN A SCORP

You can sharpen a scorp using the same tools and process above. Or, if you have a table saw, you can do it the fast way.

Buy a cheap steel disc sanding plate, a common accessory designed to turn your table saw into a disc sander. Apply #220-grit to one face of the plate and some thick paper (I use MDF craft paper) to the other with some spray adhesive.

Put the plate into your saw. The #220-grit side is for grinding (a hopefully uncommon operation). The second side is for polishing.

Put the scorp on the table saw's table with the bevel facing the ceiling. Tilt the blade to match the tool's bevel. This could take some trial and error to get it perfect. Once you have found the correct angle, engrave the angle (such as 17°) on the tool's handle.

To polish the bevel, first wipe it with a good coat of oil; this will make it easy to removing any honing compound on the blade from sharpening. Apply honing compound (about 1 micron in grit) to the spinning disc. Touch the tool's blade to the disc. Move the bevel against the disc to polish it. After five seconds of polishing, stop and check your work. If the tool is too hot to touch, cool it in water. If a tiny line of honing compound is now on the back of the bevel, you are likely

OR USE DOWELS

Diamond lapping film adhered to a 1"-diameter dowel can do a good job. It's just slow. Get a variety of grits to speed the work.

done. Polish the back of the bevel with the round Arkansas stones mentioned earlier.

Grinding uses the same procedure as polishing (minus any honing compound). Take care not to heat the blade up. You'll know when you are ready to polish when you turn a burr on the back of the bevel.

ANOTHER OPTION

You can also maintain your curved tools using three 1-1/4"-diameter dowels wrapped with three grits of diamond lapping film (15-, 3- and 0.5-micron films). The total cost of that kits is minimal. Note: You can use #1,500-grit automotive sandpaper instead of diamond lapping film.

Here's how I sharpen a travisher with a minimal kit.

Remove the blade from the tool. Take a dowel wrapped with 15-micron paper and first work the bevel of the blade until you turn a burr over on the flat side of the blade. Polish the bevel with 3-micron film. Then polish the flat of the blade on a flat #8,000-grit stone.

Here's how I use this minimal kit to sharpen a scorp or an inshave.

The bevel on these tools can be on the inside or outside of the tool's blade. Either way, I first focus on the bevel side. I stroke the bevel with 15-micron lapping film on a dowel, followed by 3-micron lapping film. Then I use either a strop or the dowel coated with 3-micron film to polish the flat surface of the blade.

What's also important is how often I sharpen these blades. Whenever I finish saddling a seat, I sharpen the scorp, inshave or travisher before I put the tool away. Every single time. When I pick up the tool for the next seat, I know it's sharp. Thanks to this sharpening ritual, I never let my tools get so dull that I have to grind them. I've owned my first scorp for since 2003 and have yet to grind it.

SHARPENING A CURVED CARD SCRAPER

I've never met two people who sharpen card scrapers using identical methods. As a result, there is more misinformation about sharpening card scrapers than sharpening any other woodworking tool. And that is saying a lot.

The following technique is based on 20 years of daily practice and a decade of research into historical methods. I won't bore you with the spreadsheets and the bibliography. Instead, I'm going to explain the process in as few words as possible.

STEP 1: REMOVE ANY EXISTING BURR OR HOOK

The first step for me is always – always – to burnish the faces of the scraper to eliminate any existing burr or hook. The burr could be the result of manufacturing. Or it is the remnants of the hook on the tool you've been using.

Place the scraper down flat near the edge of the workbench. Press the burnisher dead flat on the scraper. Press down – hard! – and glide the burnisher across the face of the tool. Five or six good strokes will do. Repeat on the other three faces.

REMOVE THE HOOK

The first step is to burnish away the hook (or the burr from manufacturing) from the faces of the scraper. Keep the burnisher flat on the tool as you move it back and forth.

STEP 2: STONE THE NARROW EDGES

To get perfect 90° corners, use a block of wood as a guide and stone the long edges of the tool. Shift the block of wood around so you don't wear a groove in your stone. Use the sharpening stone that you use to begin your typical honing process (a #1,000-grit waterstone or a soft Arkansas oilstone, for example). Seven or 10 strokes should be enough to stone away any extra metal.

If this is a new scraper, you might need to stone the edges on a coarse stone for a few minutes to ensure the edges are dead 90° to the faces and consistent. Future stonings will go faster once the tool is set up.

Repeat this process with the block of wood on a polishing stone, such as a #5,000-grit waterstone or a hard Arkansas oilstone. Look closely and continue the work until the edge is consistently polished. The first time you do this on your tool it might take a few minutes.

A 90° GUIDE

A block of wood keeps the scraper at 90° to the surface of the sharpening stones. Shift the block around to avoid making a deep groove in the stone.

SMOOTH & POLISH

I used to stone the faces of my scrapers. Burnishing the faces does the same thing. It polishes the faces and deforms the edge just a tad – making it easier to turn the cutting hook.

BURNISH THE EDGE FLAT

Hold the burnisher so it is parallel to the narrow edge of the scraper. Stroke the edge. This begins to turn the hook over.

Subsequent sharpenings will require only 10 strokes or so.

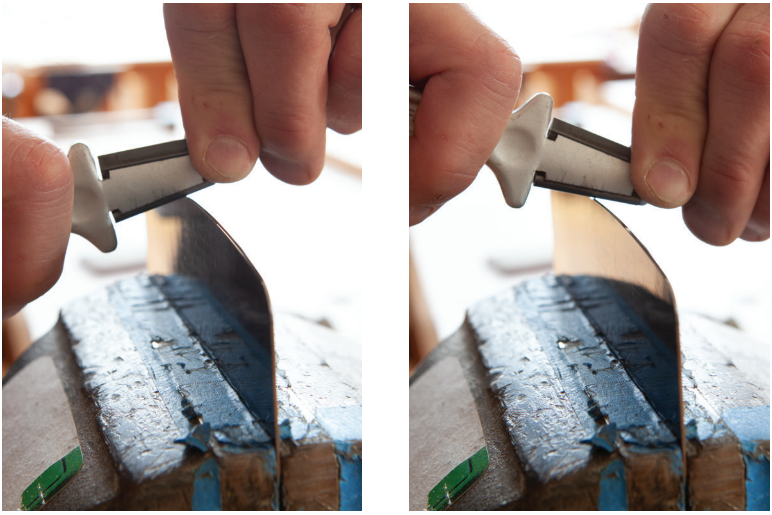
STEP 3: BURNISH THE FACES

Wipe a little oil on the scraper and the burnisher. Place the scraper flat on the bench again and repeat the same burnishing process you used to remove the burr. Remember: Use hard downward pressure (yet the burnisher should still glide across the face of the tool).

This burnishing polishes the face of the scraper (much the way a hard bone will burnish soft wood) and push a little steel up on the tool's edge. This step improves the durability of your hook and makes the hook easier to turn.

STEP 4: BURNISH THE EDGES

Secure the scraper in a vise with one edge upright. Wipe a little oil on both the scraper and the burnisher to make your work easier. Hold the burnisher parallel to the floor and burnish the edge with moderate downward pressure (like pressing the button on an elevator). Five or



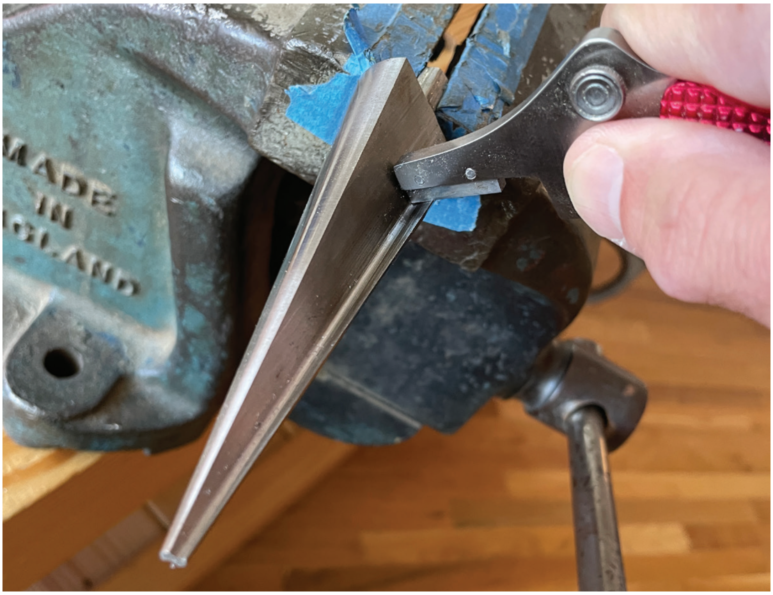
TURN THE HOOK

Tilt the burnisher about 5° (or a little more). Slide the burnisher along the corner of the scraper while simultaneously drifting the burnisher away from the corner. This compound motion helps to turn a hook.

six smooth strokes will do.

Tilt the burnisher about 5° to the right and burnish one corner of the scraper with five or six smooth strokes. Run your fingers up the scraper to feel if you have turned a hook. The hook is slight and subtle, much like the burr you turn on the backside of a chisel when sharpening it. You should be able to catch the hook by running your fingernail up the face of the scraper.

If the hook is not there, repeat with more strokes with the burnisher tilted at 5° to the right until a hook appears and you can catch it with your fingernail. Try adding more downward pressure to see if that helps. When you have a hook, tilt the burnisher 5° to the left and repeat the burnishing for the other corner. When you have two good hooks, flip the scraper over in the vise and repeat the burnishing for the second edge.



EASIER WAY

A carbide sharpener – usually used for touching up axes or garden tools – is ideal for sharpening a tapered reamer. Stroke the inside a couple times and it will give you a new edge.

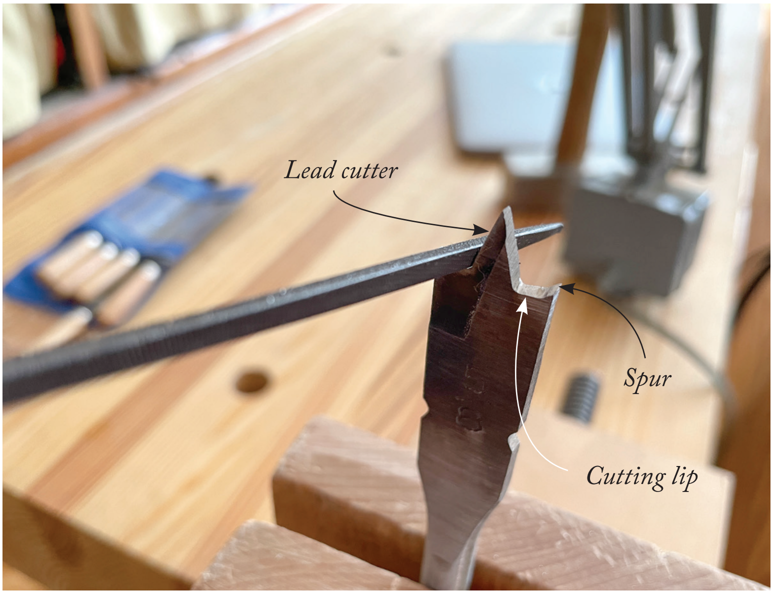
Clean the scraper with an oily rag and get to work. To improve the longevity of your burr, store the tool in a cardboard or paper envelope. The hook is as fragile as the edge on a paring chisel.

SHARPEN A TAPERED REAMER

Tapered reamers that are made from a solid chunk of steel can be tricky to sharpen. You cannot touch the exterior diameter of the reamer because that will mess up the tool's cutting geometry. So you have to confine your work to the interior lip of the reamer's cutter.

These reamers are made from a hard steel, which is good and bad. It's good because the steel keeps an edge for a long time. But because of its hardness, it can take some time to sharpen.

Many woodworkers use a coarse diamond paddle with a little oil for



FILE A SPADE BIT

A little maintenance on a spade bit works wonders for the bit's performance. Don't file the bit's exterior edges (unless you want to reduce the bit's diameter). I use a small triangular file to sharpen all surfaces on the bit's spurs, lead cutter and cutting lips.

a lubricant. You stroke the back of the two cutting lips. A lot. Keep going until the edge feels sharper than when you started. Judge sharpness by comparing your new edge to the edge at the tip of the reamer, which rarely gets used.

Or you can make life easier if you buy a carbide sharpener. These little tools cost $12 to $25 and easily scrape the steel off the inner lip, refreshing the edge in seconds. Use the tool like a card scraper. Place it flat on the edge, tilt it a bit toward you and pull it forward. You will feel it cutting the steel when you get it right. After creating a new edge, I go right back to work. I bought my sharpener from Lee Valley Tools, where it is called a Universal Sharpener.

Last piece of sharpening advice: Your reamer will last longer if you don't let it heat up too much while you are using it. That means short bursts when reaming, usually about two seconds. If you run the reamer for 15 seconds in the hole – an eternity – you will end up with a burnished hole, a burned reamer and a fairly poor mortise.

SHARPEN SPADE BITS

If you manage to purchase a decent spade bit, you can squeeze some more life out of the tool by filing its cutting edges. I use a triangular saw file. Its shape helps ensure I don't file a section of the bit that should be untouched.

File the lead cutter, cutting lips and the spurs of the bit. Try to replicate the original grinding angle on the bit. Also, don't file the exterior edges of the bit unless you want to reduce the cutting diameter of the bit (which can be a useful thing to do).

You won't get many resharpenings out of a spade bit. The steel isn't the best. And there isn't a lot of steel you can file away before the bit stops working well.

Still, you can make the bits work for a good long time with a little effort.

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WITH A LITTLE HELP

This miniature carving of a four-stick chair sat next to me on my bookshelf as I wrote this book. It was carved by Rudy Everts, one of the technical editors of this book.

ACKNOWLEDGMENTS

When I was younger, I wondered why so many woodworking books were dull reading. When I tried to write one, I found out. Woodworking is more difficult to write about than trailer fires, zoning board of appeals meetings or physics. It's both insanely technical and traditional, technological and historical, rule-based and completely flexible.

With all those alligators to avoid, it's amazing there are any woodworking books at all – including this one. This book had three groups of people who propped it up to make sure it wasn't just a word jumble stuck between two cloth-wrapped, 98-point boards.

RIGHT TECHNIQUE & RIGHT WORDS

Technical editors Rudy Everts and Klaus Skrudland are both chairmakers and artists, and they volunteered hundreds of hours reading drafts, reviewing technical drawings and generally saying "What about …" at the right times.

Megan Fitzpatrick and Kara Gebhart Uhl ensured I didn't sneak in too many weasel jokes (I count two), that my verb tenses agreed with my nouns and the language was as sharp as possible.

Josh Cook helped with the technical drawings for the five chair plans at the back of the book.

Steve Schafer helped me understand the strength formulas for wood and (I hope) prevented a lot of chair failures in the future.

Peter Follansbee and George Walker helped me generate the "Family Tree of Chairs" on the book's endsheets, which were expertly illustrated by Lee John Phillips.

Woodworker Jeff Stafford shared his thoughts on linseed oil and wax finishes, which led to the recipe in this book.

ACCESS TO OLD CHAIRS

Tim and Betsan Bowen at Tim Bowen Antiques in Wales provided access to their collection and knowledge of stick chairs. Emyr Davies at St Fagans National Museum of History and other staff members there provided me with access to chairs to examine and ask (too many) questions about. Similarly, Mark Jenkinson, a cider maker in Slane, Ireland, and a fount of knowledge on Irish chairs, generously granted me access to his personal collection.

Matty, Anne and David Sears – all people tied closely to chairmaker John Brown – freely gave me information on JB, allowed me to examine his chairs and have been nothing but encouraging.

TEACHERS

All the best things I know about woodworking came from other people. We Americans try to pretend we are self-taught, which is ridiculous. And so I tip my hat to three chairmakers who generously shared their hard-won knowledge in the classroom.

David Fleming was my first chairmaking teacher. He was the first person I found in North America who knew about Welsh stick chairs, and I am forever grateful for his instruction.

Don Weber continued my education and introduced me to the grittier and funkier forms of stick chairs. Without his tutelage, my chairs wouldn't be as grounded in the vernacular.

And Michael Dunbar, who introduced me to constructing Forest chairs. Above all, by watching Dunbar, I learned how to teach chairmaking and write about it.

ONE MORE CATEGORY

Finally, I am deeply grateful to the friends who checked in on me every week to see if I need to be committed after 56 weeks of uninterrupted work. Narayan Nayar has always been the sort of friend who tells me more by what he doesn't say, which is more helpful than the You Should People.

And Chris Williams, who is the only person who is as weird as I am when it comes to these chairs. His friendship – and camaraderie – keep me exploring new designs and techniques. Because of him I know I am not alone and crazy. I'm just crazy.

AN OAK PHASE

I find that I go through phases with chair designs. This was the final chair in a recent red oak phase. I know I'll be back to making chairs with red oak some day. But for now, I've been exploring other woods.