The Stick Chair Book

Revised Edition

THE STICK CHAIR BOOK

Revised Edition

By Christopher Schwarz

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For mom and dad.

A PLACE TO SIT

When I first saw this chair on display at St Fagans National Museum of History in Wales, it was all I could do to keep myself from sitting in it. Good stick chairs are like that.

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 your 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, deeping 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.

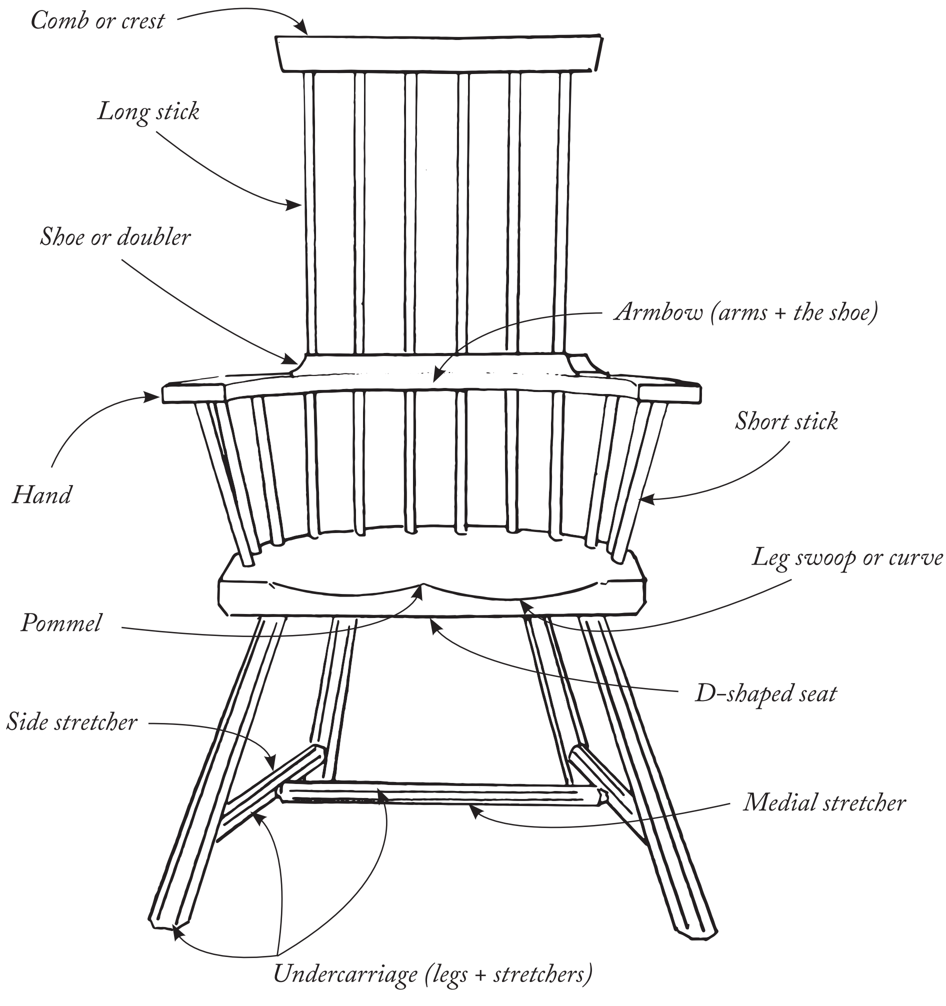
But there's more to the term "stick chair" than the materials and the form. In my mind, it's about who made the thing.

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.

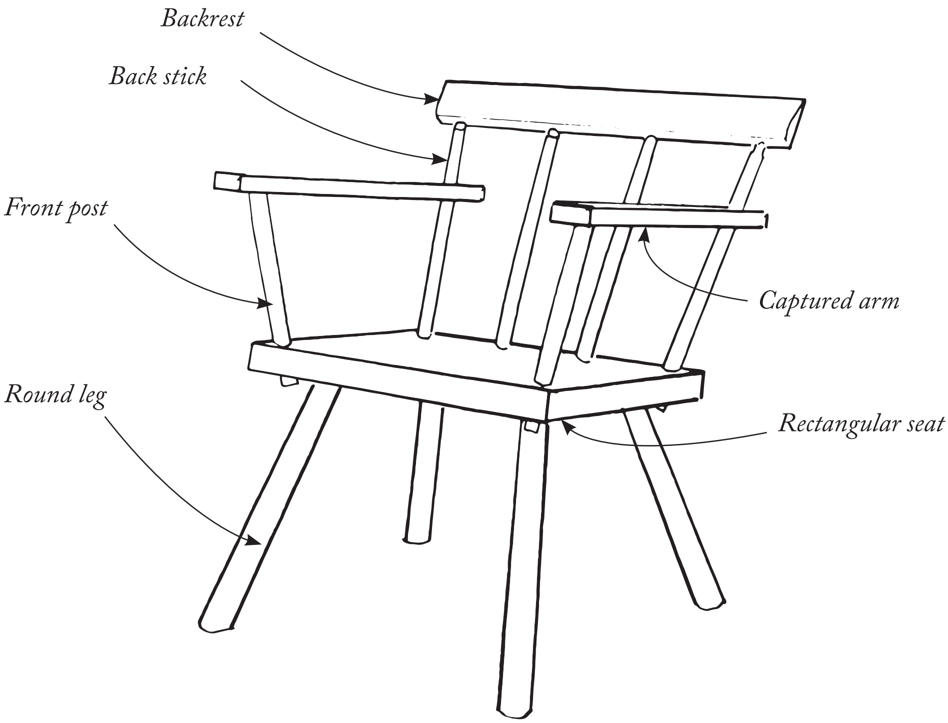
And if you have fallen in love with the way they look, you are probably wondering if these chairs could possibly be comfortable.

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 Irish Gibson 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 talk about 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.



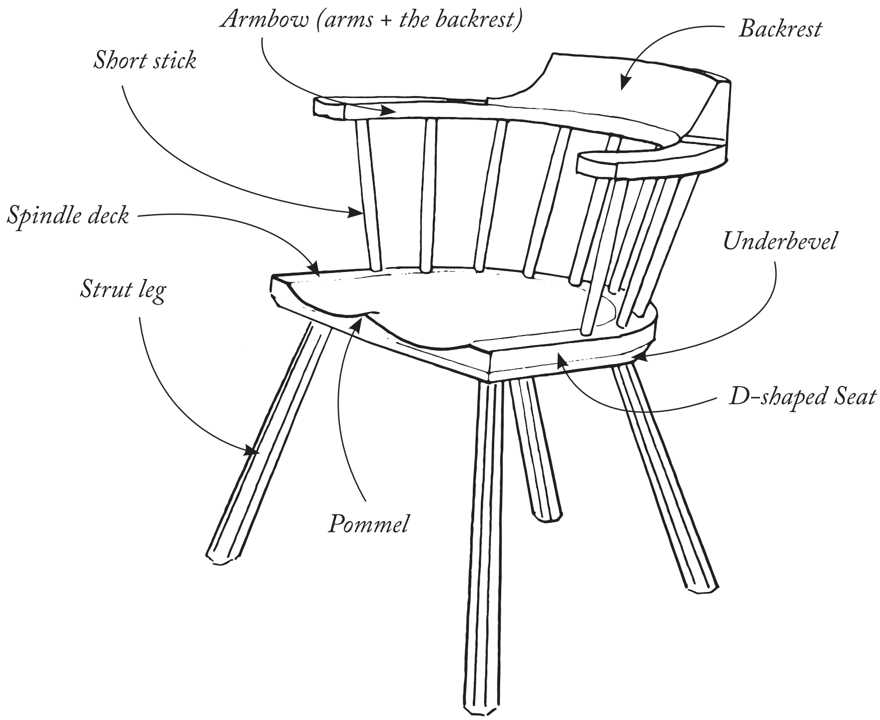
ARMCHAIR ANATOMY
A simple Irish chair with sticks that protrude below the seat board. Note that the seat is unsaddled. And how the piece that joins the back sticks is called a "backrest" and not a "comb."

Some of the chairs have sheepskins on their seats to make them more cozy. 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 16 common forms that can be made with only a couple handplanes. Add those to the 11 different arm shapes, six arm-joinery options, 14 shapes for hands, seven stretcher shapes and 11 combs, 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 can 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 cousin of the stick chair, which I call "Forest" chairs) 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 most 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 some 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 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 poked with holes.

False and real ellipses are pretty 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 the 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 all somewhat 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. 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 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 liquid-impaired) guests. But the fact it was so sturdy amused and interested me.

Of course, my "eurekas" 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, reamer and some tenon cutters. But I don't use a drawknife, adze, shaving horse, chair devil or beetle much. 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 (sometimes) a spokeshave. I hold my work at a joiner's workbench. A lot of components get finished with a cabinet scraper and a little hand 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 during the last 17 years. 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 are ready to compose your own.

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

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.

result in a set of numbers that you like. (Don't worry, I'm going to tell 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 devoted to 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 redneck can do it.

WHY THE REVISED EDITION?

When I first wrote "The Stick Chair Book" in 2021, I was also fighting cancer. So I hammered out the text with urgency and the desire to record every fragment of information I knew about chairmaking.

To be fair, that's usually how I go about writing all my books. But then I typically take a couple months off, put the manuscript aside and then revisit it with fresh eyes and a sharpened pen. My final revisions remove about 10-20 percent of the original material. The stuff I cut is usually chapters that don't match the tone of the rest of the text. Or I snip sections that aren't as relevant as when I first wrote them. I also smooth out the writing and add bits of information I'd forgotten during the first brain-to-fingers dump.

And that's exactly what I've done for this revised edition. As a result, the text is 10.1 percent shorter than the first edition. It's more to the point. And it's where the manuscript would have ended up under normal conditions.

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.

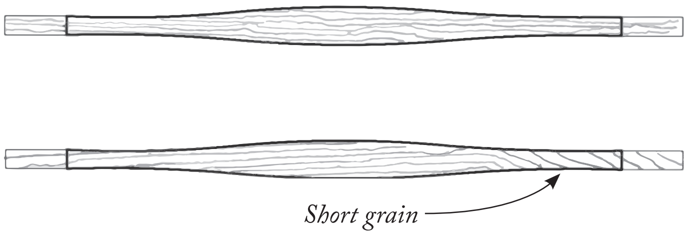
Put another way, almost any wood can be used in a chair as long as it is strong enough, dry enough and the right size. What follows is how to evaluate your stock in terms of its strength, moisture and size – without turning you into an intern at the Forest Products Laboratory.

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 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 long 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.



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.

The other aspect of strength derives from the species of wood. A 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 larger) 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. If it snaps, 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,

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.

who was looking for a way to test wood for brashness – a defect where the wood is so brittle it can be snapped 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? It's your call, but I usually use them.

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.
2. Increase the thickness and/or diameter of the part by 1/8".

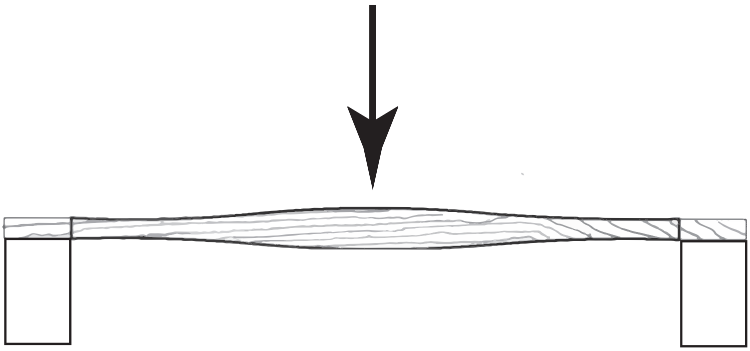
Why 1/8"? Two reasons. Eighths are a pretty standard interval when changing the thickness of your parts. Is 5/8" too thin? Try 3/4". Also, using eighths helps illustrate how the strength of wood increases or decreases, as you will soon see.

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 a warning flag. Apologies.

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



MODULUS OF RUPTURE

To test a stick's modulus of rupture, 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.

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 on the next page shows the force is 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 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

‘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.

times. Kicking the chair’s leg might break it.

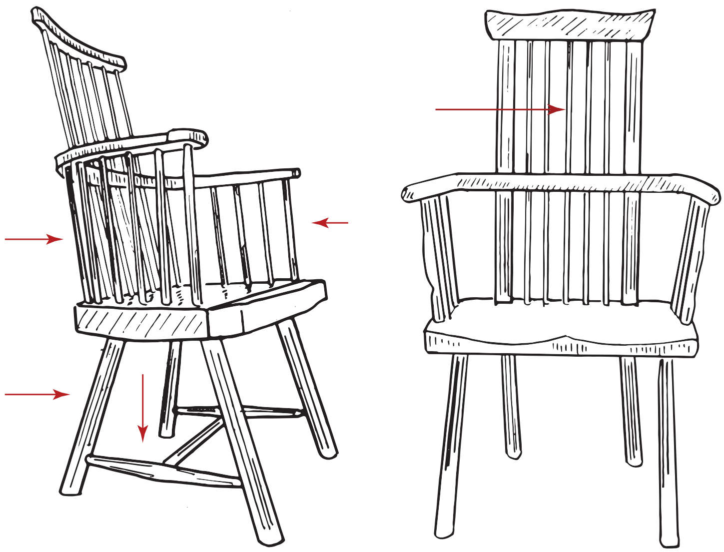
• The stretchers of a chair are definitely subject to the modulus of rupture. People put their feet on the medial stretcher and – snap – game over. Kids like to stand on a chair’s side stretchers, also a modulus of rupture problem (and a historical source of yelling).

• 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 crest. Dramatic forces against the back sticks could cause them to snap.

The other common indignity against chair parts is “shear force.” In 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) chair collapsing under the weight of a sitter due (primarily) to shear forces. The legs



MODULUS OF RUPTURE

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

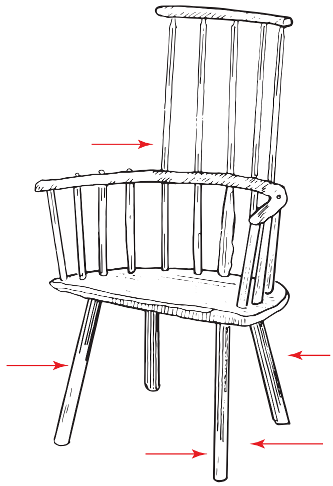
broke free from the seat. Sticks above the seat snapped like the twigs that they once were.

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 on the next page.

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 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



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.

diameter (or thickness and width) by 1/8". That small change will increase the strength significantly.

Or fetch the sledgehammer.

MOISTURE

Wood for chairmaking can be wet 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 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 managing 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.

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 unsuited to chairmaking. Brash wood can be caused by how the tree grew. If it has wide bands of porous springwood and narrow bands of fibrous 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.

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.

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 more oak that registers at 11 percent MC.

If possible, I'll use the wetter wood for the chair's seat, arms or crest rail. 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.

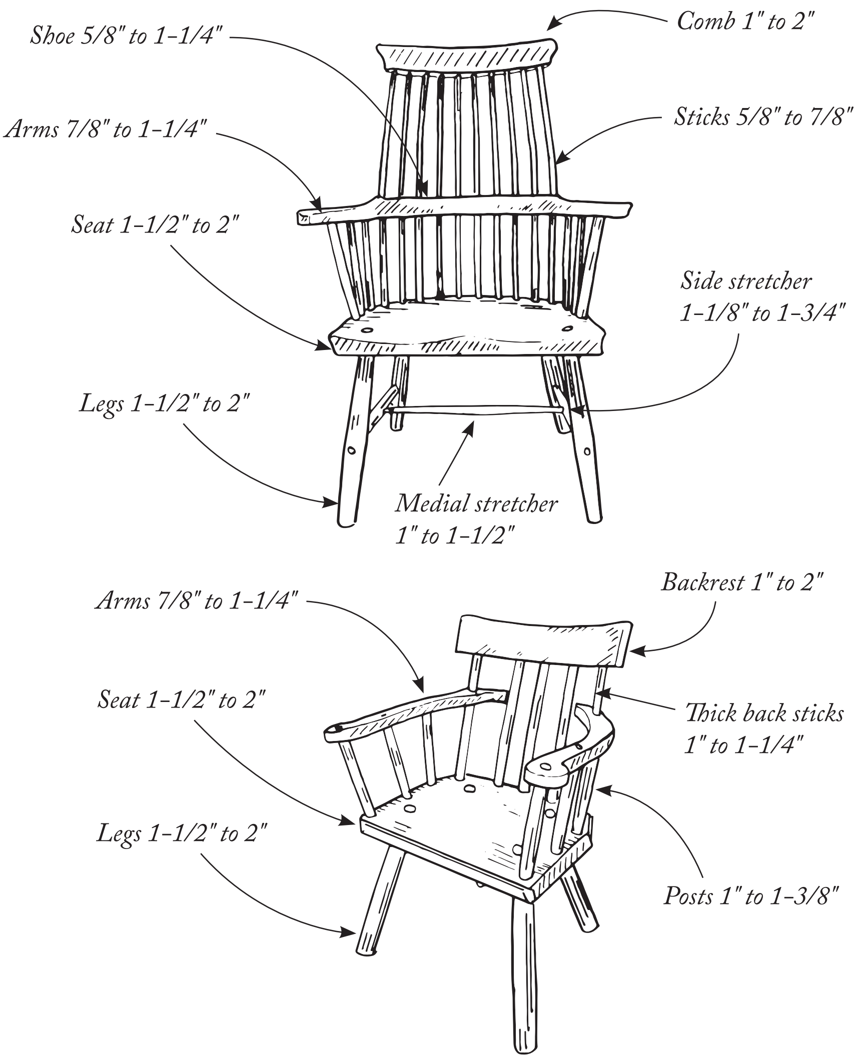
As a result, most chair parts fall into the same sort of thicknesses that a cabinetmaker is comfortable with: 4/4 (which is 1" thick in the rough and pronounced "four-quarter"), 5/4 (1-1/4" in the rough) and 8/4 (2"). The parts might end up tapered, curved or carved. But in the end, they aren't all that 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 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 (1-1/4" 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 reinforce 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



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.

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.

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. But for legs, stretchers and sticks you need boards with arrow-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.

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. 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 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 seat, arms or comb, but never 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.

With a pile of boards, 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.

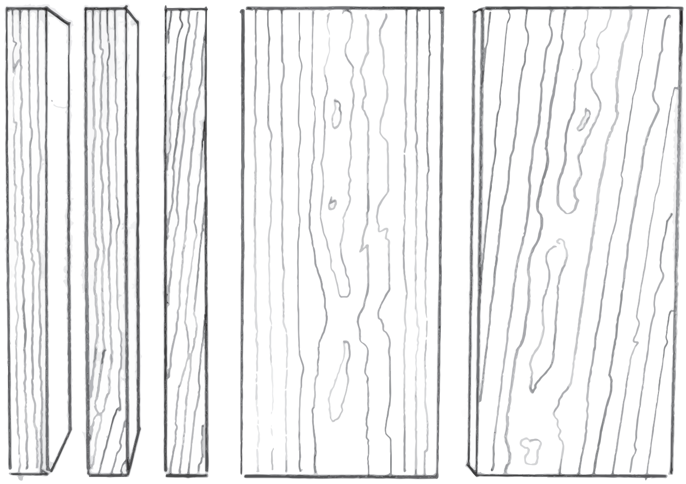
RIVING DRY STOCK

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.

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 dry 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



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.

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 …" 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.)

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 work-

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 arms from this board.

bench 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

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.)

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). Use the hacking 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 hacking 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 your yardstick parallel to the angled grain and mark a line in magic marker. Saw the board along that line.

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.

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.

A BIT OF INFORMATION

Many times you can use a common woodworking tool (such as a spade bit) instead of a specialized one (such as a spoon bit). The notches ground into the long edges of these bits act as depth guide when I'm drilling.

TOOL KIT FOR STICK CHAIRS

Unlike me, I hope you can manage to purchase your chairmaking tools with 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 particular shape to fit in an odd-shaped hole. Would this doming plane do anything good-ish to my sticks? Can this Windsor beader create a gutter on the seat maybe? Does this rounding plane really make spindles? What does this odd French drawknife do?

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 one drawer devoted to my personal kit of specialty 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 tool dull more than I liked making them sharp. Ergo, the fewer tools I have, the less time I spend on maintenance and the more time I spend on woodworking.

I have created three lists of tools for making the chairs in this book.

• Essential tools: Chair tools I'd be lost without.

• Time-savers: Tools that make life easier, though I could do without them if necessary.

• Fancy-lad tools: Tools that I simply enjoy owning and using.

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.

ESSENTIAL TOOLS

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 my hands for hours, I prefer a lightweight tool. That means a vintage Stanley No. 5. While you can invest months of your life learning all about the different 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 these 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

FINISHING UP

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

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) with a stock iron and chipbreaker. No upgrades or modifications. (Unless you count the engraving by Catharine Kennedy.)

The iron is ground with a curved cutting edge. I use a 10" 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 the 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 and ream the harder woods, but the batteries are a liability. Low-voltage cordless drills can handle only softwood seats. I have seen underpowered cordless drills catch fire while trying to ream out holes in an oak seat.

If you own only a brace, you can do a lot of vernacular 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 a brace will struggle to ream a hole 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

One thing they never tell you when you take up chairmaking is that you are also going to become a connoisseur of drill bits. The array of

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.

bits available for chairmaking is so vast that covering them all would take several chapters.

I have used many historical styles of bits, including spoon bits, center bits and many exotic augers. Plus every modern bit that has been recommended or suggested by a fellow chairmaker. But in the end, my taste in bits is low-rent.

If you use an electric drill – either cordless or corded – spade bits are an inexpensive place to start. 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.

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

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.

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.

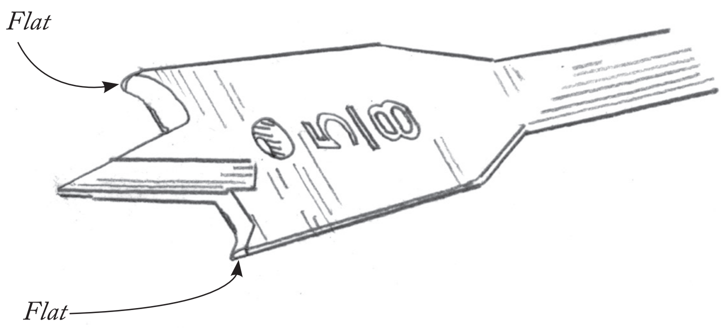
I usually buy the extra-long spade bits. These allow me to drill through an arm and into the seat without a lot of fuss.

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

3. This comes with experience, but when you buy an extra-long



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 auger bits with different characteristics. These OverDrive bits cut cleanly. However, the flutes also cut and its easy to waller out your hole.

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 is modern augers with a hex shank. 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 augers can drill through an arm then into a seat with ease.

Many of these modern bits also have advanced cutting geometry that allows you to drill through your work without backing up the exit hole with scrap. They leave few torn fibers on the exit side.

The downside to these bits is that 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. Also, I haven't figured out how to sharpen them.

If you use a brace, you are best off using auger bits – either the hex-shanked ones mentioned above or something more traditional. Another common bit that some chairmakers like is the Forstner bit. I haven't had much luck with them. They don't clear chips as well as a spade bit (so the bit gets clogged). But I haven't tried all the brands out there – there might be a magic one in a catalog somewhere.

Chairmaking is a constant search for bits that suit your work and your budget. The above suggestions are a place to start. But you will quickly develop your own preferences.

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 augers and spade 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

EXTEND YOUR REACH
There are lots of bit extenders out there. I only like the ones that secure the bit with an allen key or collet.

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 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 shave easy to adjust.

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

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. I use both.

BAND SAW

If I had to own only one machine, it would be a cast-iron 14" band saw, preferably a 20th-century American-made one. This is the most common form of band saw made in the United States, so used ones are easy to find. I like older band saws because they have fewer plastic

A DISCO-ERA WORKHORSE

My band saw was made in 1980 in Tupelo, Mississippi. I honestly wouldn’t trade it for a modern welded steel saw.

parts and heavier metal components. However, many of the imported cast-iron saws are pretty fantastic. So if you can't find an old American-made one, a quality import is a great choice.

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.

• Avoid carbide-tipped blades. They are expensive and break easily.

• 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?

• A decent fence that can be adjusted for drift.

• Some sort of mobile base.

• A magnetic task light.

• Good blades. We use 1/2" Wood Slicer blades for everything. They have a 3-4 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 gradual 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 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.

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.

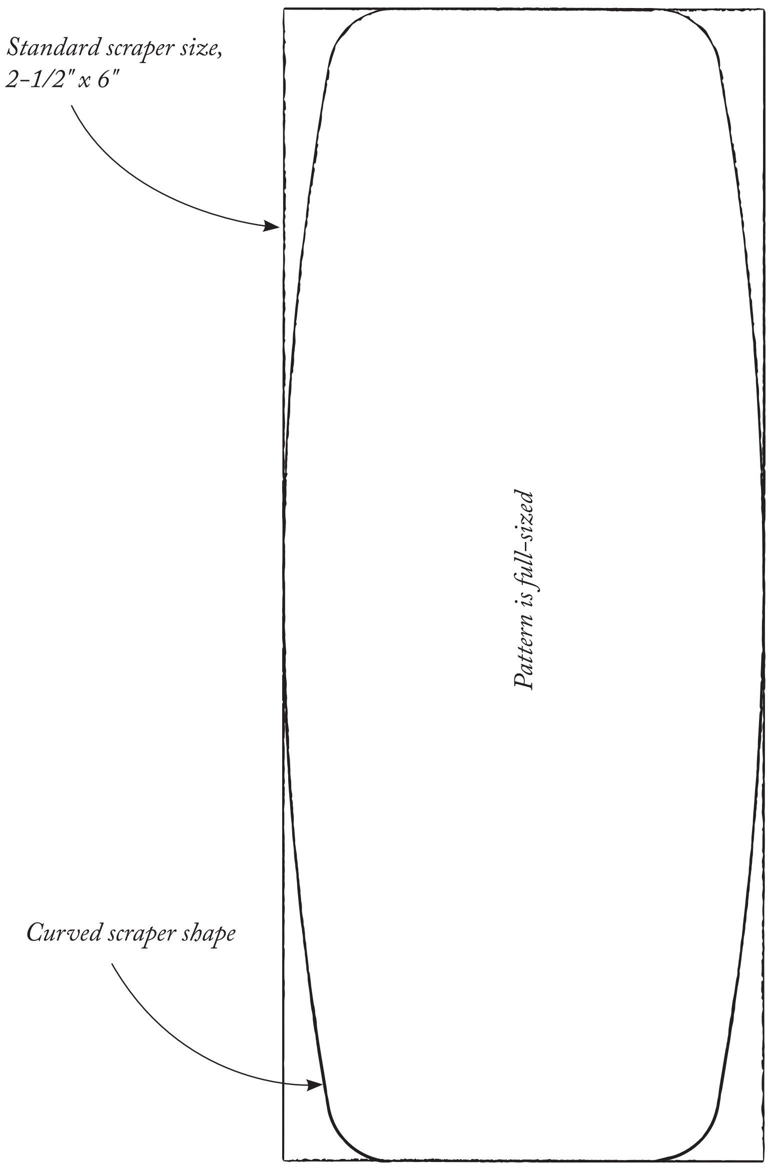
PENCIL GAUGE

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.

MALLET

While you can use a traditional all-wood square-head joiner's mallet for chairmaking, many chairmakers like to use something with more kick. When assembling a chair, there are times when the glue seizes


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

A HOMEMADE GAUGE

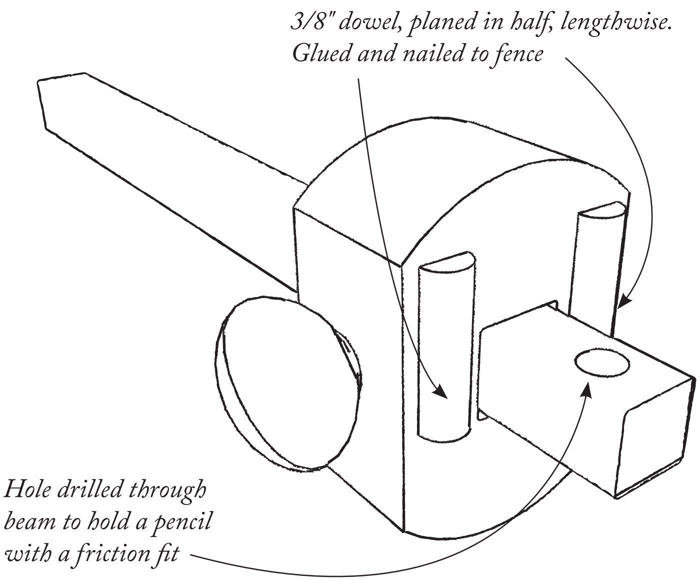
This simple pencil gauge allows you to mark lines on curved and flat surfaces. Once you have one, you'll wonder how you worked without it.

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. And the saw's small teeth make it easy to start a cut on round parts.

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



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.

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.

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.

Hand-stitched rasps come in a variety of shapes, lengths and coarseness/fineness – referred to as the "grain." The grain is a number from #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. A rattail with coarser teeth? A modeller's rasp with #11 or #15 teeth? You'll figure it out.

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.

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.

SANDING BLOCK & WOVEN ABRASIVES

Abrasives are your friend. 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 20 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

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.

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" 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. Why do you need a small one? So it can sneak up next to your auger bit without hitting your drill's chuck. In this case, smaller is more better.

(Side note: 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. You really need to try these out in person before you buy.

Small sliding bevels are hard to find (so much so that we began manufacturing them). A good budget optionis 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. Most chairmakers end up owning a lot of dividers. 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, I 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.

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.

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.

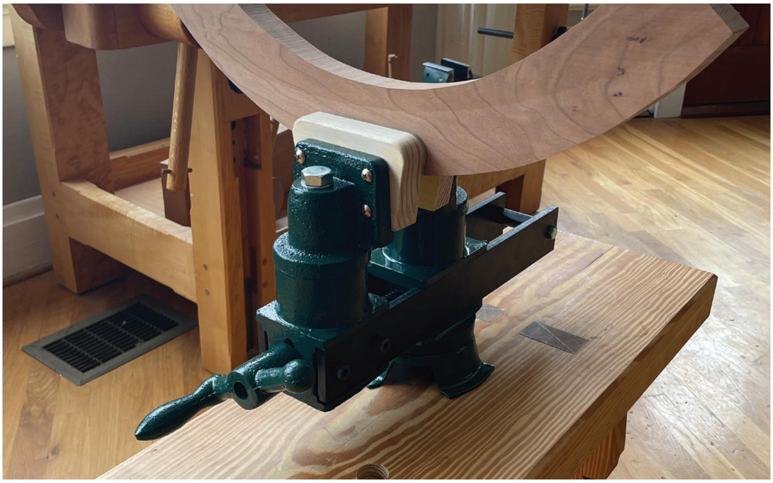
YARDSTICK

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



CHAIRMAKING VISES
A vise that can hold odd shapes above the workbench makes many chairmaking operations easier.

in it. These vises have swiling jaws that allow you to pinch tapered and curved work. Other vises, sold as "hi vises" or "machninist's vises" are also great at holing your work above the benchtop so you can shape it.

SPIRIT LEVEL

I know, this seems like 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.

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.

SOFT-JAW PLIERS

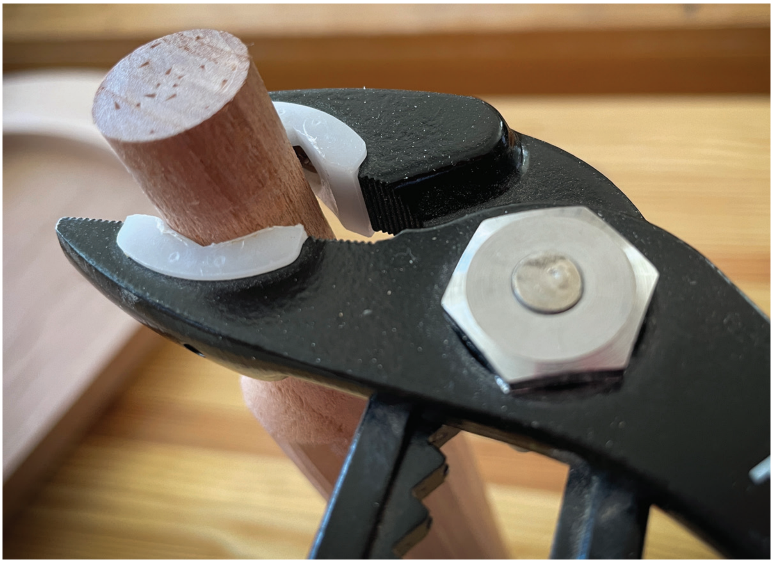
Many times you will want to reduce a tenon in diameter slightly so it will fit into a mortise. You can shave the tenon, of course, but most times it's better to compress it with pliers. The compression is easy to get uniform all around the tenon (squeeze the pliers and twist the tenon in the jaws). The 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



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.

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 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.

SMOOTHING YOUR SEATS

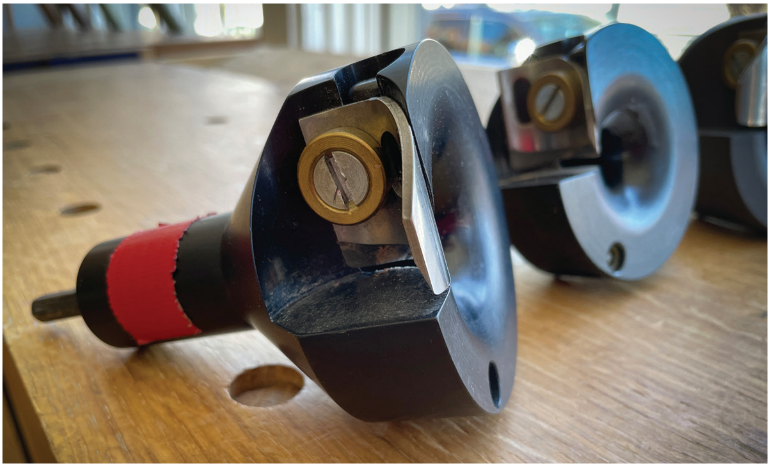
Travishers shave a curved seat. They are subtle tools that can take a light or heavy cut depending on how much you tilt them forward or backward in use.

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 am beginning to prefer the flatter curve (above).

SCORP/INSHAVE

This tool looks like a drawknife that has been bent so the 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 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



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.

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 one you can afford. Take care of it; it will serve 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.

NICE-TO-HAVE TIME-SAVERS

HOLLOW AUGERS OR TENON CUTTERS

Hollow augers (sometimes called "tenon cutters") cut cylindrical tenons of a particular size. The 5/8", 3/4" and 1" are the most common sizes in chairmaking. 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 hollow augers/tenon cutters that are dedicated to a particular size of tenon. These sorts of tools come in two flavors:

1. You rotate the tool and push it onto the work to cut the tenon.
2. You rotate the work and push it into the tenon cutter.

Both work.

The advantage of type No. 1 is that you can easily stop the tool so all your tenons are a consistent length. The advantage of type No. 2 is that it is much less expensive (but needs a bit more attention to use).

As you'll see later on in this book, there are many ways to make tenons for chairs. You can cut them with a plane, with a dedicated tool (such as a hollow auger) or on a lathe. While I own 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).

TAPERED TENON CUTTERS & REAMERS

Most vernacular chairs were made with cylindrical tenons and mortises. But today there are many tools available that allow you to make a tapered tenon and ream a matching hole in the seat for the mortise.

This tapered joint has advantages. It is self-tightening. The more you sit on the chair, the tighter the joints become. The joints are also forgiving to make. When you drill a cylindrical mortise in the seat, you have only one shot to get the angle correct. When you ream a cylindrical mortise, you can easily correct errors.

The downsides to tapered joints are as follows:

1. You need some dedicated tooling – at the least you need a reamer.
2. Reaming can be difficult in hardwoods.
3. The tooling requires maintenance – sharpening, mostly.
4. The shape of the reamer and the tapered tenon cutter need to match. So, the tooling needs more setup than a simple cylindrical mortise-and-tenon joint.

I build chairs both ways, with and without the tapered joints. Sometimes it depends on my mood. Other times it depends on the chair I'm building. If I'm making a copy of a rural chair, I use cylindrical mortises and tenons. If I'm making a more sophisticated chair in nice woods, I break out the tools for the tapered joints.

FROE

Depending on how you want to process your wood, this tool could be moved into the essential category. I like a froe that comes to a fairly

TOOL KIT FOR STICK CHAIRS

TAPERED CUTTERS

The pencil sharpener-like tool makes tapered tenons. The reamer enlarges an existing hole to allow it to accept the tapered tenon.

A QUICK SPLIT

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

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 Toolworks 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. Abrasives have been an important part of traditional woodworking since ancient Egyptian times. 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.

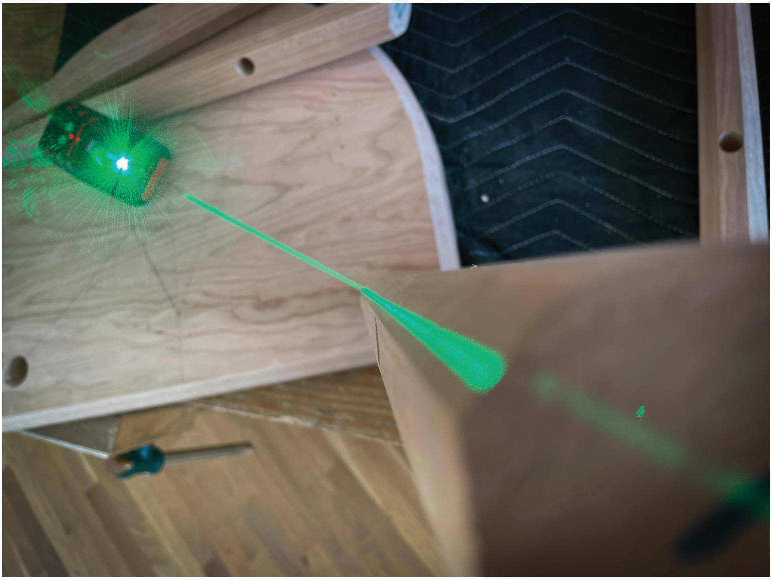
To be honest, I dislike using an electric sander because of the noise and vibration (the dust is sucked up by a vacuum). But it is so handy that I have made peace with it. Also, I don't use it much – usually about six or seven minutes during the seat-saddling process.

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



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.

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.

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.

FLUSH-CUT SAWS

These Japanese-style flush-cut saws are handy for trimming the ends of wedged tenons. But they can mar the surface if you don't steer them with care.

LATHE

If you make Windsor chairs, a lathe is essential to make the decorative baluster legs, stretchers and posts. But for stick chairs, a lathe isn't needed. I own one, and crank it up when I have a heap of parts to process. Though it easily makes round legs and round tenons, these look just a little too perfect. Other tools do just as good a job and leave behind subtle facets.

When I make sticks, I never use the lathe. Long sticks whip around too much (I don't own a steady-rest). Short sticks are easy to turn. The problem is it's hard to make turned sticks look like they were shaved.

FANCY-LAD TOOLS

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

FOR PRODUCTION WORK

Motorized sanders reduce the drudgery when shaping 18 chair arms. But they are by no means necessary for the occasional chairmaker.

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 one 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 to about 140° (F) will do the trick.

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. And thanks to overseas manufacturing, decent dial calipers are dirt cheap.

A CASE FOR RASPS

These hands were shaped primarily by rasps, scrapers and a little bit of fine sandpaper.

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.

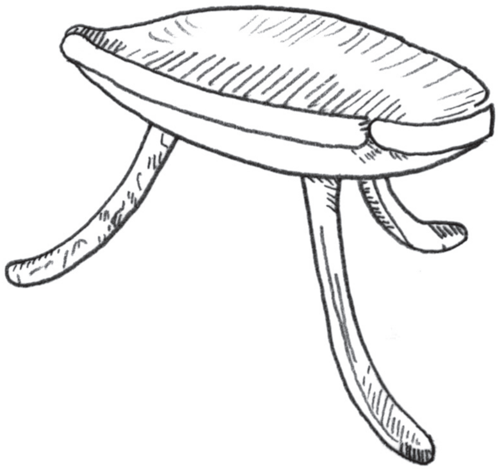
As furniture historians point out, the origin of the word "Windsor" to describe a class of chairs is complicated and has yet to be definitively settled.

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 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.

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

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?

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.

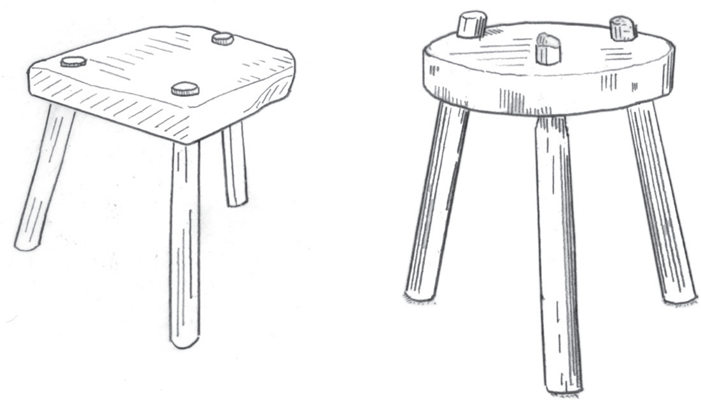
But knowing the right word for something is helpful when learning the craft of chairmaking, case construction or butt surgery. For example, the word "backstool" means different things to different people. In some books, backstool means a stool with a solid plank added as a primitive backrest. To others, 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



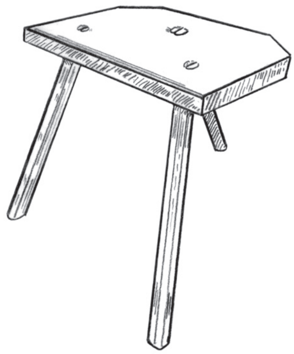
TWO LOW STOOLS
The stool at left is likely Welsh. The one on the right is Irish. The protruding tenons are a common problem on these hard-used household items.

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?

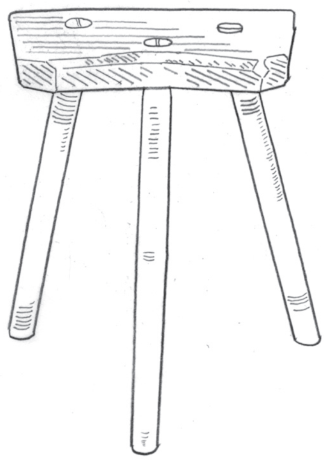
Stools aren't chairs, so it might seem a bit odd to bring them into a taxonomy of stick chairs. In truth, stools and stick chairs are so closely related that it is difficult to discuss one without understanding the other. Many times an old stool will be converted later in life to a back-stool or a chair 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.

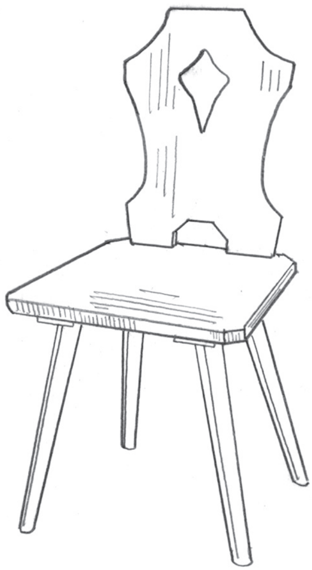
One of the common variants on the rude stool is the milking stool. Milking stools can be even lower – I have seen Shaker examples that are 6" tall. You can usually differentiate a creepie from a milking stool by the seat. Many milking stools have a decorative hole there to make the stool easy to carry 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 (cue "Don't Stand So Close to Me" by The Police).

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.



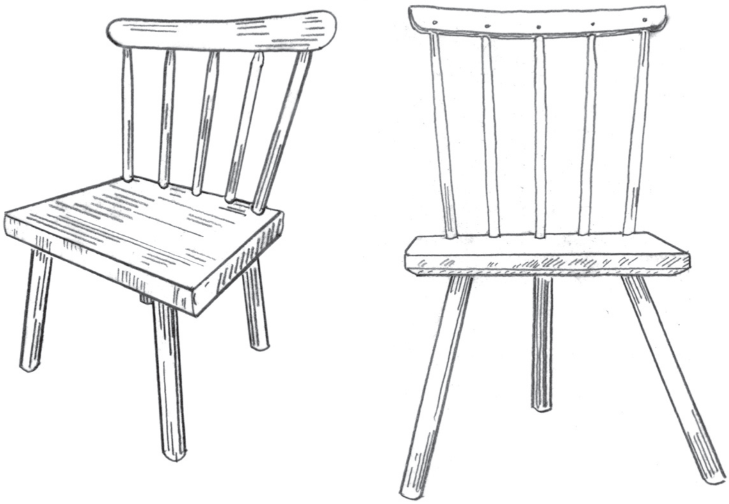
A GERMANIC/SWISS BACKSTOOL
Note the battens beneath the seat. These thicken the thin seat to make the backstool more robust.

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)

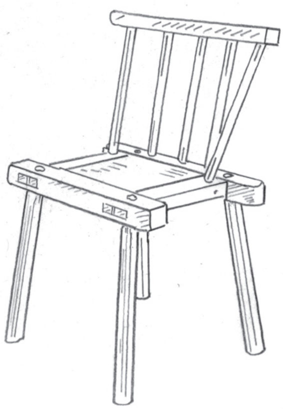
OK, here's where the language gets muddy. What most Americans call a side chair is a chair that has some sort of backrest but has no arms. A side chair's backrest can be anything – from a fluffy cushion to a bunch of thin wooden spindles topped with a backrest. Why is the term "side chair" confusing?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

To add to the confusion, some of these side chairs/backstools don't really qualify to be called a stick chair. Why? Because they don't have a seat that is a single slab of wood. Instead, the seat is a frame-and-



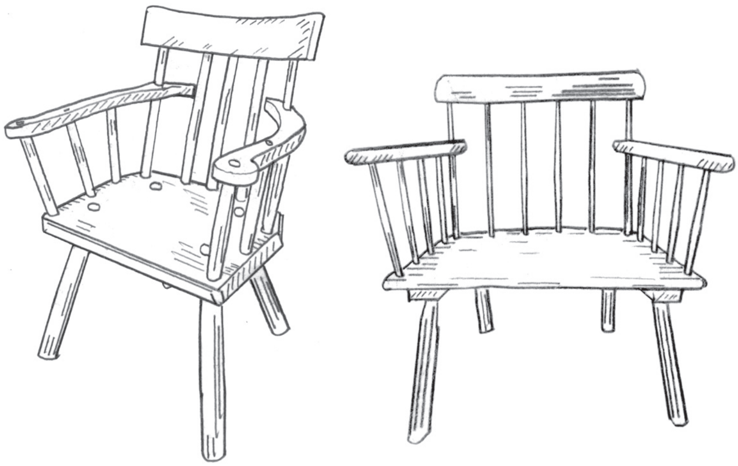
TWO SIDE CHAIRS

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

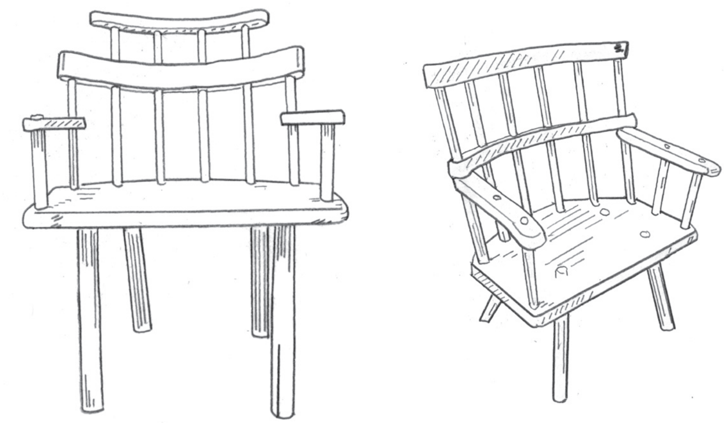
Note how the arms are linked to the back sticks. The one at left is Irish. The one at right is interesting because of its thin seat and battens.

panel construction that is skinned with thin wood. It can – at first 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 weasely 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 low enough to contact the sitter's back.

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

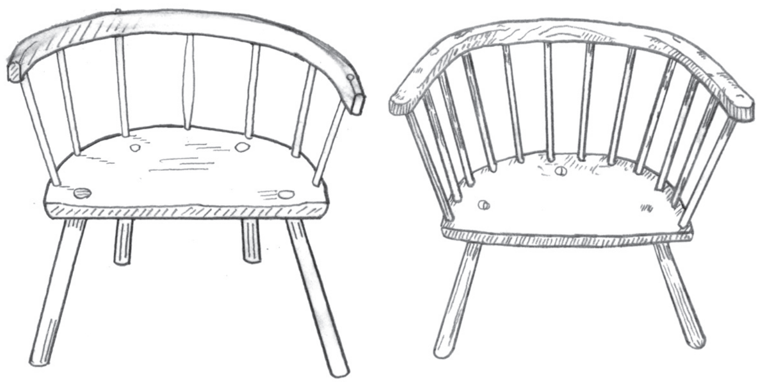
Lowbacks have a curved armbow that surrounds the sitter on three sides. The armbow can be a single piece of wood – either bent by the maker or by nature. Or the armbow can be pieced together from multiple pieces of wood that are joined. Sometimes the armbow is thickened at the back with an additional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

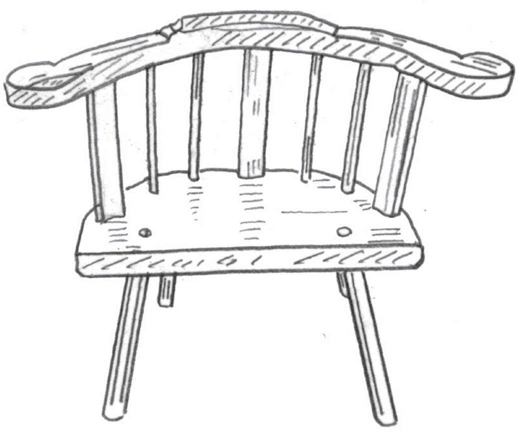
Sometimes a lowback's armbow doesn't have much curve because the armbow is a giant root that has a very gentle curve. These rootback chairs are most common in Wales.

Finally, just like with armchairs, sometimes lowbacks get some



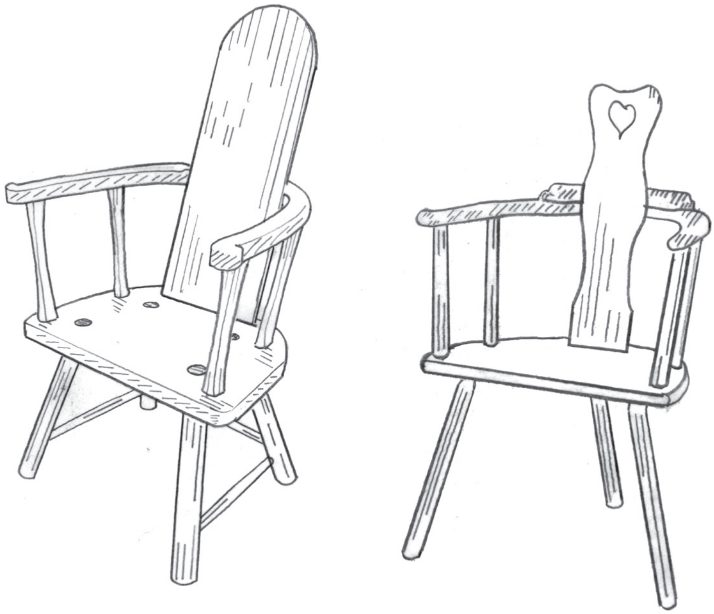
TWO TYPICAL LOWBACKS

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.

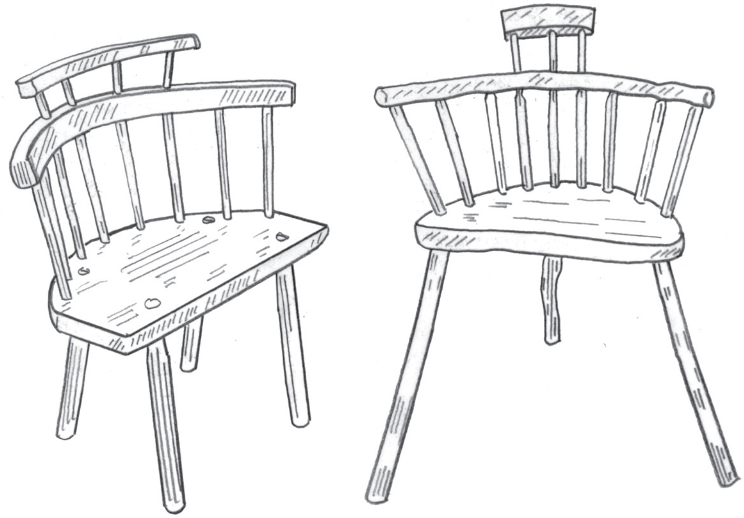
extra parts added on, either at birth or later in life. The most common "implant" is to add a little backrest above the arm.

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.

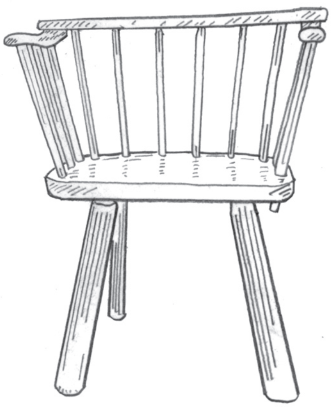
Of course, just like with the other chair forms, there are a lot of possible variations and hybrids.

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



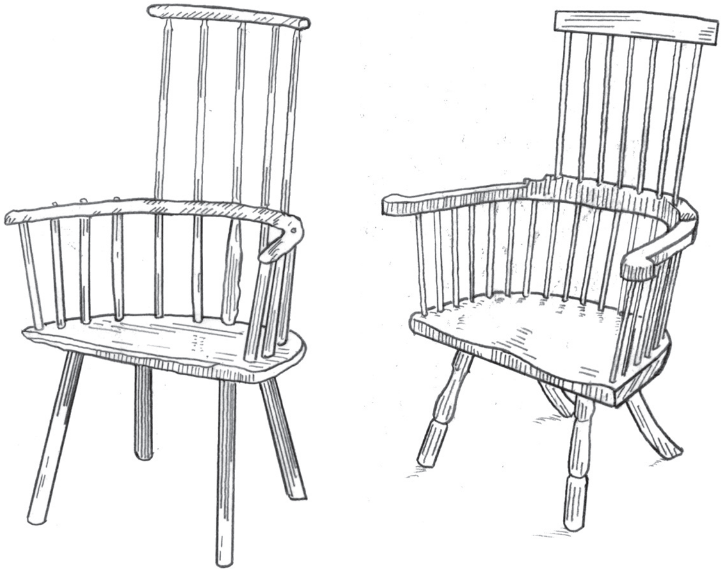
TWO LOWBACK VARIANTS

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.

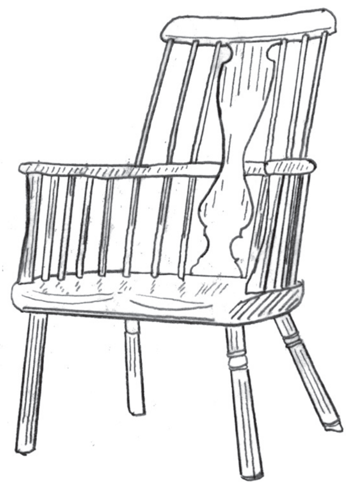
carvings. This form is common among English Forest chairs.

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

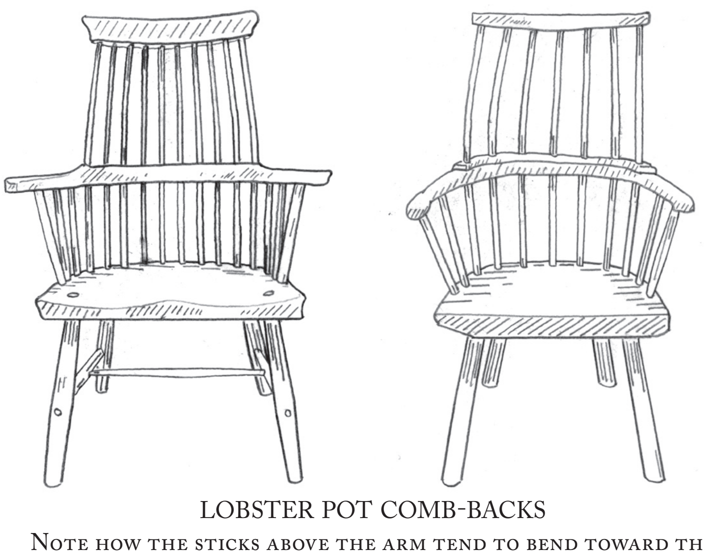
ESPECIALLY IRREGULAR CHAIRS

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.



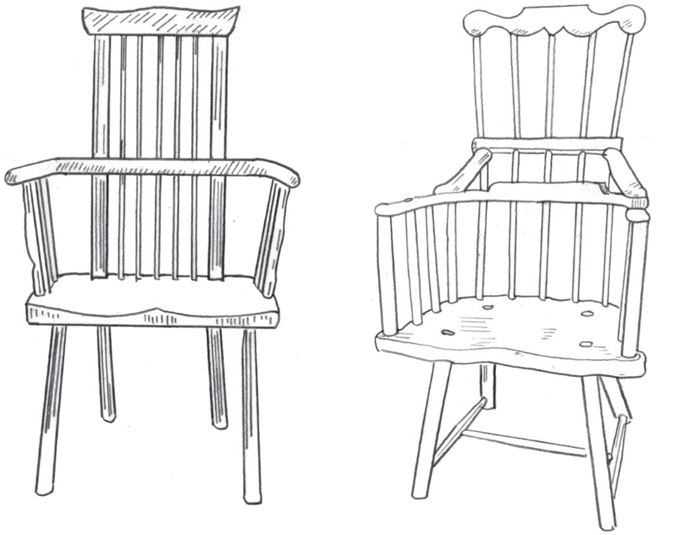
COMB-BACK WITH SPLAT

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.

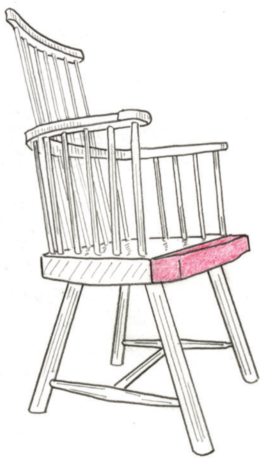


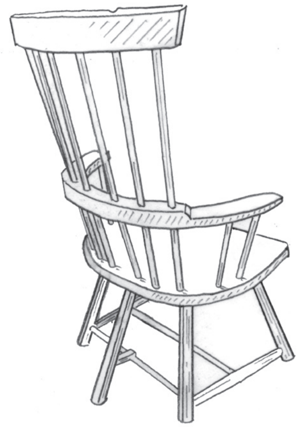
COMB-BACK VARIANTS

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.

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

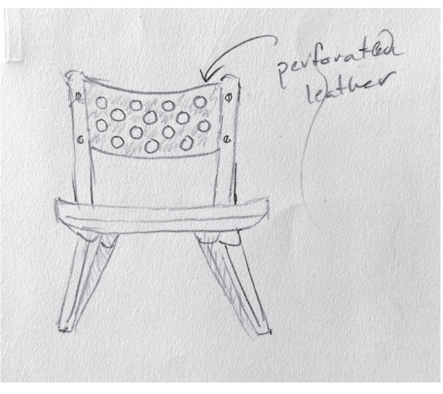
My hope is that you will refine these operations and make them simpler, easier and foolproof. And when someone asks you how you make your sticks or your arms or your legs, you'll be willing to rip off one of your own corners and give it away.

PART II:

Chairmaking Techniques

It might sound obvious to say that technique is at the heart of the chairmaking craft. In fact, if I never saw another chair plan, I'd be able to make chairs – different, new and interesting chairs – for the rest of my days. That's because I have learned the techniques that allow me to build any chair I can dream up.

The following chapters introduce you to the techniques common to building stick chairs. They aren't concerned with building one particular chair. Instead they attempt to show how to approach any stick chair, whether it is one shown in this book or is something you have just sketched on a soiled napkin.



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.

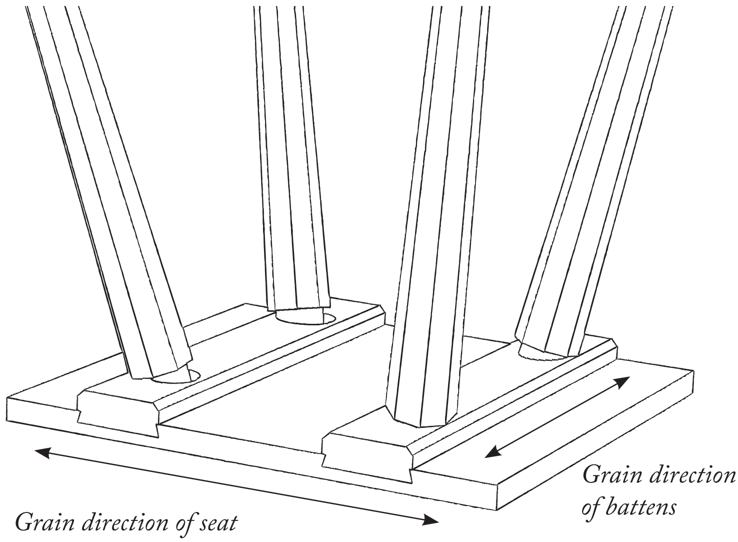
THICKNESS, WIDTH & LENGTH

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 the 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. 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 get 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.

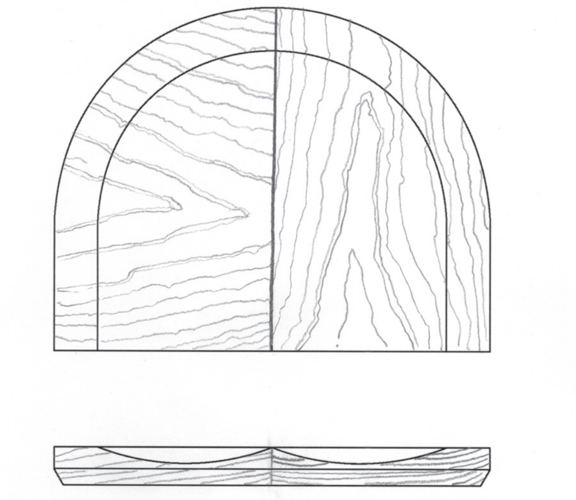
WOOD SELECTION

You can use almost any species for the seat. I prefer wood that isn't easy to split. Tulip poplar, white pine and red elm are ideal in North America. The domestic diffuse-porous and semi-diffuse porous species are also good for seats, such as walnut, cherry and maple. They'll split, but it will take some effort or abuse.

The ring-porous species – ash, hickory and oak – are great 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).

Of course, make sure there aren't big checks in the material. If there are knot holes with splits, keep those splits away from the joints for the



EITHER WAY

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

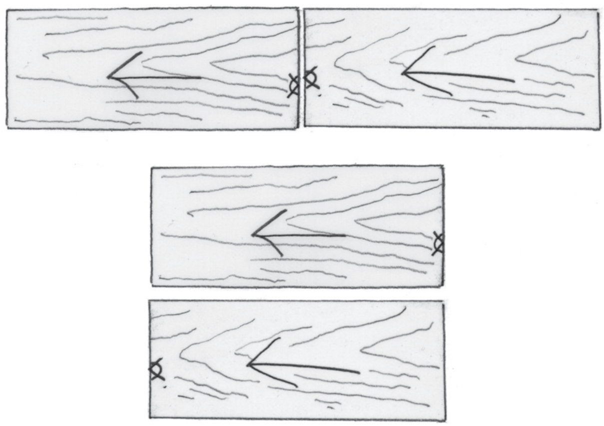
legs and sticks. Make sure the wood is sound. If there are discolored areas, stab them with a pocketknife to ensure they aren't rotten.

If you can't decide if a piece of wood is good enough for the seat, then it probably isn't. Set it aside for something else. If you have no choice and must use that piece, keep your seat material as thick as possible and make it look lighter by adding a large bevel on the seat's underside. That underbevel will fool people into thinking the seat is svelte (the vertically striped shirt of the chair world).

And if, in the end, the seat is ugly, paint it.

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



A SOUND SEAT STRATEGY

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

wood's defects were.

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 and Europe. Seats require thick and wide pieces of stock, which have always been harder to find than the slender pieces needed for sticks and legs. In fact, wood could be so precious there are accounts of people poaching wood from royal or government lands.

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.

SINGLE-BOARD SEAT

Single-board seats are the best. When I visit the lumber mill (or the guy who bought a schoolhouse and filled it with lumber), 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 couple chair seats. The yard is happy to be rid of them, and so they aren't as expensive as buying a huge slab and cutting it into chair-sized pieces.

When I can't find (or afford) wide boards, I switch gears and look for boards that are ideal for a seat that's glued up using two boards.

GLUED-UP SEAT

Because wide stock is 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. For the seat, I don't have to worry about the grain being straight. In fact, I prefer my seats to have interesting figure.

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 your chair will be painted, 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 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 big fuss about alternating the heart side and bark side when gluing up a panel or seat. I suggest you 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 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 the 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 good chance the chair's owner won't notice that the glue joint has failed. The pegs through the tenons, the undercarriage and the sticks above will keep the seat boards close to one another.

I have a mortising machine that makes slots for loose tenons. 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 yellow glue. Unlike the rest of the joints, this one won't ever have to come apart for a repair.

Peg all the tenons from the underside of the seat. You can use small oak pegs, bamboo skewers or chopsticks. Be cautious not to drill the holes for your pegs too deep into the underside of the seat. You'd hate to encounter the pegs while saddling the seat.

I use bamboo skewers. They are consistent in diameter (about .165") and work well with a 5/32" drill bit (.156"). I drill the hole, put a drop of glue in the hole and drive the peg in. I put four pegs in each tenon.

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

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

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 a defect. This can be as simple as making the seat 1/2" narrower. Or changing the radius of a curve to avoid a small split. Sometimes I shift my 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 composed of 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

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.

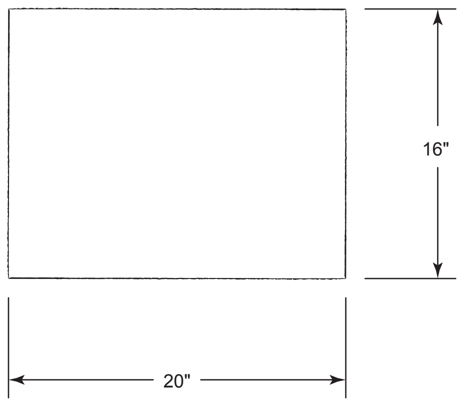
back of the seat to accommodate extra sticks to reinforce the backrest. This extension can be added to almost any seat shape.

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

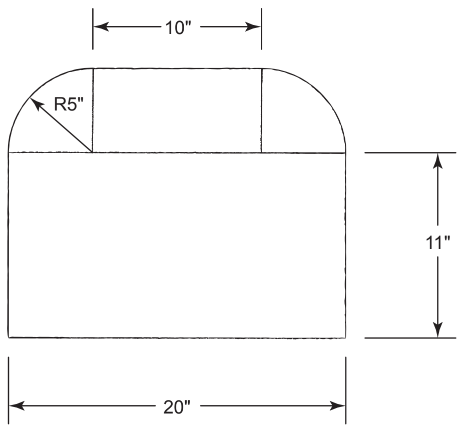
When I use a seat shape for the first time, I draw it full size on butcher's paper. I use a simple compass, a yardstick drilled with holes and plastic drafting squares. Plus a good gum eraser.

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.

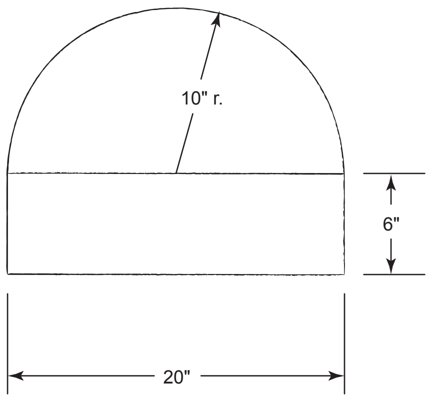
These patterns and notes are a useful snapshot for future chairs. Though I rarely build the same chair twice, I often take a seat or arm shape from a past chair and alter it. My patterns are like long-distance love letters. I can't have the object of my affection (an old chair) with



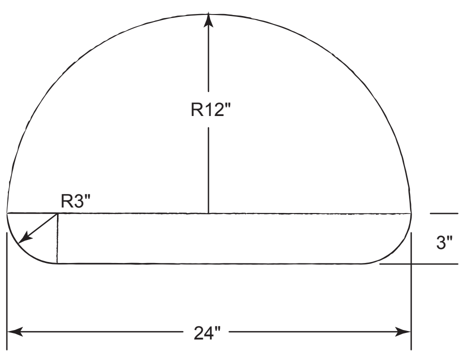
Simple rectangle



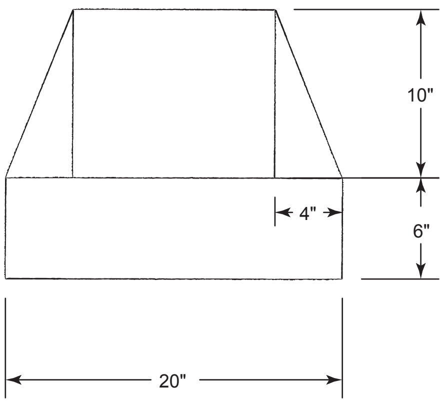
Square back or rounded rectangle



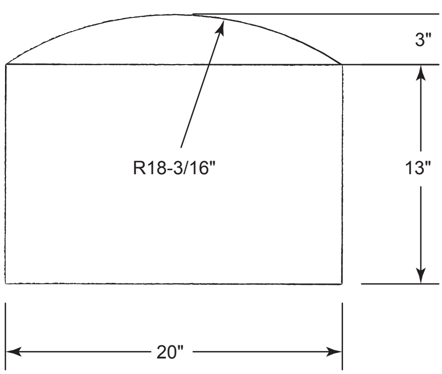
Traditional D-shape



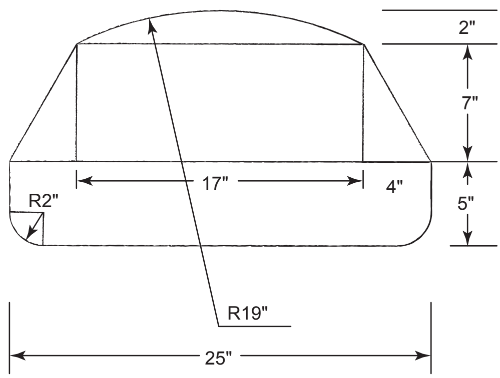
Half-circle with rounded corners



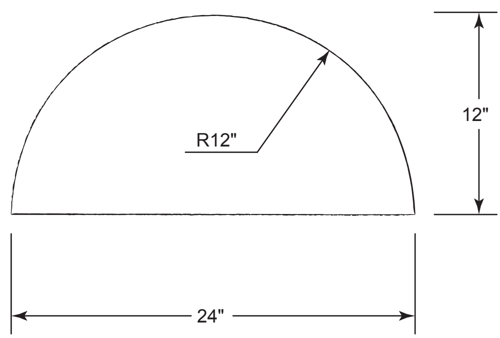
Clipped corners



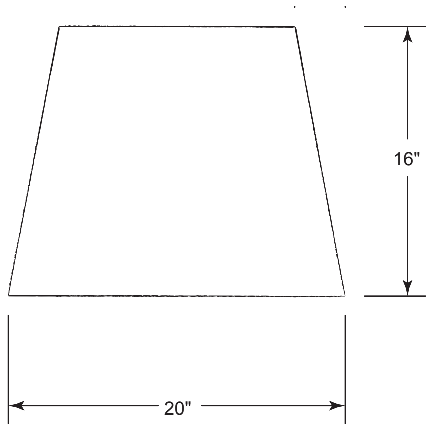
Rectangle and arc



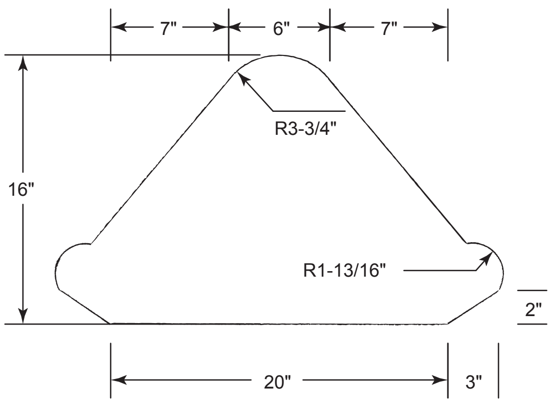
Irish Gibson



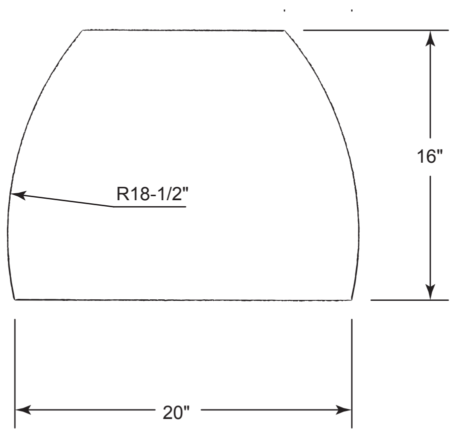
Half circle



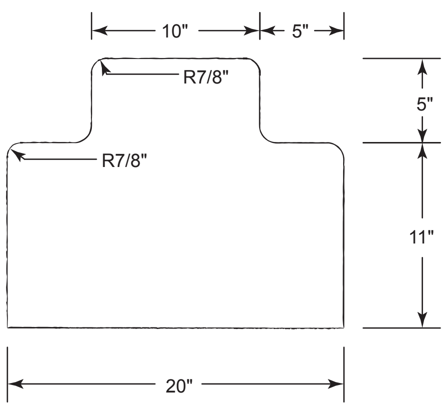
Trapezoid



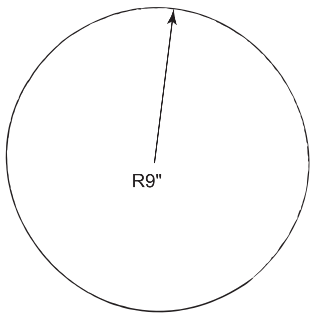
Welsh triangular with round extensions



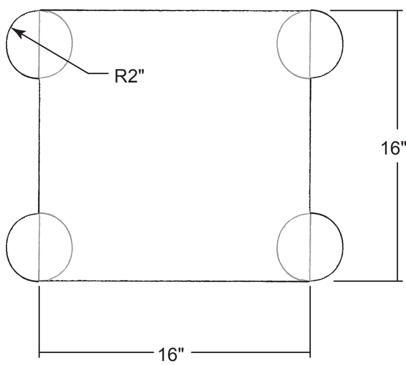
Bulging rectangle



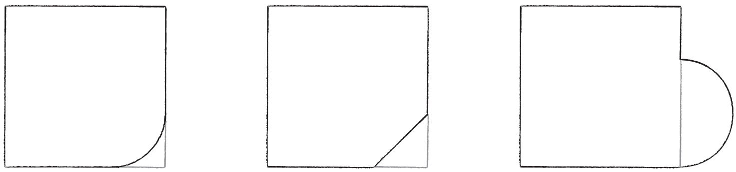
Rectangular with an extension for back sticks



Circle



Square with round extensions



Rounded *Clipped* *Extended*

ENDLESS VARIANTS

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

me, so the pattern reminds me of what I adore about it.

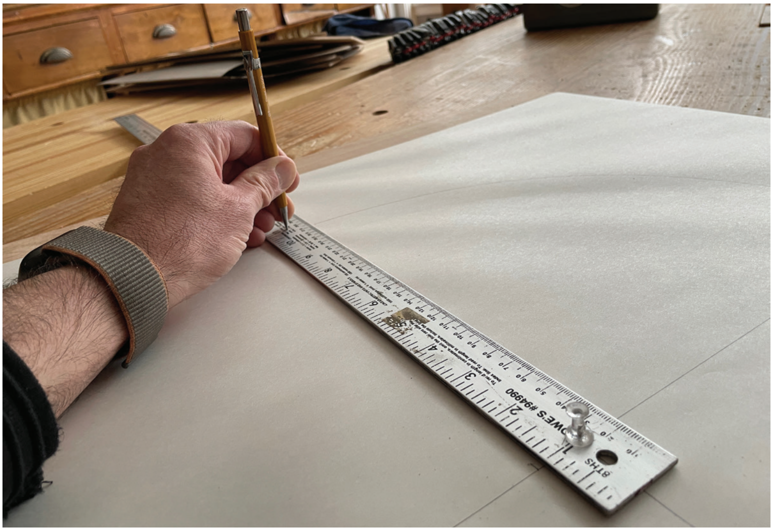
Patterns are also important because photographs are lying jerks. The foreshortening and parallax that crops up in photos of a chair will fool you. I remember seeing chairmaker John Brown's patterns for his settee. The seat's shape looked nothing like I thought it should, and I've seen dozens of photos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

Make patterns and keep them around.

After you draw the seat shape on the wood, cut it out. I prefer the band saw for this. Some chairmakers leave the seat as a rectangle as they cut the joinery and shape the saddle. The corners of the rectangle are great places to clamp the seat blank so you can 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.

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



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.

BEVEL THE UNDERSIDE

Many vernacular chairs have a bevel or curve on the underside of the seat, called an underbevel. The bevel or curve 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 30° 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 vernacular chairs. I like my bevel to match other aspects of the chair. If the chair has rounded 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 30°). Draw the height of the

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.

bevel on the edges of the seat. Place the seat flat on the table (face up) and make the cut. If you're a first-timer, practice on scrap first.

For many years I cut the bevel with a drawknife. Draw the limits of the bevel on the edge and underside of the seat. Clamp the seat in your face vise and peel off the waste. When you get good with a drawknife, you won't even 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, but the learning curve is short.

CLEAN UP THE SEAT'S EDGES

The rough-sawn edges of the seat can be cleaned up with a spokeshave and block plane (or a smoothing plane). Use the planes for the straight sections of the seat; use the spokeshave 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 with a spokeshave and plane. In the end, the seats look about the same.

With the seat at its final (I hope) shape, I lay out and cut the joinery for the legs.

DRAWKNIFE DOES THE JOB

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

TROUBLESHOOTING

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 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 evaluate 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 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 "The Chairmaker's Workshop" offered the best explanation of the technique. After learning that method, I embraced it. And I have 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.

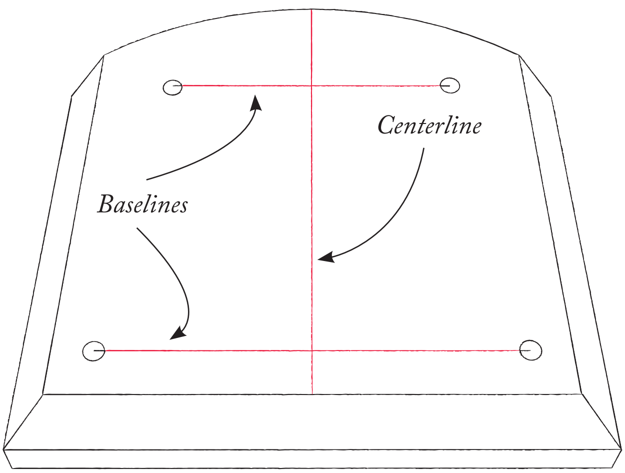
Many chair plans provide sightlines and resultant angles for you to use (this book does, too). So first I'll show you how to lay out sightlines and resultants from a chair plan. And use them to drill the mortises. After you know how to use them, then I'll show you how to devise your own sightlines and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

If you have any trepidation, remember this: The last time I took a standardized intelligence test, my math skills were in the 13th percen-

LEG-TO-SEAT JOINERY

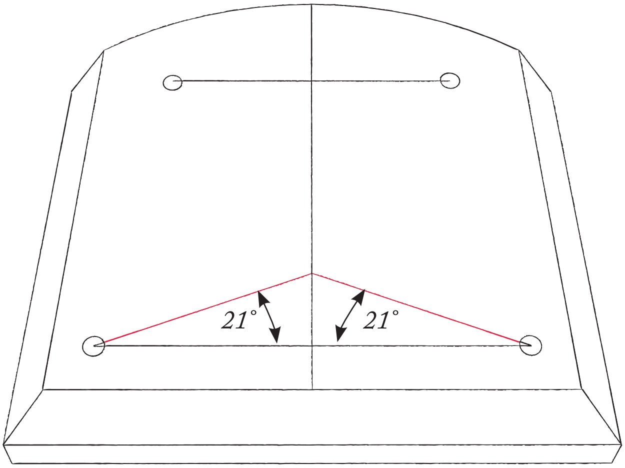
TWO BOSSES

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.



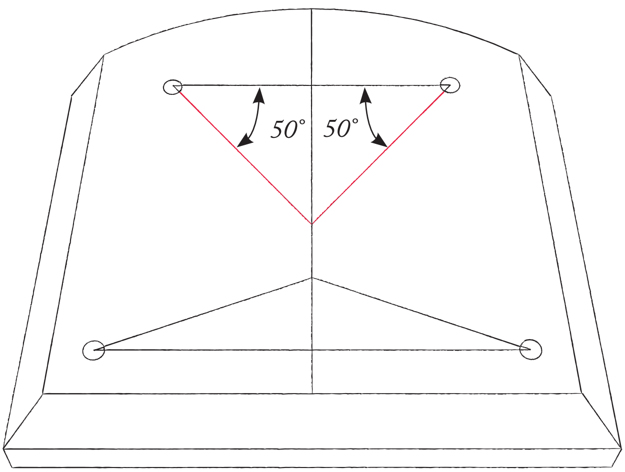
BASELINES & CENTERLINE

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



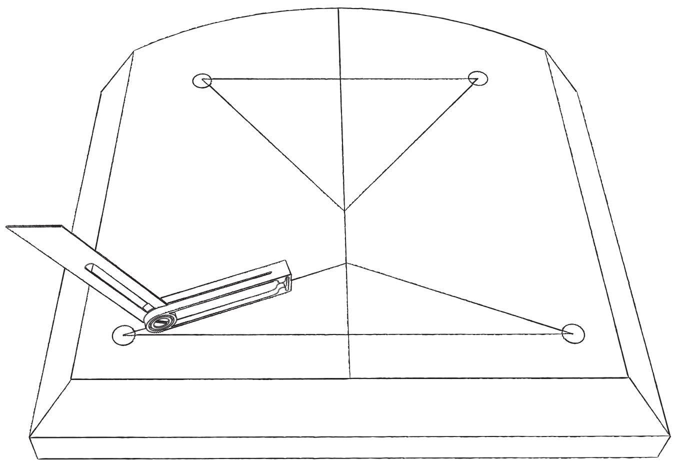
FRONT LEG SIGHTLINES

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.

tile (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 mortises. You are ready to drill that mortise. Take a drill bit and drill

FOLLOW THE BEVEL

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

it aligned with the blade of the sliding bevel. Drill (and perhaps ream) the mortises in the seat.

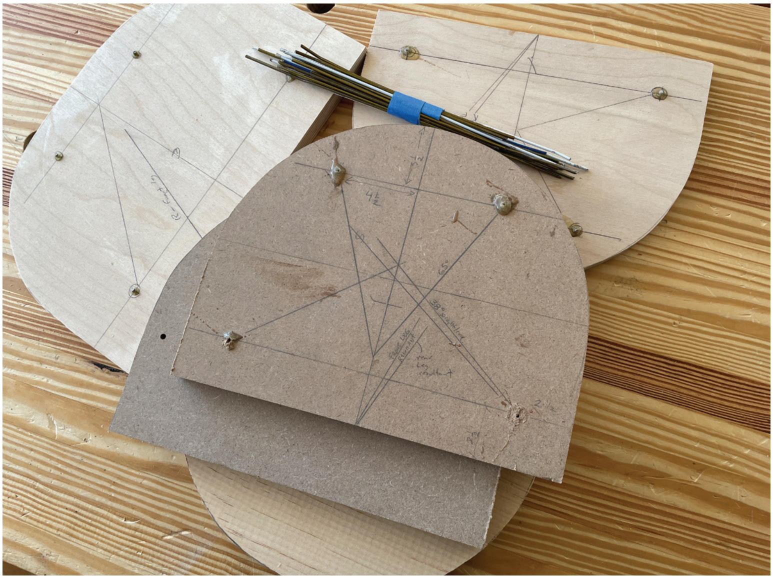
Let's say the resultant angle for the back legs is 26°. Set a sliding bevel for 26°, put it on the sightline for the rear leg and drill a rear leg mortise aligned with the blade of the sliding bevel.

We'll discuss how to drill and how to ream 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 to sightlines and resultants. There are equations, tables and calculators



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

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.

Once you have your model made and your legs bent, you can figure

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

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.

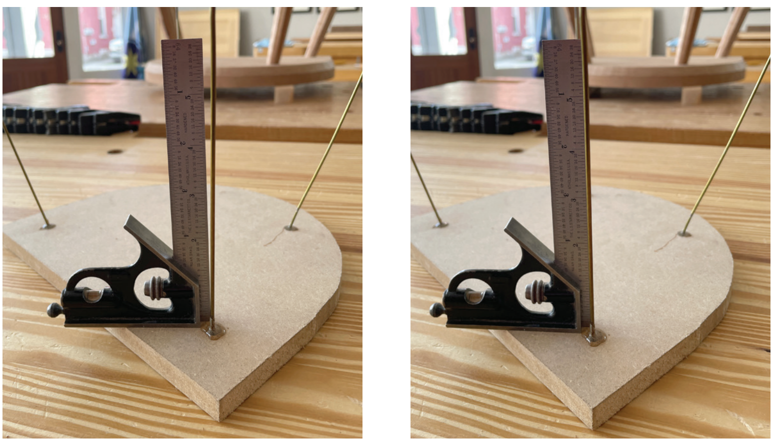
At the moment when the leg appears vertical, freeze your position. If you could shoot a laser line out of your eye and burn it on the chair seat, that 1) would be very cool and you should join the circus and 2) is your sightline.

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 try 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 to give numbers to these lines (for example, sightline: 23° and resul-

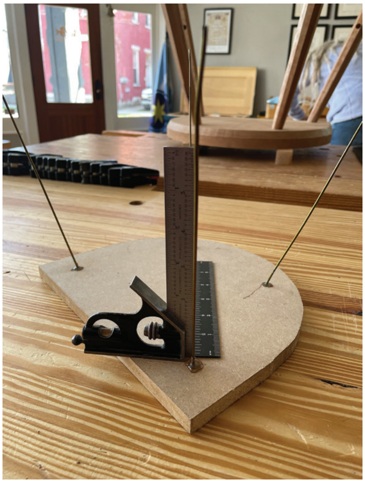
MORE SPLAY

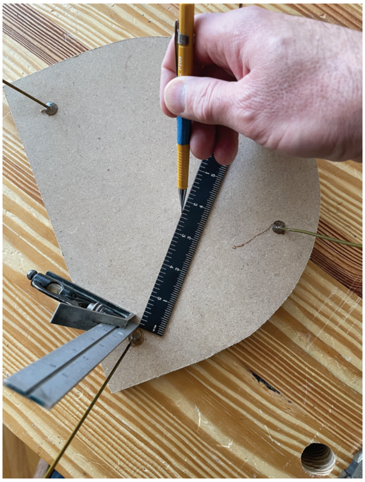
A school protractor and needlenose pliers let you dial in the exact rake and splay.



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.

tant: 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: TAPERS OR CYLINDERS?

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 (or if you cannot afford a reamer and/or tapered tenon cutter), 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 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

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.

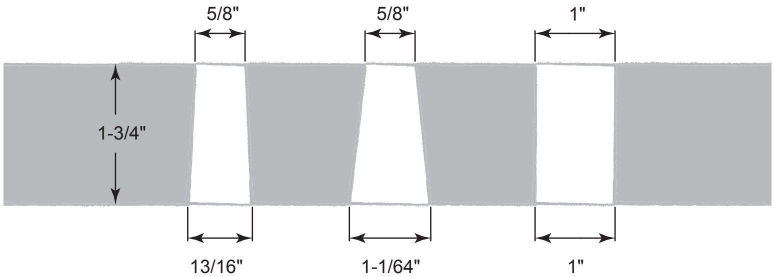
seen this approach in old chairs). From a pure engineering point of view, a cylindrical glue joint is not quite as strong as a tapered mortise-and-tenon's glue joint. But that's just on paper and is an unanswerable debate in chairmakers' barrooms.

A tapered mortise-and-tenon joint is more common in manufactured Forest chairs and handmade chairs made by professional chairmakers. The mortise is cone-shaped, and the tenon matches it. When well-made, these joints fit tight, even without glue. Plus, the more you sit on the chair, the tighter the joint becomes.

The major advantage to the tapered joint, in my view, is that the mortise is forgiving to cut. If you bore the initial mortise at the wrong angle, you can correct it when reaming. The reamer allows you to sneak up on the correct angle.

GOOD TENONS

All of these tenons are on leftover legs from the last year or so. All them are strong enough for a stick chair.



UNDERSTANDING TAPERS

In a typical 1-3/4"-thick seat, a 6° taper with a 5/8" pilot isn't the right choice for a chair with strut legs (left). Two solutions are a 12.8° taper (middle) or a 1" cylindrical mortise (right).

One downside to the tapered joint is the additional tools required. You need a reamer and a tapered tenon cutter. Their shapes need to match exactly. Commercial examples of these tools come with different "included angles," anywhere from 6° to 12.8°. I've used both and both work well. The nice thing about the 6° tools is you don't have to ream away as much wood as with the 12.8° tools. And when you are reaming oak, you feel every shaving.

The second downside to a tapered joint is that the tenon will likely be smaller as it enters the seat of the chair. With a 6° reamer and a 5/8" hole, you will end up with a 13/16"-diameter tenon as it enters a 1-3/4"-thick seat. With a 12.8° reamer, the hole will be a bit more than 1". If your chair has stretchers, then the 6° reamer is just fine with a 5/8" pilot hole.

But for a strut-leg chair, it's weak. For strut legs you have three choices: 1) Use the 12.8° reamer 2) Use a 1"-diameter cylindrical mortise 3) Use the 6° reamer but with a 3/4" pilot hole (instead of 5/8").

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

AUGERS BIG & SMALL

A Scotch-eye auger (above) is powered by a broomstick. More traditional augers (below) can be used in a brace or electric drill.

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 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. You get one shot to get it right. Most augers have a lead screw. Put the lead screw where

BIG MORTISE

Some stick chairs have huge mortises. For me, a 1-1/2" mortise requires a corded drill with a side handle.

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.

After that, it's on you to keep the auger in line with the blade of the sliding bevel. Drill until you cut through the seat. Be ready to accept your errors.

MAKE A TAPERED MORTISE

A tapered mortise is created in two steps. First drill a hole (usually 5/8") through the seat. Then use a reamer to open up the hole and create the tapered shape. The good news is that a reamer can correct a poorly drilled hole. The bad news: You need to learn to use a reamer.

First drill a 5/8" hole through the seat as described above.

WHERE IS PARALLEL?

When reaming, you need to sight the bevel against the drill's chuck. To make life easier, you can tape a straight stick to the body of the drill to align the tool with the bevel.

ELECTRIC REAMING

If you are using a reamer in an electric drill, here's how to go about it. You still can use the sliding bevel to guide you, but the bevel needs to be sighted against the drill's chuck. Set the drill to the lowest speed and disengage the drill's clutch (if it has one).

Lightly touch the reamer to the rim of the hole (don't read this out loud to your children; I am embarrassed to write it). Pull the trigger on the drill and plunge forward. The reamer will cut quickly at first and slow significantly within a second or two. Stop reaming.

You need a "dummy leg" to gauge your reaming skills. (Why? Your legs are probably tapered.) My dummy leg is a 1"-diameter dowel that has a tapered tenon cut on its end. Make one with your tapered tenon cutter. You could also use a scrap octagonal leg for this. Mark a vertical line along the length of the dummy and sight only against that line.

REAM, LEAN & CHECK

If your dummy leg doesn't line up with the bevel, you need to make a correction. Here, I am about to check the reaming angle. Note the line ont he dummy leg. This line ensures I'm checking at the same place on the dummy leg.

That will help ensure all your legs are consistent.

Pull the reamer out of the hole and insert the dummy leg. Slide the sliding bevel toward the dummy leg and show it to the line on the dummy leg. Likely you are off by a little. Left, right, forward, back.

Let's say you need to tilt the reamer forward to correct things. Here's what I do. First, push the reamer firmly into the hole so it is seated. Get into position to ream. Pull the reamer out of the hole a tiny smidge and start rotating the reamer slowly in the hole without allowing it to cut. When you are ready to plunge, push the reamer in the desired direction and pull the trigger a bit more. Let the reamer cut for a second or two and release the trigger.

The reamer is a scraper. If you let the reamer spin for more than a couple seconds, the reamer will clog, and it will stop cutting. Then the reamer will burnish the hole, which makes it difficult to ream some more. Also good to know: glue beads up on a burnished surface.

The routine is: Short burst. Check your work. Clear the reamer. Adjust. Short burst. Check your work and clear the reamer. Adjust.

Try to ream all the holes in the legs to the same depth. I shoot for the point where the reamer fills the 5/8" hole on the topside of the seat. If you have to go a little deeper, that's OK.

The first chair is a bit stressful. But after a few, you will like the fact that you can control the reamer and get the legs where you want them.

REAM WITH A HAND REAMER

Hand-powered reamers work much the same way as the drill-powered reamer. But there are some advantages. First, the hand reamers don't remove a lot of material, so it's a bit of an easier process.

The steps are the same. Drill the hole. Ream it until the reamer clogs. Pull the reamer out, clear the shavings and check your work with a dummy leg (or check it against a large sliding bevel). Adjust. Ream. Check your work.

NOT MUCH DIFFERENT

Reaming by hand works just like doing it with a drill. Cut for a few seconds, clear the shavings and check your work.

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.

MAKE & TENON THE LEGS

Like the seat, the legs of the chair are also 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 has to 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 perfect legs, you can put them aside for a future chair.

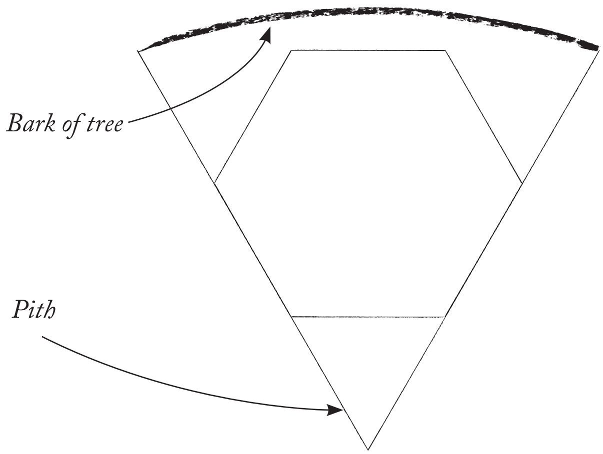
THICKNESS, WIDTH & LENGTH

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 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. Take photos and look at the chair on a computer screen or a printout.

You might be shocked by what you see. My early chairs had legs that were 1-3/4" tapered octagons. I didn't, however, make them equilateral octagons, 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 to the eye. Chairs with a low seat (15") can handle thicker legs. Taller chairs (18") look better with thinner (or thinner-looking) legs.



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.

As I pick through my stock for legs, I look for straight grain. When 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. After roughing out a bunch of legs, I square them up using handplanes or machinery. The next step is to make them octagonal.

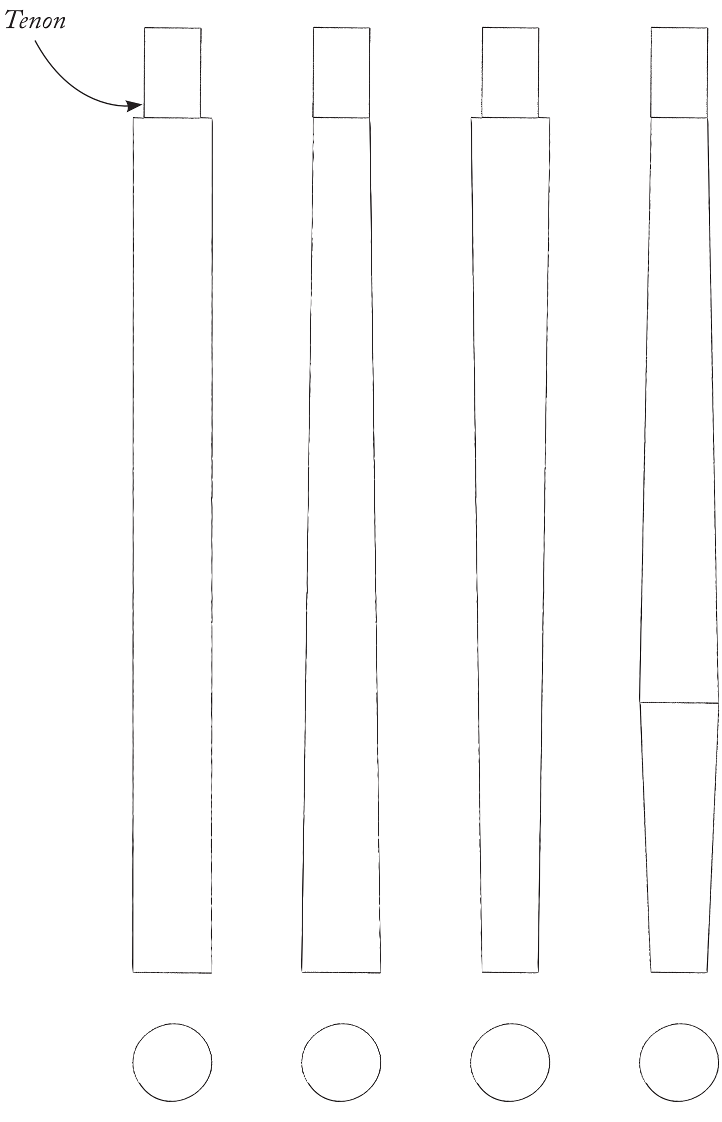
There are wide variety of leg shapes. The following pages show some common ones that appear on stick chairs that have been shaved. I don't turn legs for stick chairs, though those appear in the historical record.

MARKING OUT OCTAGONS

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

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

MAKE & TENON THE LEGS

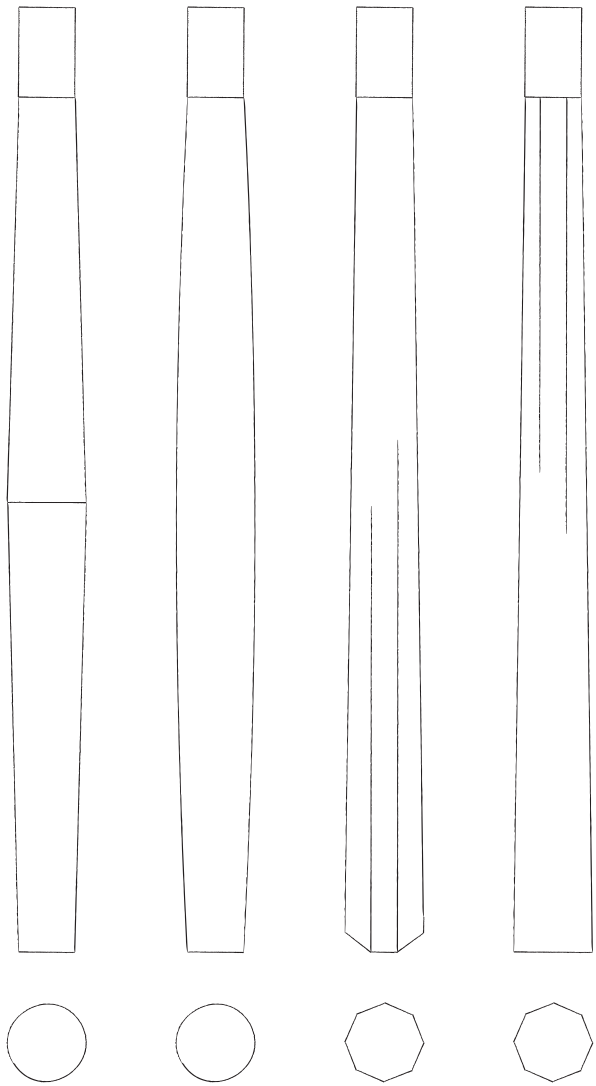


Straight cylinder

Tapered round

Reverse taper, round

Double-taper, round & offset



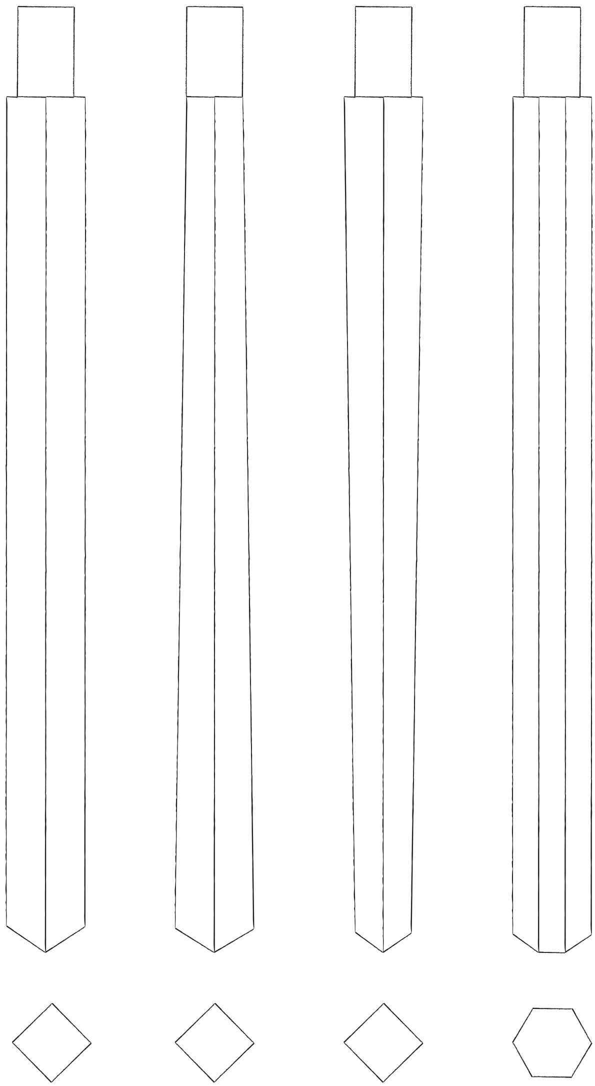
Double-taper, centered

Round with entasis

Octagonal, round at top

Octagonal, round at foot

MAKE & TENON THE LEGS

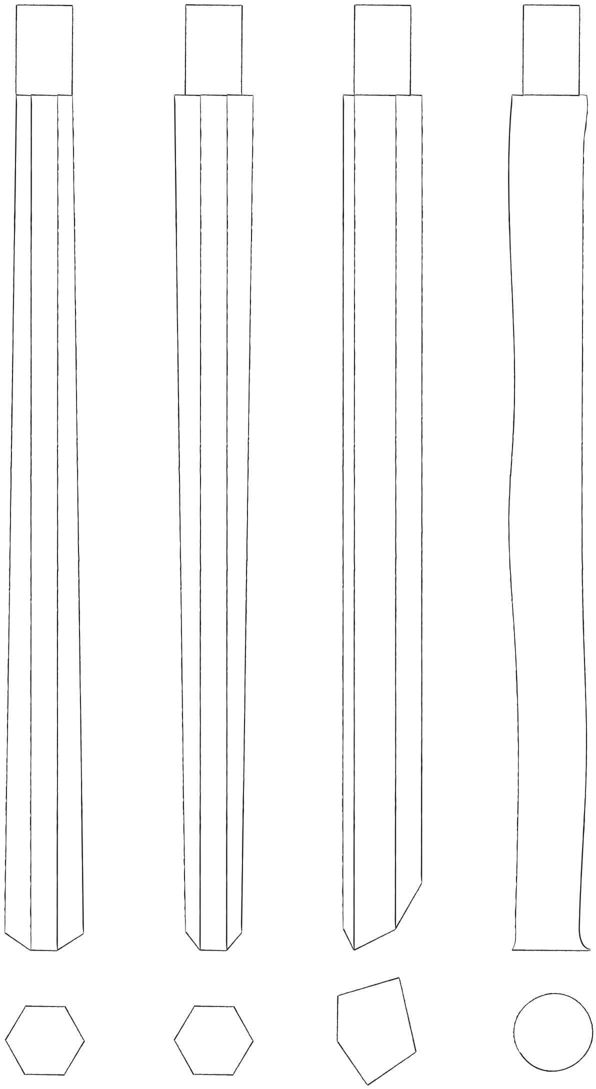


Square, straight

Square, tapered

Reverse taper, & square

Hexagon, straight

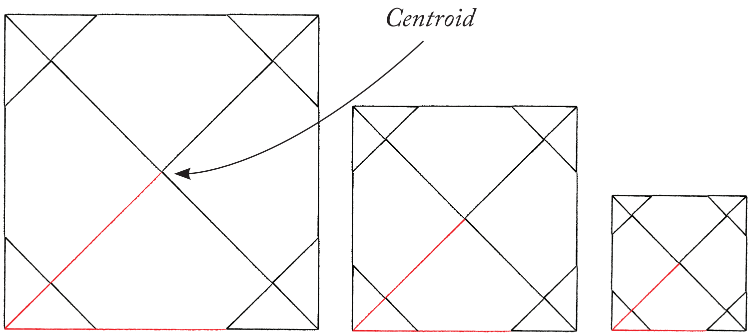


Hexagonal, tapered

Hexagonal, reverse taper

Split, irregular

A stick



OCTAGONS IN A SQUARE

The red lines in the above octagons are the same length. If you set a combination square from a corner to the centroid, you can lay out the entire octagon.

"centroid" of the square. You get the centroid by drawing lines from corner to corner of the square. Then you can lay out the entire octagon. Here's how.

1. Join the corners of the square to create an "X" in the middle.

2. Set the stock of a combination square against one corner of the stock and extend the blade until it touches the center of the "X."

3. Now use this setting to mark all the corners of the octagon. The two photos on the next page explain it better than words.

You can use the square to pencil in these lines along the faces of the leg. Then plane down the corners until you reach your lines.

PLANING OCTAGONS

I use a planing cradle to convert square stock to octagonal stock. The planing cradle has two 45° angles butted against one another. When you drop the square stock into the cradle, a corner you need to plane faces up. Plane down to the pencil lines, then rotate the stick 90°. Repeat. I prefer a jack plane set for an aggressive cut. Keep the sole lubed with paraffin (canning wax from the supermarket) to make the job easier. If you prefer hexagons instead of octagons, make the cradle with 60° angles instead of 45°.

EASY OCTAGONS

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

OCTAGONS AT THE BAND SAW

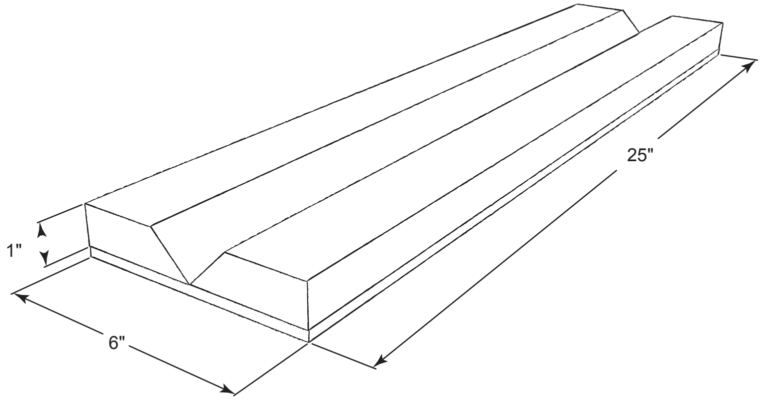
If you own a band saw you can make a simple jig that will transform square stock into octagons quickly and safely. The jig is like a planing cradle. It holds square stock at 45° to the blade so you can clip the corners and create an octagon.

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.

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.

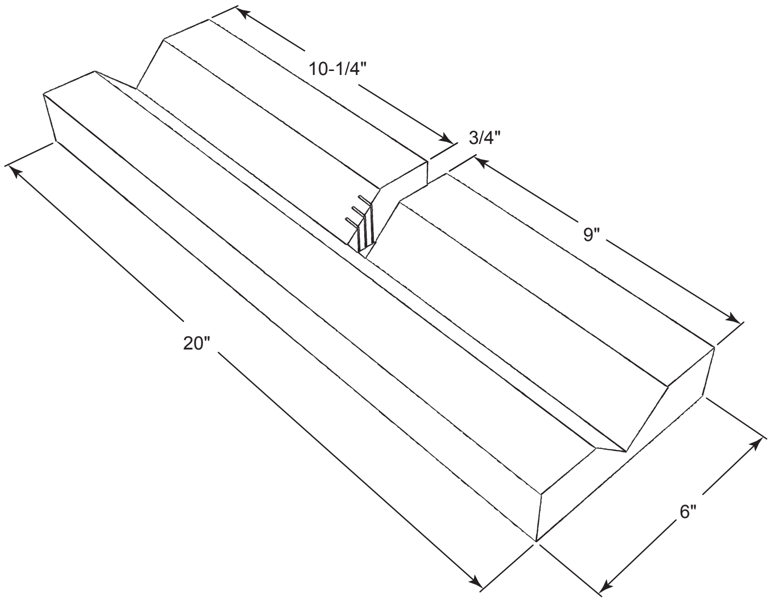
First cut the 45° angles along the length of the jig (I used a table saw). Then cut the 3/4"-wide notch in the middle of the jig so the jig surrounds the blade of your band saw.

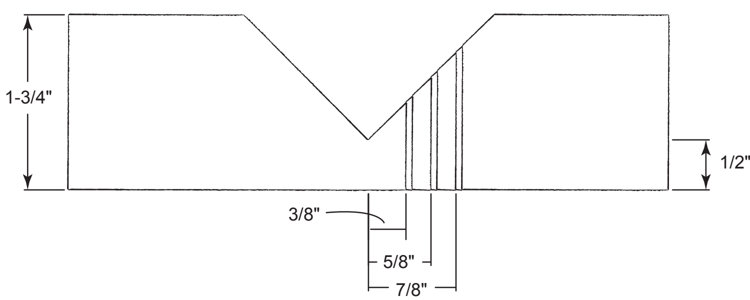
Take a piece of scrap leg stock and lay out an octagon on one end.



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

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.

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.

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. 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 quickly set the jig next time. Repeat the process with 1-1/4" stock (for stretchers) and 3/4" stock (for sticks).

OCTAGONS ON THE TABLE SAW

There are days when I need to make 200 sticks into octagons 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,

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.

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, 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.

NO SHAVEHORSE NECESSARY

A simple stop is all you need. Hold the jack with one hand and your work with the other. Work the arrises.

Though you will occasionally find turnings in vernacular chairs, shaved components are more common. Lathes were expensive and were used by skilled woodworkers. Shaved components, on the other hand, 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 resist using 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 plane (followed by a block plane). I first learned this technique from John Brown in his book "Welsh Stick Chairs" and have embraced it fully.

All you need is some sort of stop to restrain your work (it can be as

FINISH WITH A BLOCK PLANE
After the jack plane, finish up the legs with a block plane.

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 to be 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, which is traditional, if you have a lot of wood to remove.

• I wield the jack 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. The block plane will clean it up later.

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.

I shave the legs until they are as round as possible with the jack. They 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, where the woodworker clearly began shaping the leg's tenon.

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, I first shave the leg round. Then I taper the top half of the leg so it's 1/4" or 3/8" less 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 do the same tapering at the foot.

MAKE & TENON THE LEGS

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.

TAPERING LEGS

Tapered legs are always 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 tables, 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 table's apron 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 cradle or a carver's vise. You might be tempted to try it on the table saw or the jointer. Here's my take on it: When I teach people to do it on the table saw or jointer, their first four or 20 legs put them in danger until they get a feel for it.

No matter how many rules I explain or guards I add to the machines, beginners struggle with where to put their hands and where to apply pressure. After years of trying to teach machine methods, I now stick to hand-tool techniques. Tapering legs with a jack plane is safe, fast and (to be honest) more fun.

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.

Put the leg in your 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 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. The facet becomes quite wide near the top of the leg as you taper it. The second, third and following facets are easier. 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 either toward you or away from you to correct it. The curved iron helps make these corrections.

Wax the sole. And repeat until you get to your target line at the end of the leg. Rotate the leg to the adjacent facet and repeat the process. If you are getting tear-out, turn the leg 180° in the cradle and make a full-length stroke with the jack plane 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.

REMINDERS
I mark my planing cradle to indicate where each tapering cut should begin. This helps my legs look consistent.

When you get to the seventh facet, the leg can become unbalanced in the cradle. I deal with this by planing the seventh facet a bit and then the eighth facet, back and forth. You'll figure it out at the bench.

After the legs are at their final shape, cut the tenons on the ends. Cutting tapered tenons is just as simple as cutting cylindrical tenons. There are several ways to go about making both joints, depending on the tools at hand.

MAKE THE TENONS ON THE LEGS

There are many methods to make the tenons on the legs, from as simple as a block plane all the way up to a dedicated tenon cutter. The shape of the tenon needs to match the joint you plan to use in the seat: Either a straight-sided cylinder or a cone.

First we'll discuss tapered tenons. Then cylindrical ones.

You can shape a conical tenon using only a block plane if you like.

DUMMY MORTISES

These two mortises help me plane my tenons to the proper shape and size. The mortise at left was made with a 12.8° reamer. The one at right was a 6° reamer.

The trick is accurate layout and a dummy mortise that has been reamed so you can check your work. Here's how to do the layout:

When you make the mortise in the seat, you start by boring a straight hole that is usually 5/8" in diameter. Then you ream the hole. The goal is to have the small end of the hole remain 5/8", and the large end of the hole opened up. Its finished diameter depends on the included angle of the reamer and the thickness of the seat.

This sounds more complicated than it is. When using tapered joints, I first make a sample reamed mortise in 2"-thick scrap. Then I saw it in half. This sample joint answers all my questions about layout. If my seat is 1-3/4", then I know what the diameter of the tenon needs to be as it enters the seat. I also can use the sample mortise to check the fit of my tapered tenon as I plane it to shape.

Let's say the tenon is 5/8" diameter at the tip and needs to be 1" where it enters the seat. Step one is to taper my legs so they are 1"octa-

DRILL YOUR TARGET

A shallow 5/8" hole on the end of a leg is a quick way to lay out the taper for the tenon.

PLANE TO FIT

The dummy mortise shows me exactly where I need to remove material when making tapered tenons.

gons at their tips. This means they'll be bigger than a 1" octagon a couple inches down from the tip.

Find the centerpoint at the tip of the legs. Drill a shallow 5/8" hole into the end of the leg. This is your target diameter for the tip of the tapered tenon. Now press the leg against a stop in a vise and make tapering cuts with a block plane or jack plane to taper the leg rapidly down to 5/8" at the tip. You are both tapering the tenon and rounding it. When I make a shallow taper (such as 6°), I'll begin the taper about

6" from the tip of the tenon. For steep tapers (12.8°), I begin the taper about 4" from the tip of the tenon.

Once you get to 5/8" at the tip, show the tenon to your sample mortise. It will show you where you need to remove material. Keep working until you get a good fit all around.

Note that the tip of your tenon might end up being 1/2" in diameter or smaller. That's OK. The legs are over-long and will be cut to finished length after assembly.

TAPERED TENON WITH A TENON CUTTER

If you build a fair number of chairs, you'll want to invest in a tapered tenon cutter. These tools match the included angle of your reamer. So, all you have to do is rough out the tenon shape with a plane (as explained above) then finish it with a tenon cutter. These tools work like a giant pencil sharpener. If you don't want to buy a commercial one, you can make your own with a cutter from a handplane and a block of hardwood. Plans for this tool are widely available.

TAPERED TENONS ON A LATHE

When I have to make a bunch of tapered tenons, I will chuck the legs into the lathe. You can rough out the tenons and finish them with a tapered tenon cutter. Or you can try to get a perfect tapered tenon right on the lathe and compare it to a sample mortise. Once you do 20 tenons or so it gets pretty easy to hit the shape.

STRAIGHT TENONS: HOLLOW AUGERS

My favorite way to make straight tenons is with a modern hollow auger. These aluminum hand tools chuck into a brace or an electric drill and make perfect tenons. (Production shops even chuck them into a lathe.) With this tool you can both fine-tune the tenon's diameter and set the finished length of the tenon.

Each tenon size requires a dedicated tool, so it can get expensive. But these tools save lots of time. I own several. The most-used sizes in my shop are 5/8" in diameter (for sticks), 3/4" (for sticks in armchairs) and 1" (for legs, large sticks and posts).

There are some tricks to using them. The first trick is this: If you are going to use cylindrical tenons on a leg, cut the tenons before you taper

TAPERS WITH A TENON CUTTER

A tenon cutter adds speed and accuracy to the operation. Clamp the cutter in a vise to finish the tenon (top). The three stages of making the tenon with a tenon cutter (below).

ALMOST PERFECT

In production work, I rough out my tapered tenons on the lathe. It takes only a few turns in the tapered tenon cutter to finish the job.

the legs. This will make it easier to center the tenon on the end of the leg. A quick run-through of the process will illustrate why.

To cut accurate tenons, both the leg and the hollow auger need to be level to the floor. If one is off kilter, the tenon will veer off at a weird angle – as will the leg. So, step one is to put the leg in a vise and level it with a spirit level. This is why you should cut cylindrical tenons before tapering the legs. If the legs are tapered before cutting the tenons, it's difficult to level the leg in your vise unless you have a self-leveling laser and level the tapered leg with that tool.

The second trick is this: Make a sample tenon on a piece of scrap first (I usually use a dowel or a defective leg). This sample tenon will help you create a stop so you can make tenons of the correct length. The hollow auger can make tenons that are 3"-4" long (or a bit longer). You need to add a stop to the tool if you want tenons that are chair-length (I typically cut all my tenons to 2-1/4" long – then trim them to the final length.)

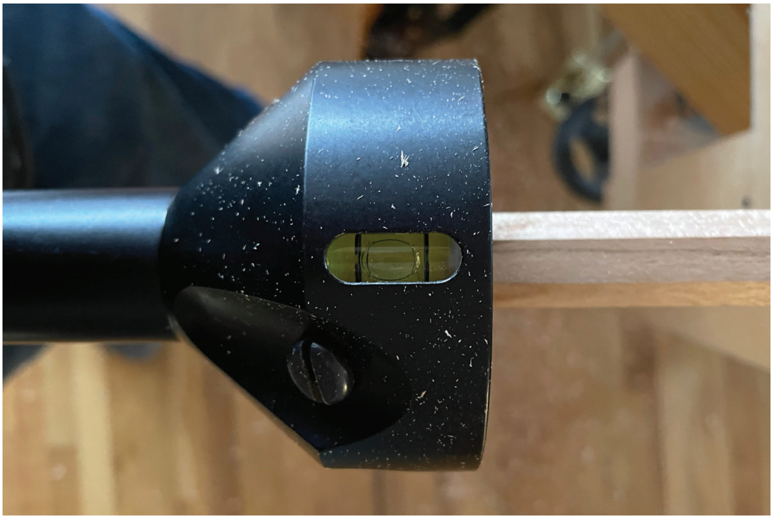
MODERN HOLLOW AUGERS

In just seconds, a hollow auger can make a tenon that is the right diameter and length.

To make the sample tenon, level the scrap piece in your vise. Press the hollow auger against the wood and adjust it until it is both in line with the scrap piece and level to the floor (there is a bubble level on the hollow auger to help you). Then cut a full-length tenon with the hollow auger. Centering the tenon on the stick requires some practice. One excellent tip from chairmaker Travis Curtis is to sight along the entire leg. Don't just look at where you are cutting. This is similar to when you drive a car. You will drive straighter if you look a mile down the road instead of right in front of the car's hood.

Measure the resulting tenon on the 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 scrap, check the diameter of the tenon and make sure it's cutting the right size for your chair. If you aren't



LEVEL THIS & THAT

To ensure your tenons are centered, first level the leg in your vise (top). Then make sure the hollow auger is level (below) before you start cutting.

DEPTH STOP FOR A HOLLOW AUGER

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

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 hollow auger if you first taper the tip of thre stick so it will enter the mouth of the plug cutter. After that, it's all about keeping the cutter straight and level.

STRAIGHT TENONS WITH PLANES

There are a couple good ways to make a cylindrical tenon using a handplane. My friend Chris Williams takes the John Brown approach. You think "round" as you plane, skew the plane radically and test your

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.

NOW IS GOOD

After I cut the tenons on my legs I cut the kerf for wedging them. It's easy to forget to do this before assembly.

tenon in a sample hole. The hole also tends to compress and shape the tenon. It's the simplest method, but it takes some practice.

Maybe it's actually not the simplest method – the first cylindrical tenons I made were whittled with a sloyd knife in my backyard.

STRAIGHT TENONS WITH A BEDAN TOOL

When there are mountains of tenons to make, I use my lathe and a bedan sizing tool to make tenons for legs and stretchers. 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.

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.

KERFING FOR WEDGES (OR NOT)

Before assembling the undercarriage of a chair I usually saw 1-1/2"-long kerfs that split each tenon. These kerfs make it easier to wedge the tenons during assembly. I usually use a tenon saw to make the kerfs, but in large scale work, I'll use a handsaw or a band saw (these saws make wider kerfs).

Many chairmakers don't do this. They split the end of the tenons with a chisel after the undercarriage is glued up. I've done this several times as well. Sometimes on purpose. Sometimes because I forgot to saw the kerfs in the tenons.

After you finish making your legs you can position them in the seat.

THE DOUBLE-CHECK

After you have made the legs and reamed all the mortises, 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.)

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 or meter stick 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.

NUMBER FOR SAFETY

I mark my legs the same way every time. This has prevented some serious errors at assembly time. Also, the seat is propped up on two softwood battens on the benchtop to allow the tenons to seat all the way in their mortises.

DEAL WITH A WONKY LEG

When you have all your legs knocked into place, you might want to see how well your drilling and reaming went. You can investigate this with winding sticks or in a variety of other ways.

I think the best method is this: Put the chair on the floor and stand about 6' away. Walk around the chair while looking at the legs. Small errors in the angles are almost impossible to see. Heck, large errors are sometimes difficult to see.

If you have to actively look for the error to see it, I wouldn't try to fix

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.

SIGHT OFF THE SEAT

You can check your drilling skills in many ways. Some people put winding sticks on the legs. You can sight off the front edge of the seat as shown or with the chair on the floor.

it. Many times, the "fix" makes it worse. One more thing to consider: I have looked at hundreds and hundreds of these chairs since the 1990s. I have yet to see an antique one with perfect legs.

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 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 mostly a design decision. They add visual 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.

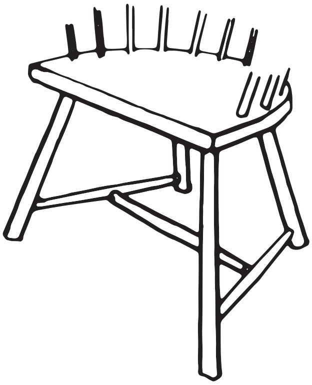
• The H-stretcher is the most common arrangement. It is durable and easy to execute. The medial stretcher is a nice place to rest your heels. Some chairs have two (or more) medial stretchers. Additional medial stretchers add strength and create a shelf for a hat or a purse.

• 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.

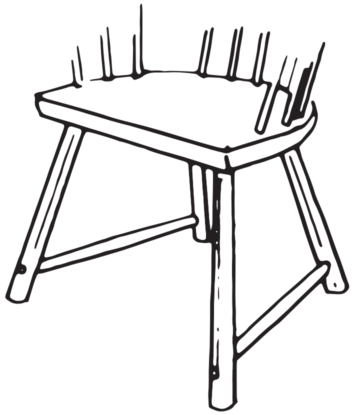
• Occasionally a chair will have an H-stretcher plus an additional stretcher between the rear legs.

• 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 wear and should be made from the 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.

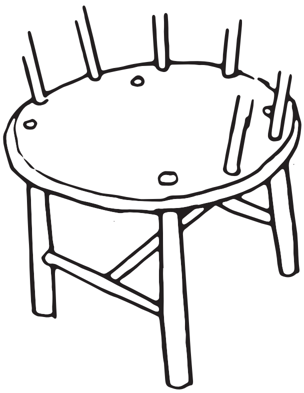
• The typical box- or H-stretcher arrangement can be rotated 90°



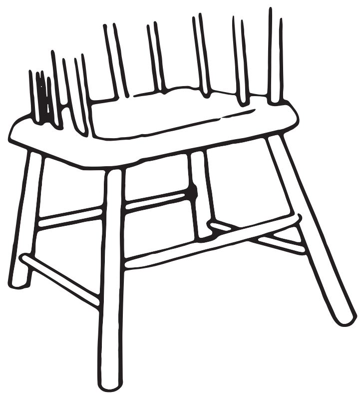
H-stretcher



Side stretchers

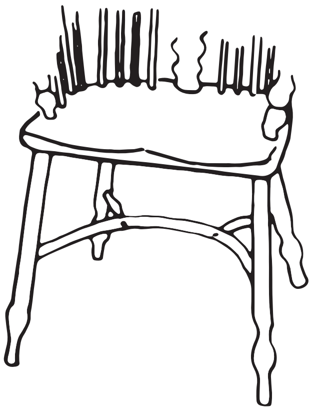


H-stretcher rotated 90° (rare)

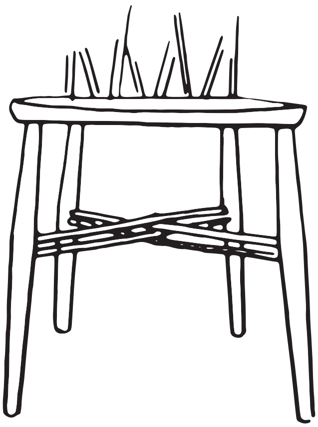


Box stretchers

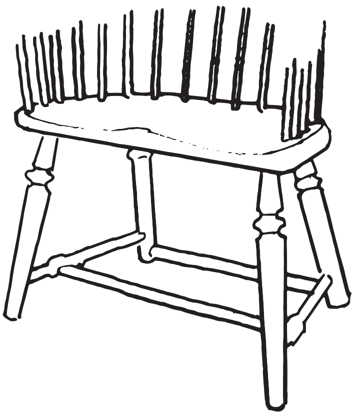
STRETCHER PATTERNS



Crinoline stretcher



X-stretcher (rare)



H-stretcher with back stretcher (rare)

STRETCHER PATTERNS, CONTINUED

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 but old feel (not a bad thing).

from what is typical. This is fairly rare and looks odd. (Dont 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 stick 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.

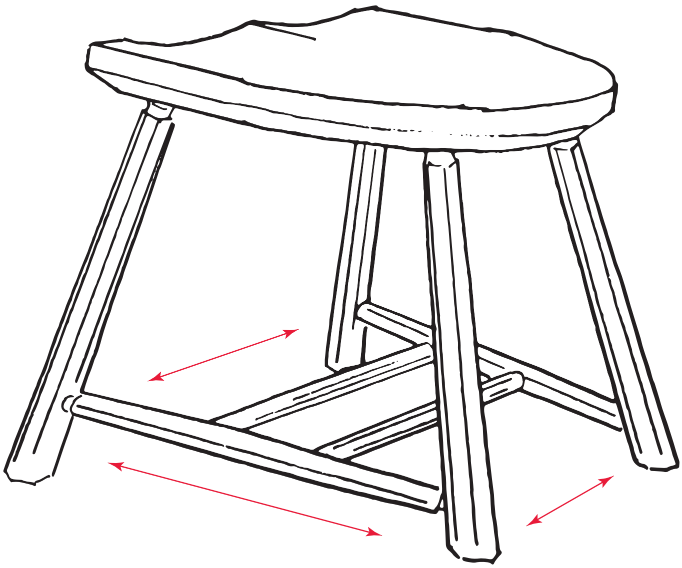
somewhat easier to repair. You heat the joint to make the glue elastic then pry out the wedge. Then the joints comes apart easily.

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). 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 simple to make. But they aren't as appealing to people who like expressed joinery. They don't have as much gluing surface as the through-tenon, and they aren't usually reinforced with wedges. Repairs require you to inject alcohol into the joint to crystallize the glue heat the joint with a heat gun to loosen things up.

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 hollow auger. 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" in diameter, when on the small side, up to 1-3/8" on the thick side. 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.

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 tab 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.

Is this necessary? I don't know.

What do I know? Well, I've done it both ways. To be honest, I prefer to add tension, which is what I was taught to do. When you assemble an undercarriage with tension, it's a bit of a fight. All the pieces get tighter and tighter as you drive the legs into the seat. It can feel like you are one mallet blow away from disaster.

When I glue up a chair without tension, it goes together easily. I feel like it might fall apart easily. But I could be wrong.

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 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 hand-planes, spokeshaves and scrapers. So they follow these basic patterns:

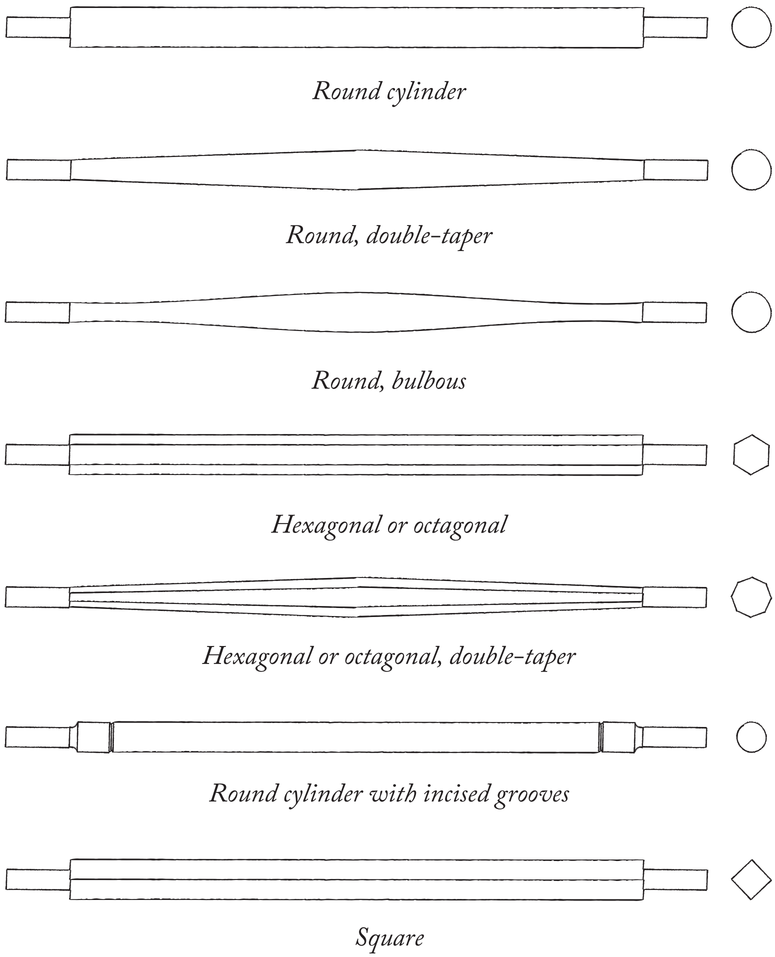
• A straight-sided round cylinder.

• 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 faceted. 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.



SHAVED STRETCHER SHAPES

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 has to intersect the legs – which 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 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 simple to explain.

There are fancy jigs for laying out stretchers. I have used them, 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.)

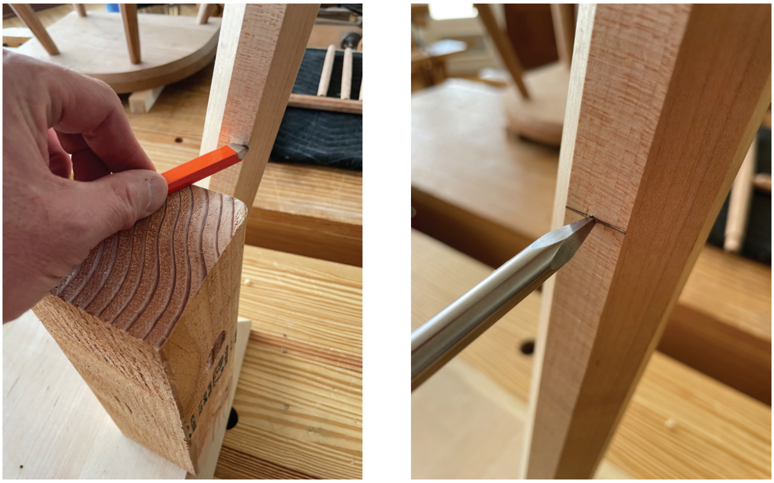
With the seat upside down on your benchtop, place the 11" 4x4 on the seat. Slide it over to one of the legs and use the half pencil to scribe a line on the facet that will receive a mortise. Repeat this for the other three legs. Take an awl and – by eye – poke the midpoint of each of the four lines. The layout for the stretchers is complete.

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



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.

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 one for this method. You simply take your drill, put the tip where the mortise will go and drill the mortise by eye. The trick, is, of course, to hold the drill in the correct place.

I use a 5/8" spade bit 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 help guide you. Honestly, this offers enough guidance for me.

ALL THE GUIDANCE YOU NEED

Use the block that marked the stretchers to drill the mortises. Sure, you can fetch your laser. Or you can be done. Note the line drawn on my drill. That helps.

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, stop drilling when you can feel the lead tip of the bit just start to emerge on the far side.

(Note: If you use one of the fancy bits that are designed to drill without a backing block, you can drill straight through the leg and skip the next steps.)

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.

A SNUG FIT

To keep it from popping out as you drill, the plug needs to be tight in the mortise. Add blue tape as necessary.

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 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 come around to the other side of the mortise and place the tip 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.

DRILL FROM THE OTHER SIDE

The plug is a big help as you align the drill. And it prevents the bit from crashing through the leg and splintering the surrounding wood.

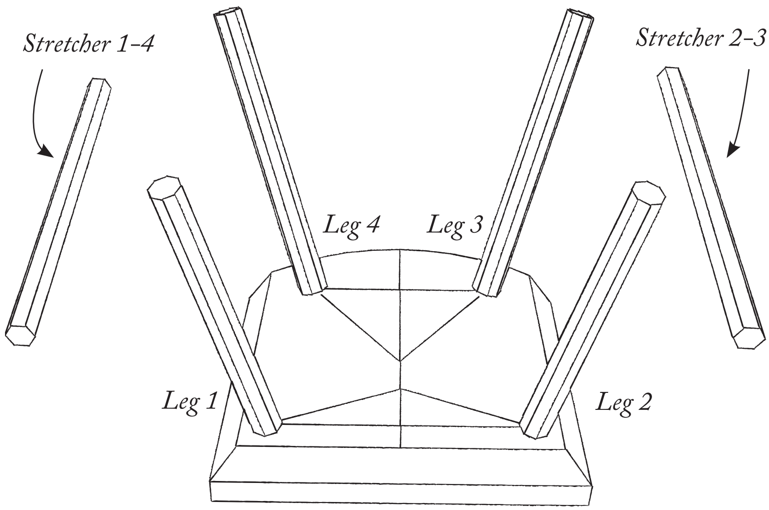
1. Have a friend tell you when the drill is in line with the dowel.
2. Use a laser like you did when starting the mortise.
3. Swing your head and shoulders around the chair so you can see the dowel and your drill. This usually is enough to keep me on target.

Drill out the end of the mortise. It should take only a few seconds. 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 even make a little drawing of each stretcher with dimensions and details so that I don't get confused.

Each stretcher gets a name, and that name derives from the legs it



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.

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.

To measure for a stretcher with blind mortises, get two pieces of skinny scrap – I use the triangular bits that are sawn off my legs when I turn them into octagons. 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.

With a pencil, make a few tick marks that pass across both scraps. These tick marks will 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 rim of the mortise on the scraps. These marks tell you how long each tenon should be.

MAKE THE STRETCHERS

MARK & MEASURE

Two skinny scraps allow you to determine the length of the stretcher and the length of its tenons. After you mark the tenons, tick marks help you reassemble the scraps to determine the overall length of the stretcher.

MEASURE FOR THROUGH-TENONS
With through-tenons you need only one piece of scrap. But you need to mark both ends of the tenons.

Remove the scraps and reassemble them using the tick marks. Now you can record the entire length of the stretcher and the length of each tenon. Add 1/8" to the overall length of the stretcher and write this information down. This additional 1/8" adds the tension to the undercarriage.

MEASURE FOR THROUGH-TENONS

If your tenons go through the legs, you need only one piece of skinny scrap. Thread it through both through-mortises. Mark the length of the stretchers between the legs. Mark where the tenons emerge from the outside of the leg. Remove the scrap, add 5/8" to the overall length and write this information down.

MEDIAL STRETCHERS ARE EASY

After you install the side stretchers, follow the same steps to install the medial stretcher(s).

Of that 5/8", add 1/8" to the length between the legs to add tension to the undercarriage. And add 1/4" to the length of each tenon. You need the tenons to stick out a bit to wedge them. Now you can make the stretchers that go between the legs and cut their tenons.

STRETCHER TENONS

Making the tenons on the stretchers is like making cylindrical tenons on the legs. You can use a 5/8" power tenon cutter, a dowel/plug cutter, a lathe (with a bedan sizing tool for precise joints) or make the tenons with planes.

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 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 length of the medial stretcher and its tenons.

JACK TO ROUND

Using the jack one-handed, remove the facets from the octagonal stretcher. Keep working until the stretcher is round.

Note: Some people use 1/2"-diameter mortises for medial stretchers. Others use 5/8". It depends on how beefy your side stretchers are.

SHAPING STRETCHERS

Like shaping legs, shaping stretchers begins with straight-grain stock. Warning: Stretchers are thinner than legs. They are horizontal. And so, they are vulnerable to kids stepping on them and snapping them. You can get dead-straight grain in your stock by sawing it, riving it or a combination of the methods. Then make it square and then make it octagonal. These methods are covered in the chapter on legs. After that, decide on the final shape of your stretchers.

CYLINDRICAL STRETCHERS

The most common form of stretcher on a stick chair is the straight cylinder. While these look turned, they are shaved round with handplanes or spokeshaves. Start with square stock. Shave it octagonal. Then shave it round.

FINISH WITH THE BLOCK

Refine the surface and remove any tear-out with a block plane. Its mouth needs to be tight.

I prefer to first cut the 5/8" tenons on the ends of the stretchers when the stock is octagonal (this is covered in the chapter on legs). Then shave the facets with a jack plane until all the wide flats are tiny flats. If I want the stretcher to look and feel turned, I'll scrape and sand it.

Just like with the chair's legs, I work against a stop in a vise or on my bench. My left hand holds the stretcher at the rear tenon and presses the other tenon against the stop. My right hand holds the plane. The action is simple: Shave and rotate. Over and over.

You can blend the cylinder in with the tenon using a curved bottom spokeshave. Or knife the transition between the stretcher and tenon.

BULBOUS STRETCHERS

The second-most-common shape is the bulbous stretcher. This form is found on both stick chairs and high-style pieces. The stretcher appears turned, but instead is shaved with edge tools. These stretchers are thicker in the center of their length, which is where the joinery for the medial stretchers is located. The extra wood shores up the joints.

There are lots of ways to make this stretcher. When I make them, I

BULBOUS STRETCHERS

Make the stretcher round with the jack. Then taper the ends down to the tenons. Finally, use the block (skewed) to refine the curve from the bulbous center to the tenon.

SUBTLE SHAPE

I prefer my stretchers to have subtle curves. You can make them more dramatic by shaving out the areas between the bulbous center and the tenons.

prefer to first cut the tenons on the ends of the stretcher blank and then shape the bulbous section and its transition to the tenon.

As with legs and sticks, I do this by working against a stop. One hand holds the work, the other moves the plane. First work the arrises of the piece with a jack plane until it is basically round.

Next it's basically a taper cut, but you avoid cutting the thick center as much as possible. Skew the jack plane as much as possible so you can make the quick transition from thick to thin. Another way to make this shape is with a spokeshave. The spokeshave doesn't need to be skewed and can be pulled toward you.

After you rough out the stretcher with the jack, finish the stretcher with fine cuts using your block plane or shave. Scraping and sanding can add even more refinement (but can remove texture).

DOUBLE-TAPERED STRETCHERS

While not as common as the shapes above, double-tapered stretchers are found on historical stick chairs. The stretchers can be hexagonal or octagonal.

ADD TAPERS

Planing a double taper is easy in a carver's vise. The jaws rotate to hold tapered shapes.

I make these while holding then in a carver's vise. I make the initial cuts with my jack plane. It removes material quickly but might tear the grain here and there. I then clean up the cuts with my smoothing plane. When sharp, it will remove shallow tearing left by the jack.

The transition between the facets and the tenon is (mostly) a design decision. Some chairmakers want their stretchers to have a shoulder and to jam that shoulder against the leg. Other chairmakers allow the tenon to swell, which restrains the tenon like a shoulder. And with blind tenons, the end of the tenon can restrain everything.

TURNED STRETCHERS

When making stick chairs, I avoid using the lathe to make the stretchers. Yes, it's fast. But the results always look off to my eye. It's a funny problem. The stretchers of a lot of historical stick chairs are trying to pretend that the maker owned a lathe.

So why not use a lathe? I've approached this question head-on at times. I've made stretchers with lathes, and they always look unsatisfactory. They are too round and too perfect. When I make the stretchers with planes and spokeshaves, their surfaces match the legs, especially when I blend the facets of the legs into a roundish shape as they enter the seat.

Honestly, I might be a little too particular on this issue. And I might be the worst turner in Kentucky, to boot. If you are handy on your lathe, make some stretchers and decide for yourself.

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 lucky, 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 sticks together – one for the sitter's right hand, one for the spine and one for the left hand.

On the other hand, a chair's arms can have insanely 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 and 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

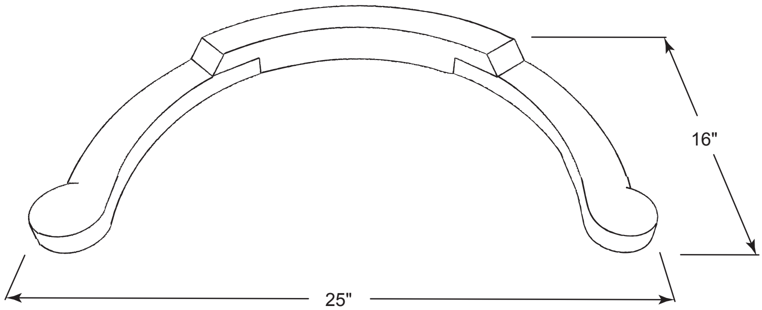
The mechanical goal of every arm on every good stick chair is simple: Avoid short grain as much as possible. If you plan to build your chair with two separate, disconnected arm pieces, things are simple. You can easily find two sticks to do the job and avoid weak short grain.

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 over a form to make a 180° curve.

• Saw up a bunch of thin (1/8"-thick) pieces of veneer. Apply glue



TYPICAL PIECED ARMBOW
The-three-piece armbow is strong and can be made easily with boards from the lumberyard.

to their faces like spreading butter on bread. Bend them over a curved "form" that represents the arm's final shape. Let the glue dry. This 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 eliminates short grain, sometimes adding a piece called a "shoe" to the top to cover and strengthen areas of short grain.

TYPICAL DIMENSIONS

Arms can vary quite a bit. A steambent arm might be 1" thick and 1-1/2" 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

GET YOUR ARMS IN THE AIR

I spotted these curved branches on a tree on the grounds of St Fagans, the national history museum of Wales. It could be one massive armbow or several 90° bends, depending on how you cut it.

or take. In a strong material, such as oak, I'll accept 7/8" thick. For width, I like 1-3/8" wide for arms that I've bent. And about 2-1/4" 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 glue.

When assembled, the armbow is oversized compared to the seat. If my seat is 20" wide, then my armbow will 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 the 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, the arms can vary a lot in a stick chair. 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. The North American forest tends to produce arrow-straight tree trunks as the leaves stretch upward for sunlight.

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. 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, really. 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

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.

are ideal for arms. (Thanks to chairmaker John Porritt for showing this trick to me.)

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, a way to make steam (I use a wallpaper steamer), a bending strap and a form. The biggest challenge, however, is getting the right wood. The grain has to 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 needs to be rehydrated before bending. Cut the stick to shape then soak it in 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 couple weeks, 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 few days 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 my eye. Basically, making a bent lamination involves sawing multiple thin strips of wood from a board in sequence. You apply 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 can look a bit 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. It's like steambending without the steam, strap or failure. I've had only one failure in 10 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 $150. When I sell a chair for $1,400, a $50 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

COLD-BENDING

My favorite 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.

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 acclimates to your shop's equilibrium moisture content.

The comp wood is indistinguishable from wood that has been steambent, 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 to four bits of wood that are sawn

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, then 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.

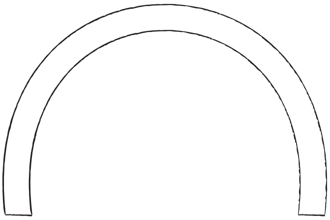
and glued to avoid short grain. A pieced armbow allows you to use flat boards from the lumberyard (or sticks from your backyard) and, with a bit of cleverness in selecting the grain, create a sturdy armbow.

The joinery can be as simple as butt joints and glue, or as showy as mitered lap joints or long scarf joints.

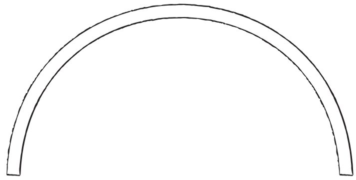
Making a pieced armbow begins with choosing the shape of the arm, choosing the joinery, then making patterns for the parts.

ARM SHAPES

Like seat shapes, most armbow shapes are simple geometric forms – mostly arcs and rectangles. A few arms look triangular, but those

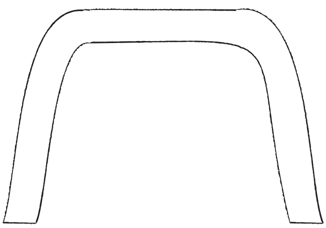


D-shape arm

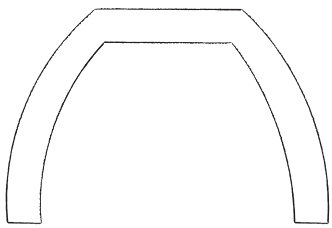


C-shape arm

Arc segment

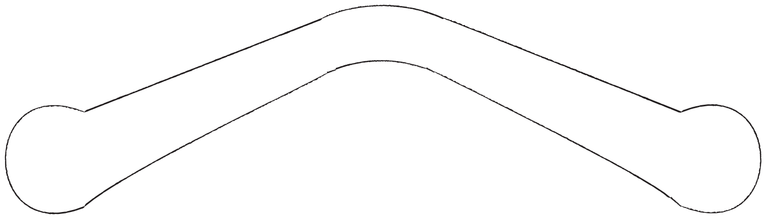


Square back

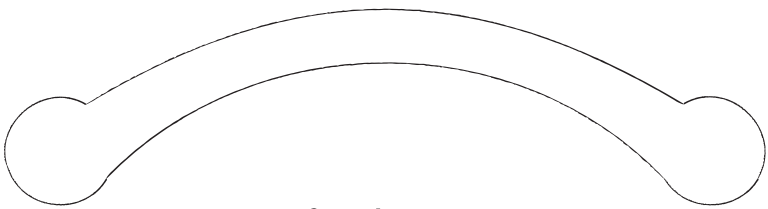


Square back,
rounded arms

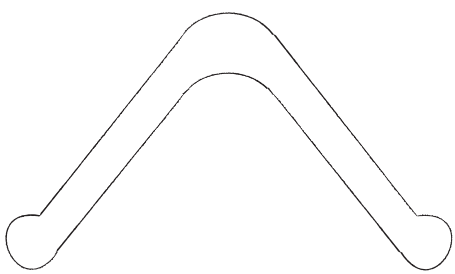
COMMON ARMBOW SHAPES



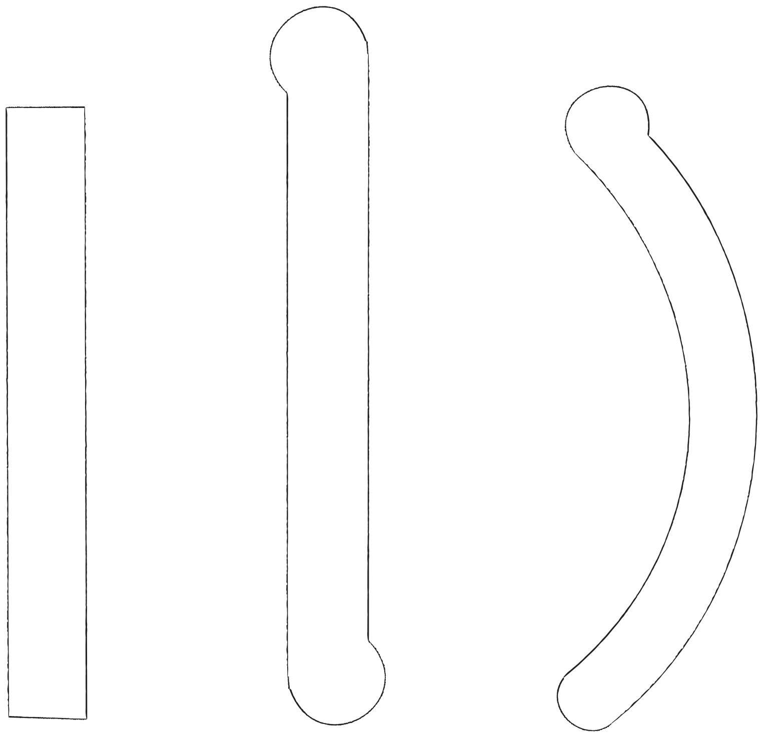
Triangular root arm



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).

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 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 branch. These arms look dramatic, but they aren't as comfortable.

Of course, if you aren't making an armbow, then choosing the shape of your arms is much easier.

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. When I teach chairmaking, this is the armbow we start with. It's the least challenging and has a low risk of failure.

When made well, the butt-joint armbow is durable but isn't flashy. Making it is straightforward: Plane the two ends of the arms simultaneously until they are true. Then drill a couple pocket holes in one of the arm pieces. Apply glue and screws to pull the joint together.

After the glue is dry, cut the shoe to shape and glue it on top.

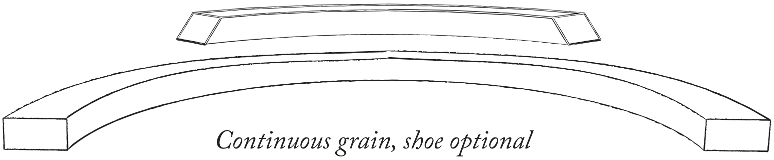
If you prefer complex joinery, you can use a half-lap or scarf joint to join the pieces of your armbow. These joints are simple to cut and look nice. If the grain runs continuously through each piece of your armbow, you don't need a shoe. If you do have short grain, a shoe is required.

The illustration on the next page shows some common ways chairmakers make 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.

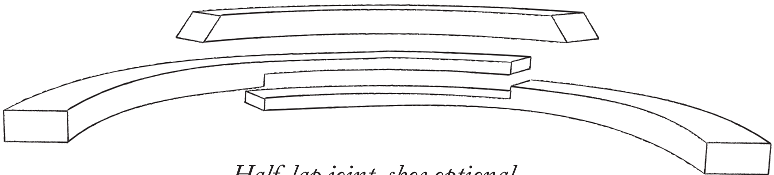
Making the complex joints is more fussy than difficult. When I make them, I saw out the half-laps and true the surfaces with a shoulder plane. The trick is getting the ends of the half-laps mated tightly. First, saw them closely. Then press the joints tightly together, clamp them in place and run a fine saw through the joint, which trims both pieces. After a cut (or three) the pieces should mate tightly.

CHOOSE YOUR HANDS

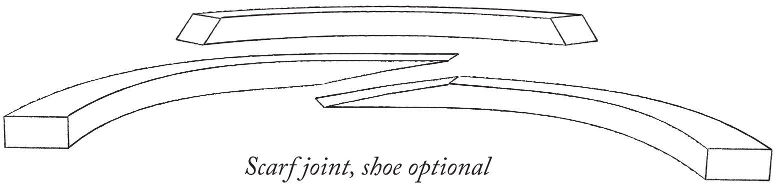
The last thing to do before making the patterns for your arms is to decide what sort of "hands" the arms will have. The hands can be as



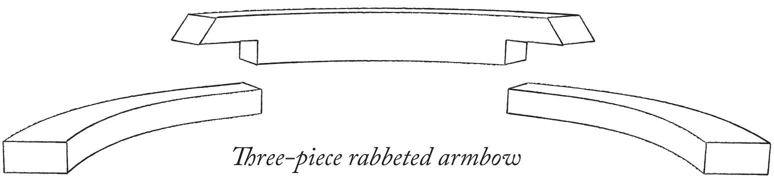
Continuous grain, shoe optional



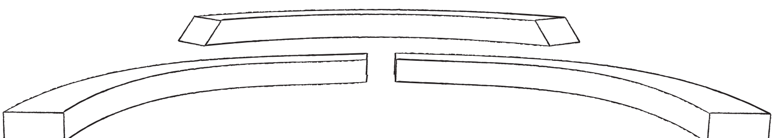
Half-lap joint, shoe optional



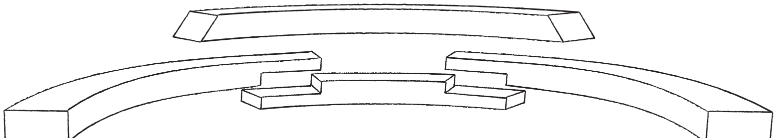
Scarf joint, shoe optional



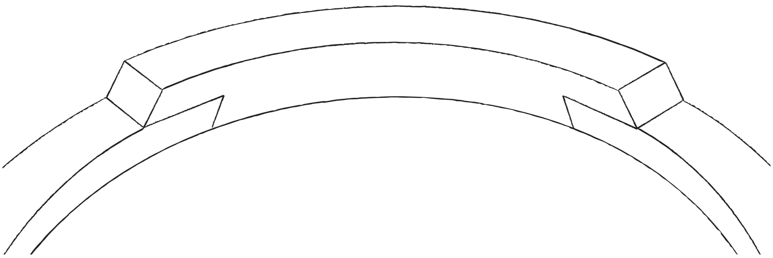
Three-piece rabbeted armbow



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.

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 a drink.

Sometimes I draw the 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 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

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.

pattern as a starting place makes my next design far, 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.

Then I decide if the armbow needs a shoe or not. The shoe, which is the 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.

I've built several chairs without a shoe, but I always prefer to add a

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.

shoe for durability.

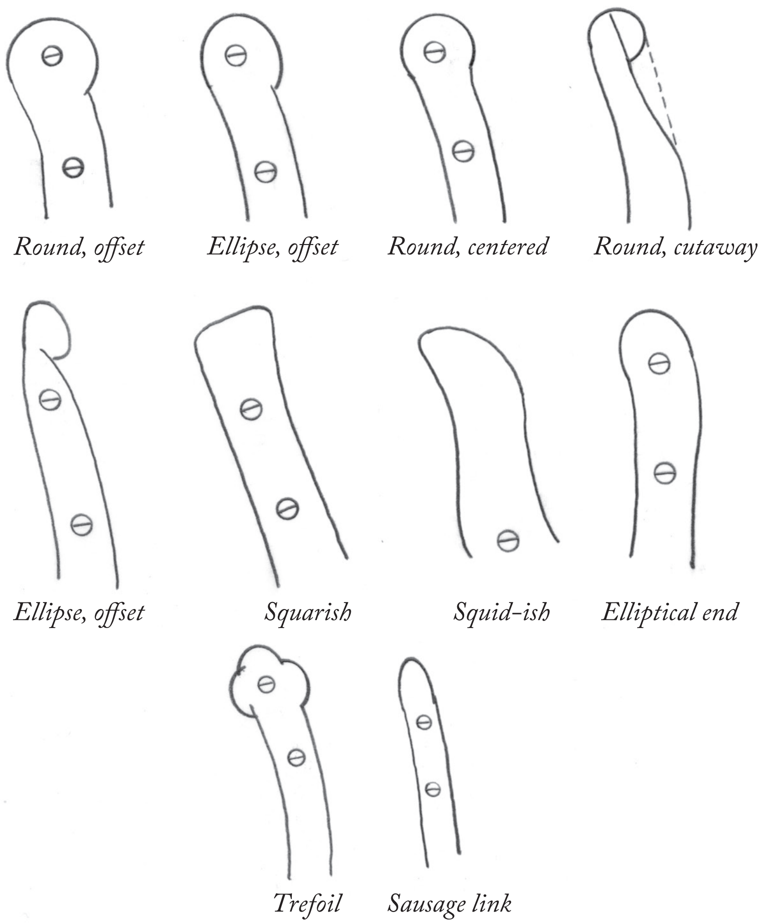
Once I have my patterns finished for the arm, I also make a pattern for the shoe. I usually make the shoe's pattern 1/8" wider and 3" longer than the desired finished size. This gives me some flexibility with my chair's design – I might have to add some sticks to the back.

PICK THE GRAIN

Now you can use your patterns to mark out the parts for your arms. 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.

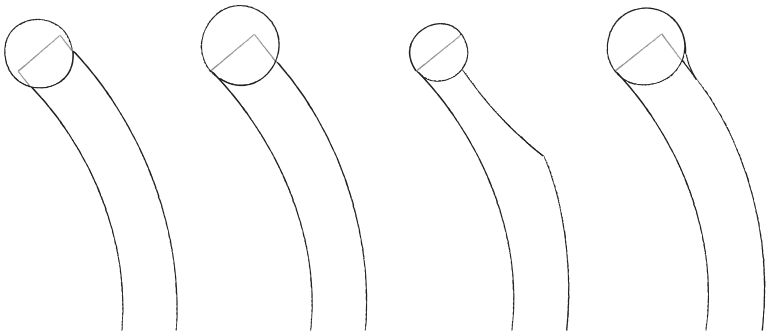
The hands of the arms should have little short grain. The grain should be as straight as possible through the hands. The area of the arms that gets covered with the shoe can have considerable short grain. The shoe is there to reinforce it.

The shoe typically doesn't have a lot of curve to it, so it's pretty easy



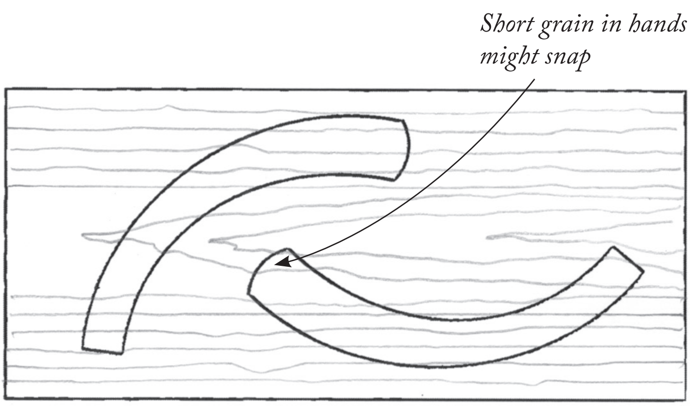
SOME BASIC HAND SHAPES

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

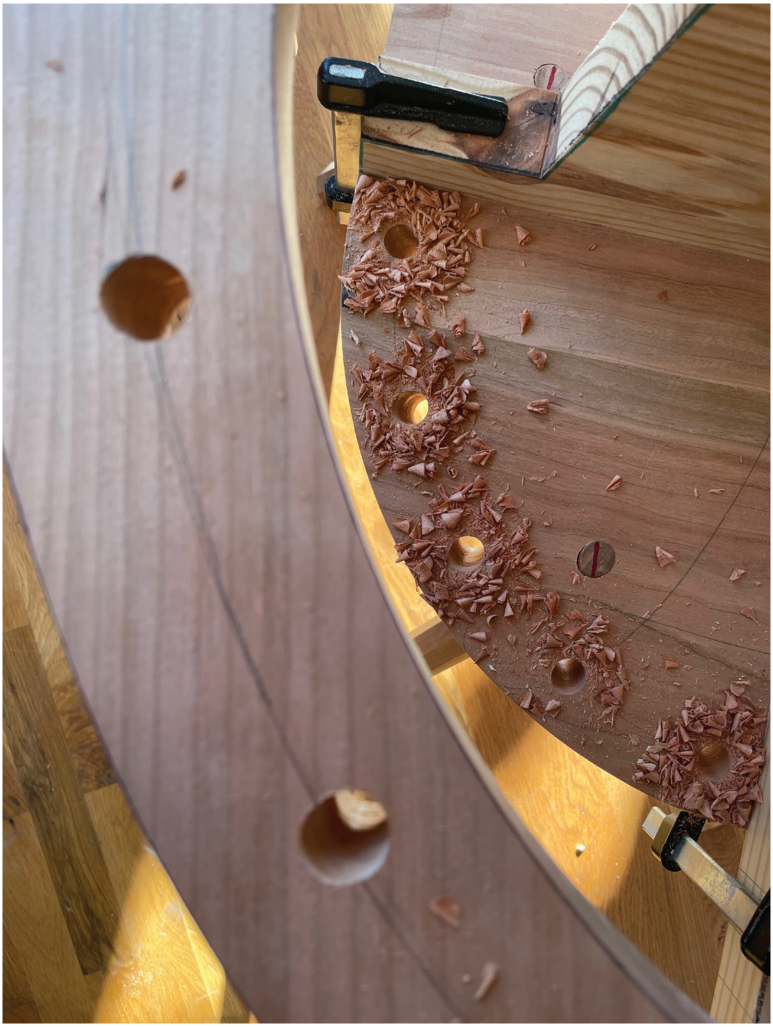
Keep the short grain near the head joint of the armbow, and the shoe will cover the short grain. Short grain in the hands can snap during assembly.

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.

to avoid too much short grain, though sometimes you'll get a little at its very ends. With arms, nothing is completely perfect. Do the best you can. The next arm will be better. Maybe perfect.

With all the parts drawn out on your wood, saw out the arm parts, cut any joinery and use rasps to smooth all the curves or bevels. Then glue the arm into one solid piece.



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 drilling the mortises for the stretchers. 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 2000 that I can buy to make this dirt simple?

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 10 years or so). 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 about 2" in from the perimeter of the seat. The mortises in the seat are about 1" from the perimeter. Mark a line for the mortises. If you are working from plans, mark out 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. You can use a marking gauge with a pencil, or merely use your fingers as a fence against the seat (as shown here).

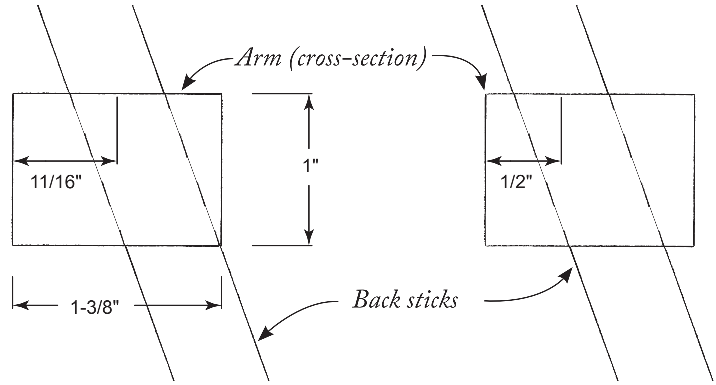
THE ARM-DRILLING JIG

There are ways to drill the mortises for the sticks without the arm-drilling jig, 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 this jig.

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.

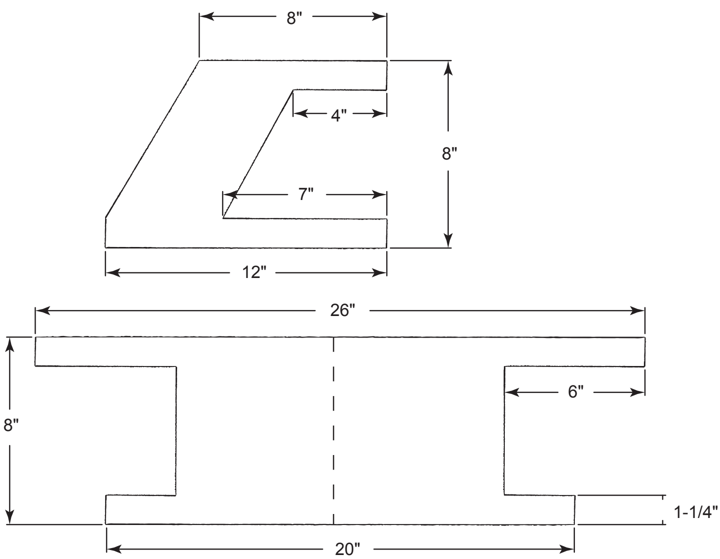
I make the jig from 2x10 construction lumber. The longer front board clamps near the front of the seat to hold the hands of the armbow. The smaller back board clamps to the rear of the seat and supports the back of the armbow.

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.

The width of the jig represents how far above the seat your arm will sit. I usually use 8", though 9" common. Sometimes I use a 9" 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:

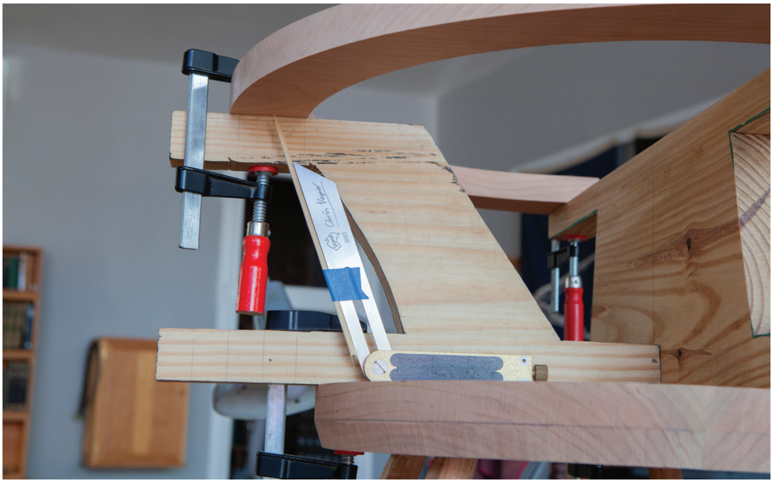
• Centerlines on the edges of the jig. One centerline where the jig touches the seat. One centerline where the jig touches the armbow.

• Inch marks on the top edge of the jig.

DRILL THE ARM & SEAT

LINED UP FOR DRILLING

The head joint of the 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.

These marks help you position the jig on the seat and the armbow on the jig. Clamp the jigs to the seat. Then lay your armbow on the jigs.

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.

Typically, the mortises on a seat are equally spaced. A good place to start is to space them every 2-7/8" or 3". That's where I usually begin when I design a new chair.

The spacing of the sticks 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 move things around.

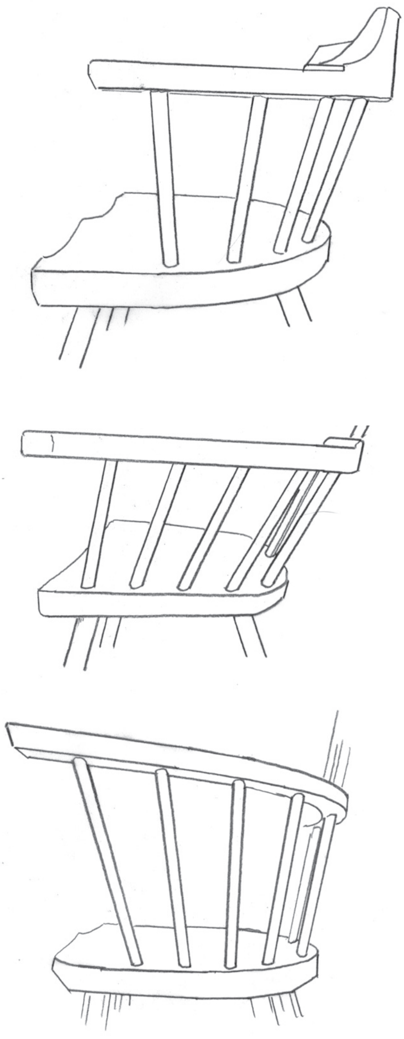
The short sticks can vary quite a bit. Here are some typical arrangements to consider.

• 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 further (up to 15°) to add some forward motion to the chair. These 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.

The method I use to space the 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.



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.

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 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.

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.

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 separation between the back sticks and the short sticks.

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 use 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.

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, 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.

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. Note the handscrew clamped to the leg that I'm standing on. This is helpful if you are working on a smooth floor.

USING A SPOTTER

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. Here a laser is assisting in the operation. You don't need a laser. 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.

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, the bar of a clamp, a stick.

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.

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

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.

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.

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 longer. 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. But don't remove the arm from the jig just yet. The clamped-up arm, jig and seat can help you determine the final length of your sticks.

A THREE-LEGGED FRIEND

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).

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 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.

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.

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 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 using well-chosen dowels from the home center.

In the end, all that really matters is that the grain is straight, the wood is dry and the sticks are the right size to do the job.

DIMENSIONS, SHAPE & MOISTURE

Sticks can vary in diameter quite a bit. Many antique and modern stick chairs have sticks that are 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 1"-diameter tenons).

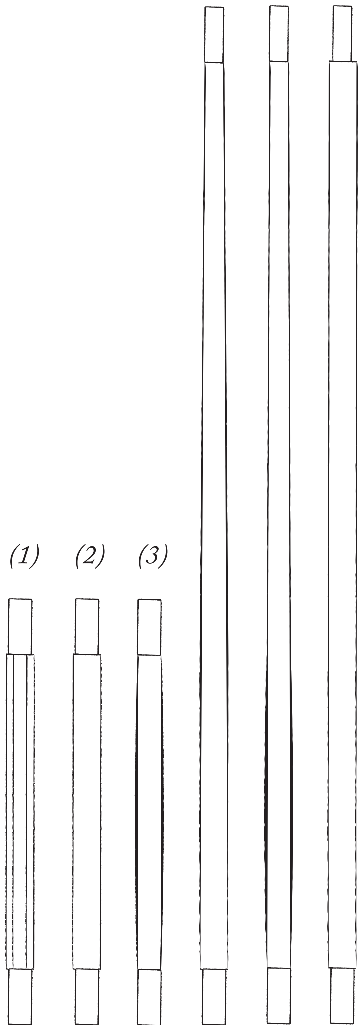
The other thing to consider is the shape of the stick. Sticks can be a straight-sided cylinder – like a dowel. This is quite common. I have spent hours enlarging photographs of chairs (and looking at them in the wild) and found lots of straight sticks, particularly the short sticks that run between the seat and the arm.

Some chairs have sticks with a subtle bulge along their length, called entasis. Let me repeat the word "subtle" so you don't make the same mistake I did. When I first started making sticks, they looked like a snake that had swallowed a corn dog. The difference between the thin and thick parts was dramatic – 3/8" or a little more. Now my sticks might be 3/4" or 11/16" in the middle and 5/8" at the ends.

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 little entasis. But above the arm, the stick has a straight taper as it heads toward the comb.

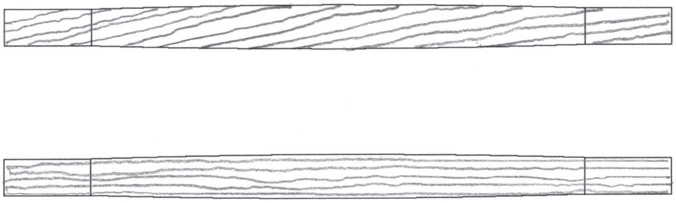
(4) (5) (6)

(1) (2) (3)



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.

Typical back 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 tapers from 5/8" to 1/2" at the comb.

But sometimes the sticks don't have entasis and they don't taper. They are cylinders along their entire length. Other times, the sticks really are sticks – pulled right from the hedge or a tree – and they have a rustic shape.

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 will remove all the water from their sticks by keeping them in a kiln. After assembly, the sticks will 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, get the straightest-grain stuff you can and ensure the grain runs continuously

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 it has some challenges (color, for the most part), you shouldn't be ashamed to use it.

from one end of the stick to the other. Short grain in a stick is typically a disaster. It can snap under normal daily use.

And if you ever wonder if a stick is strong enough, hit it with a sledgehammer as described earlier. That will give you the 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, I had to collect hundreds of dowels for these beginners' chairs. 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-

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.

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 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 the 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.

MAKE STICKS WITH A DOWEL MAKER

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.

After a couple years of working with the machine, I mastered its controls. But the learning curve was steep (for a journalism major). There are lots of adjustments to make to create nice dowels. For a production setting, making 100 dowels in a day, the Dowel Maker is ideal. It was far superior (and cheaper) than ordering custom dowels from manufacturers. Even the custom dowel manufacturers I've worked with don't truly comprehend the idea of "straight grain."

There also are "rounding planes" and other dowel-making jigs that can make sticks quickly. However all these tools make sticks that need considerable clean-up with planes. That's why I concluded that if you make stick chairs for yourself or make just a handful to sell, you are better off sawing them to shape and shaving them with handplanes.

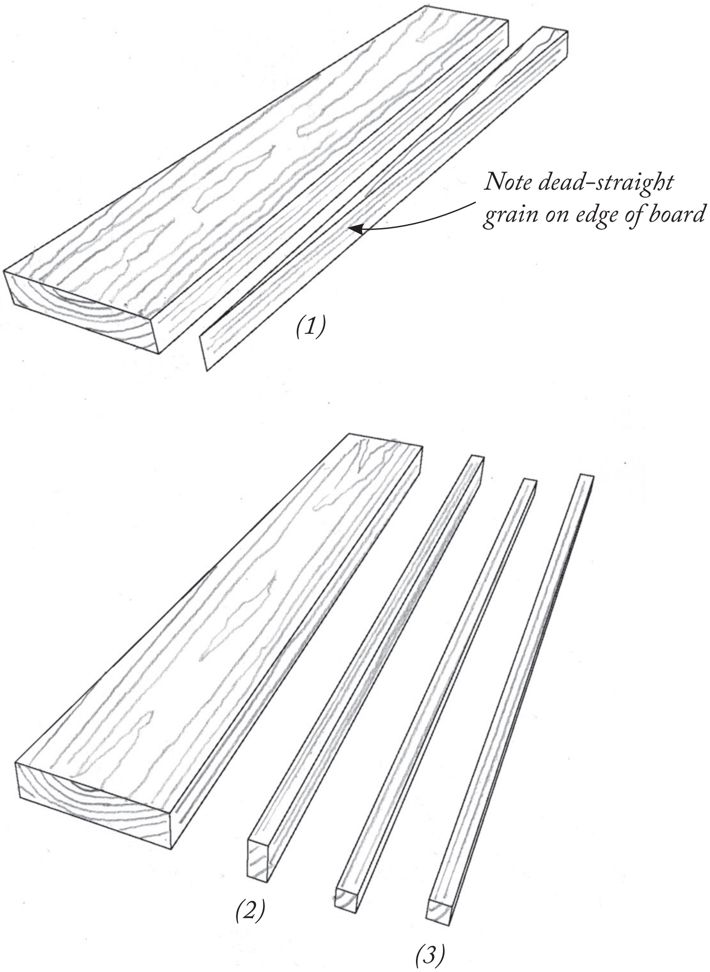
SAWING OUT STRAIGHT-GRAINED STICKS

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 38" long. That length allows me to cut one long stick or three short sticks from the blank with ease.

Then I make a saw cut on the face 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 38" will provide all the sticks I need for a typical chair (with sticks left over).

After I slice up the board into 3/4" x 3/4" x 38" lengths, I find the

MAKE & SHAPE THE STICKS



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.

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.

best sticks for the long back sticks. Then I'll look for short sticks and cut those to 12-1/2" long. Then I make them all into octagons, usually at the band saw.

Safety note: Yes, you can make your sticks into octagons on the table saw, but I do not recommend it without special push sticks. Your fleshy bits will be too close to the blade. The band saw is the safe choice.

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" octagons. I have found that sawing sticks gives me a better yield than riving them.

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.

MORE SKEWER STUFF

After drilling the mortises in the armbow and the seat I use barbecue skewers to determine the final length of each stick. The length can vary depending on the pitch of the stick and how deep the mortise is.

THE LENGTH OF THE STICKS

No matter how I get my sticks from a board, I turn them into octagons using the band saw or by planing their corners. Then, if the chair is a new design, I determine how long the sticks should be.

I usually do this by measuring things after drilling the mortises through the armbow and into the seat. I take a dowel or bamboo skewer and thread it through the arm and into the seat. I mark the dowel or skewer where it enters the seat and the armbow. Then I know how long each stick should be. Here's the formula:

Depth of mortise in seat + space between seat and armbow + thickness of arm + 1/4".

I write this information down. Now I know the final length of every stick and how long the tenons need to be. At this point I cut all my

TWO TENONS

When tenoning the short sticks, you can do both joints with one setup if you use a Hi Vise or handscrew to hold the stick.

PARALLEL TO THE FLOOR

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.

LEVEL THE TOOL

The tenon cutters have a bubble level. Use it. Otherwise, you will experience the same tenon troubles you get with a stick that hasn't been leveled.

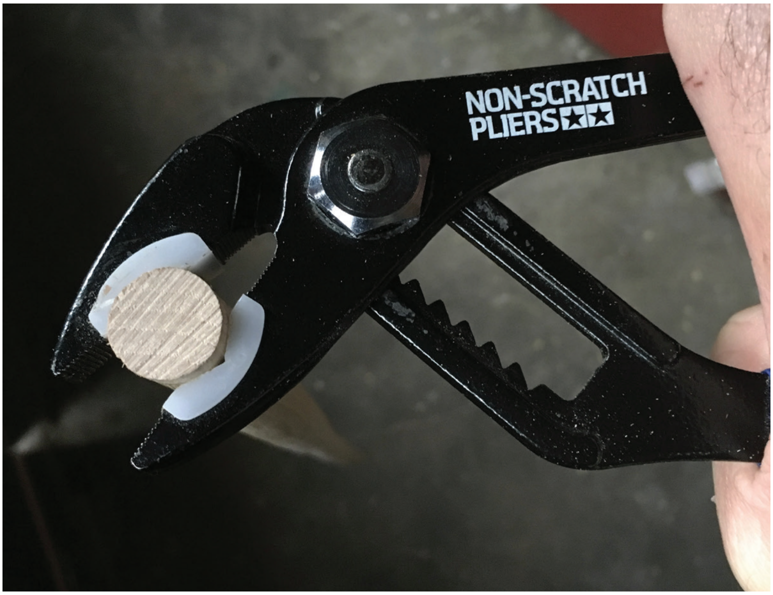
sticks to their finished length. I number each stick and each mortise in the arm so they can be reunited at assembly time.

MAKE TENONS, THEN SHAVE THE STICKS

I think it's best to first cut the joinery on your sticks then shave them to finished shape. The tenons act as a target as you shave the stick's facets. Once you shave down to the tenon, you stop.

You can cut the tenons on the lathe or with a hollow auger, which is my preferred method. The hollow auger 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 – a piece of wood from the chair that had some short grain. I cut a tenon on one end and test it in the mortises in the seat. If it is too loose, adjust the hollow auger. If it goes in smoothly, I still think that's too loose.



PRESS FIT

You can get your tenons fitting exactly how you want them with soft-jawed pliers. They can compress a tenon ever-so-slightly. Then, when the wet glue hits the tenon, it will expand, making the joint even better.

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. You level the stick in your vise. Then you press the hollow auger against the stick and use its bubble level to make sure it's level. Then you cut the tenon.

For cutting tenons with a hollow auger, the mantra I repeat (not

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.

with the kids around): Level, lubed and low.

Level: Level the sticks in the vise and level the hollow auger.

Lubed: A squirt of dry lube into your hollow auger will reduce the annoying squeaking sound it makes. Or wipe out the interior of the tool with an oily rag.

Low: Keep the drill's speed at low, which gives you control.

Short sticks need two tenons – one for the seat and one for the arm. Long sticks need only one tenon for now – the tenon into the seat. You'll cut the tenon for the comb after assembly.

SHAVE STICKS WITH HANDPLANES

When I started building chairs, making the sticks induced a bit of anxiety. I couldn't decide on the best way to make them. I tried all

A QUICK SHAVE

It takes about five minutes with a block plane to turn an octagonal stick into a shapely stick with entasis.

sorts of rounding planes and trapping planes and other gizmos. I even made a steady rest for the lathe at work. After years of frustration, I found that my favorite way – the method that brought the most joy – used the furniture-making tools I already owned.

Basically, it's just a jack plane and a block plane, and you use those tools to shave the sticks round and tapered 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.

Always shave the arrises (aka the corners) first. 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

THE HAND SAYS 'STOP'

Grasp the long stick with your off-hand. This hand rotates the stock as you work, it supports the stick from below and it serves as a stop for your jack plane.

take a final stroke along two-thirds of the short stick.

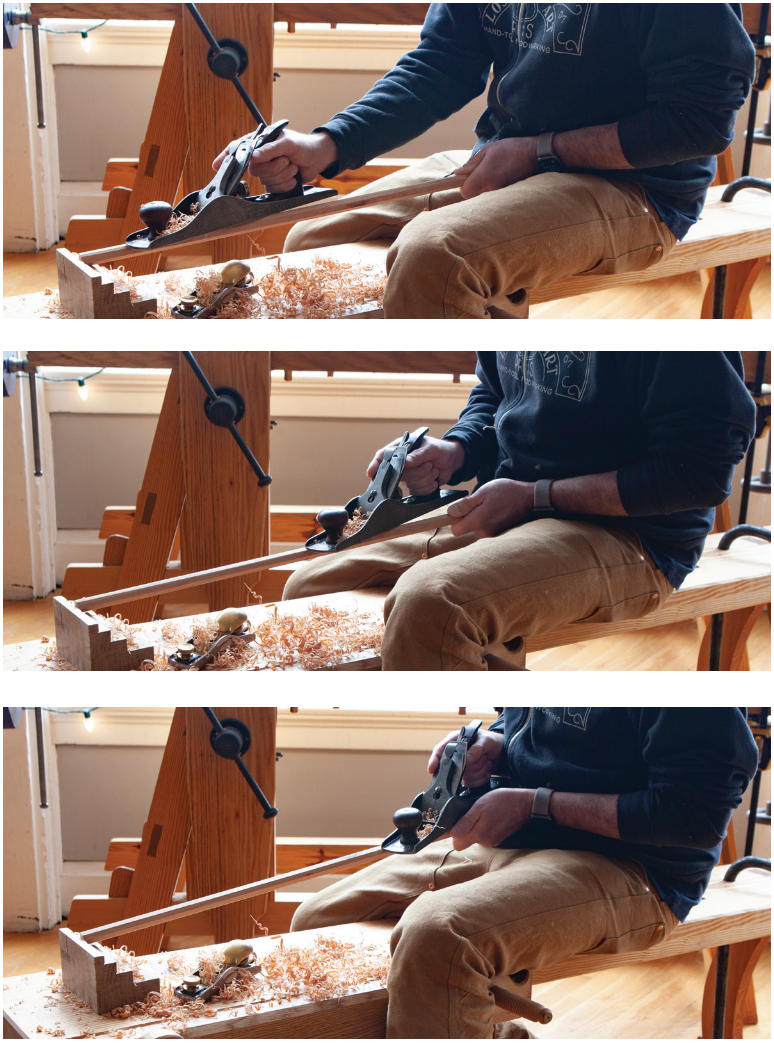
It won't take long, and soon half the stick will be tapered and round. Flip the stick end-over-end and repeat.

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. Or use scrapers and sandpaper to do the job.

The last thing I do to a stick is grab a handful of shavings and use them to vigorously burnish the stick.

SHAVE LONG STICKS

The long sticks are a little more difficult than the short sticks because one end has a long taper and the other end has a very short



THREE STROKES

Each of the three tapering cuts begins at a different place on the long back sticks. The third one begins with the plane's body against your off-hand. Also note how the plane is skewed, which allows you to take a continuous cut along an uneven surface.

taper. Luckily, your hand position can do all the layout work for you.

When shaving long sticks, I start shaping them with a jack plane. One hand holds the stick and presses it against a stop. The other hand skews and pushes the jack. 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 jack 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 long taper on the long sticks is done with three strokes. The first stroke begins about 4" from the end of the stick. The second begins about 8"-10" from the end. The third stroke begins with the jack plane pulled all the way back against your off-hand.

Work the arrises (the corners) of the stick. After a couple sets of three strokes, rotate the stick in your hand so you can plane a different arris. Work your way around the stick, always trying to remove an arris. If you plane one of the broad flat spots, you'll know it – the plane will be much harder to push. And don't forget to skew the tool.

Work around the stick. When the tip of the stick reaches 5/8" and can enter a hole through your armbow, the planing pattern changes.

Instead of taking tapering cuts, take only long strokes, from your off-hand to the tip of the stick. The stick will be fairly round now, so there won't be many arrises. Test the stick in the armbow occasionally. When it will go in about 8"-10", switch to the block plane.

Set your block plane's mouth so it has the tightest aperture possible and can pass a shaving. Shave the stick using long strokes, from your off-hand to the tip, rotating the stick after each stroke. The tight mouth should remove tear-out. If the tear-out persists, tighten the mouth or turn the stick around to plane the tear-out going the other way.

Skew the plane quite radically so that only a small amount of the sole contacts the stick. That allows you to take long, continuous shavings over a surface that is slightly bowed up or down.

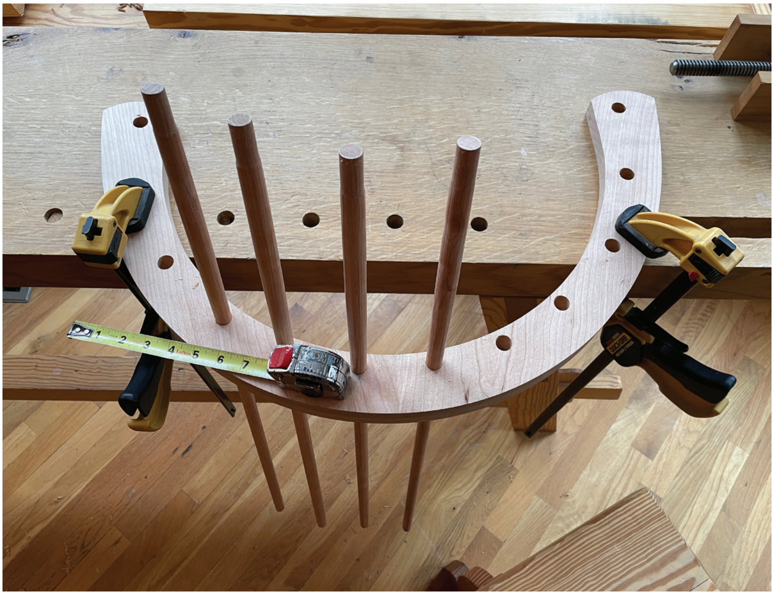
I usually have to plane out the middle of the stick a bit to get things to fit. No matter how much I try to support the long stick, it flexes,

A STOPPED SHAVING

Many times I need to work out the middle of the stick so it will fit in the correct place in the armbow. I do this by starting the cut at point A and stopping at point B. Work all the way around the stick.

MORE SKEW

The more you skew the plane, the faster this job will go. Skewing the plane fools the wood into thinking you have a plane with a tiny sole, which can follow the sometimes-irregular surface on a stick.



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 8-1/2" + the tenon.

and I don't quite plane the middle section as much as needed. A few "stopped shavings" all around the stick fixes things.

When the stick goes into the armbow so that it wedges where it is supposed to (usually protruding about 8", plus the tenon) then stop planing the long taper.

Turn the stick around and taper the bottom of the stick with your block plane. Blend in the stick with the tenon. This is exactly the same motion as when you tapered the short sticks.

TIP: GRAIN DIRECTION IN OAK

I make a lot of oak stick chairs. After planing hundreds of sticks, I noticed a pattern with oak's medullary rays and the grain direction of the stick.

THE ARROWS POINT THE WAY

If the stick has grain direction, the medullary rays can point the direction you should plane. The shiny V-shapes indicate which direction the grain is running on that surface.

In round stock, the shiny medullary rays make a V-shape that points the way the grain direction runs on that surface. In dead straight grain, the rays won't make a V. But if there's even a little bit of grain direction, the Vs are visible. Knowing this trick helps you plane up oak sticks with confidence – you can flip the stick end-for-end to avoid tear-out.

SCRAPERS, BLOCK PLANES, 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 will tend to 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 will ensure the cutter removes the high spots.

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.

For the most part, I use a block plane to clean up my sticks. It has a sole and I can close up the mouth really tight to remove tear-out. But I use other methods at times when backed into a corner.

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 the best option. A cork sanding block does the trick here.

ROUND ISN'T THE ONLY SHAPE

In old stick chairs, the sticks were usually round, or they started life round. But there are other options to consider. I have made dozens of

A MODERN STICK CHAIR

For this chair I left the sticks octagonal and used reverse-tapers on the legs. These two small changes completely change the look of a traditional form. (Photo by Narayan Nayar)

chairs with octagonal sticks. This saves a lot of time and makes the chair look more contemporary (which is neither good nor bad).

I start with square stock, then make it octagonal on the band saw. I cut the tenons, then I plane the eight faces of the sticks with a block

FLATS ON FAT STICKS

When the sticks are thick and you can spare some girth, adding flats can increase the comfort of the chair.

plane. Usually it takes only a few plane strokes on each facet to remove the tool marks. Sometimes I will taper the octagonal sticks down to the tenons.

You might think that the facets of the octagons would bite into your back when you sit in the chair. I haven't found that to be the case. But maybe I have an unfeeling backside.

Another stick shape that I like takes a little more work and is used when I have back sticks that are beefy. I shave them round as per usual. Then I clamp them in a vise and plane a wide, flat surface on each stick.

When I assemble the chair, I turn the flats toward the sitter. This adds to the comfort of the chair. I only do this when the sticks are beefy – 1" diameter or more. Planing flats on 5/8"-diameter sticks weakens them.

I started doing this after I saw the feature in a photo of an Irish Gibson chair. When I inspected the chair in person, however, I found that the flats were a trick of the light in the photo. I was seeing facets from shaving the sticks – not flats.

ADDING FRONT POSTS

Some stick chairs have a bent branch where the front short sticks would usually be. These posts are lovely and give you some more legroom, but they require hunting up some curved branches. Then you dry them.

Posts normally have a bigger mortise-and-tenon joint. Usually it's about 1" in diameter and passes all the way through the seat. Feel free to wedge the post down there if you like.

They are attached to the arms with a screw, wooden peg or a nail.

KERF THE STICKS

If you are going to wedge your tenons at assembly time, it's best to cut a kerf in the stick now so you don't forget when the glue bottle is out, the clock is ticking and your IQ has dropped 20 points.

For sticks, I use a fine saw to cut the kerf, usually a dovetail saw. The band saw or a full-size handsaw will remove too much wood. I usually kerf my sticks about two-thirds the length of the tenon.

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

FUN WITH BENT BRANCHES

Branches with just a little curve can be used for posts under the armbow. These are mortised into the seat then fastened to the armbow with a peg, nail or screw.

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.

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 ask: Do I 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 longtime 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.

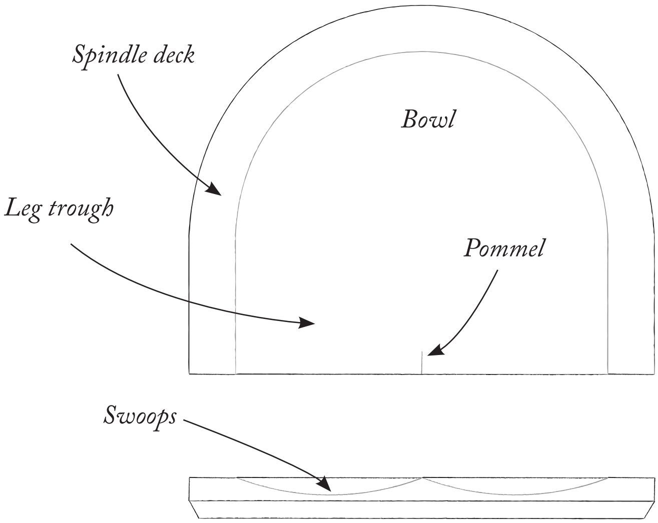
OK, maybe don't think that.

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 skill 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, apart from mine) 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 swoops 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.)

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 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 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.

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.

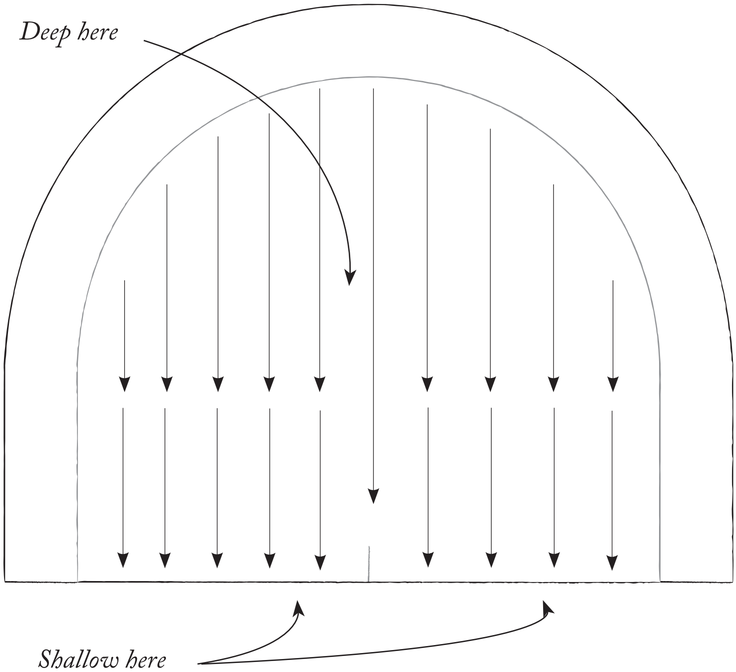
The pommel is the high point at the front of the seat that rises between your sitter's legs. I think pommels should travel a short distance – 1/4" to 1" back from the front edge of the seat. Some chairs have 8" long or longer pommels. I sat in one of these long-pommel chairs recently, and I think the chair should have bought me dinner

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 screws won't hold anymore.

FOR SWOOPS & SANDING

This pattern marks the swoops on the front edge of the seat and becomes a sanding block for final shaping of the swoops.



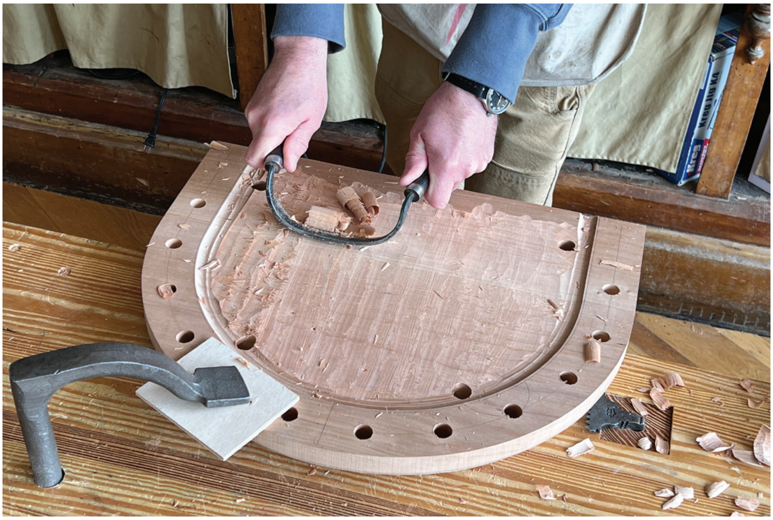
SCOOP TO THE FRONT EDGE

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.

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. Some people call these “leg holes.” I wish there were a more elegant name (meat loops?). We’ll call them “swoops.”

I like the curves 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 curves. After I scoop out the curves, I wrap the pattern in abrasive to fair the curves. (You’ll see a lot of this approach in the book.) If



THE FIRST STROKES

Work across the seat, keeping the furrows as regular as you can. On the next pass, try to take the high spots of the furrows down to the low spots.

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 your 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, and there is an appendix on how to sharpen this chairmaking tool. In short, I treat mine like a giant carving gouge and maintain its edge continually with a strop and honing compound. Before I put my scorp away at the end of the day, I strop its edge so it's ready to go the next morning.

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 cuting 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.

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.

Then return to the back edge of the spindle deck and repeat. But this time your stokes should try to take off the high parts of the furrlows 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.

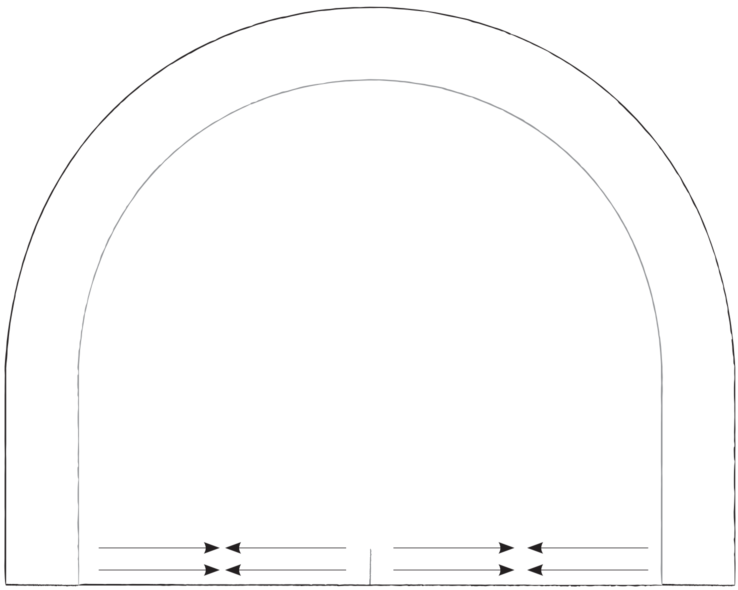
Now scoop out the swoops on the front edge of the seat. These scorp cuts are with the grain. Work from the end of each swoop down to the bottom. Then scoop from the pommel to the bottom of each swoop.

When you remove the last bit of waste, you might have a small bit of tear-out at the bottom of the swoop. Removed 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 swoops. The next step is to blend the bowl area down to the swoops. This area is called (unromantically) the leg troughs.

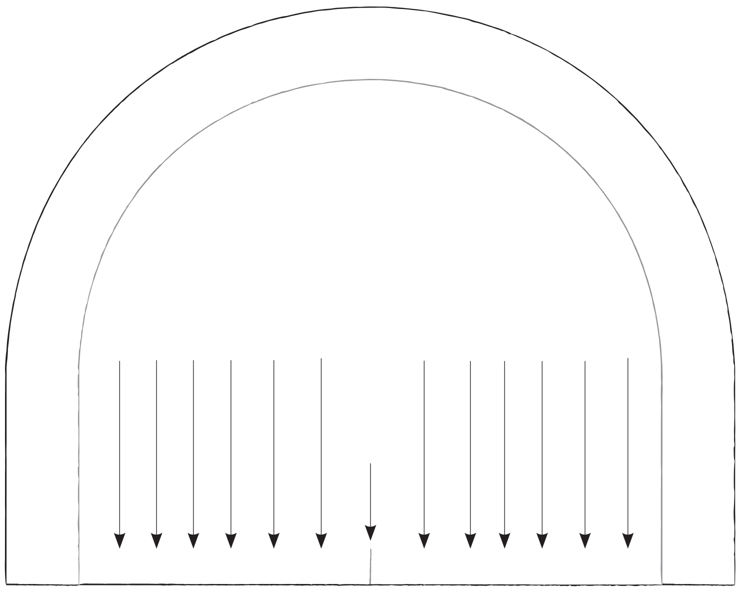
You scorp this area in the same way you worked the bowl. Use across-the-grain cuts. With each subsequent pass, try to remove the

SADDLE THE SEAT



SWOOPS

The swoops are the illusion. By scorping them out to 3/4" deep, the saddling appears more dramatic than it is. Work each scoop to the pencil line using with-the-grain cuts.



BLENDING

To blend the bowl and the swoops, work across the grain with overlapping strokes. Keep working until the bowl blends neatly into the swoops.

high spots from your previous pass. You'll have to work around the pommel a bit, but this sould 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.

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

SAME STROKES, FINER TOOL

With the travisher, repeat the steps you took with the scorp to refine the saddle. The major difference is that the travisher is pushed, the scorp is pulled.

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 controls 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, leg troughs and swoops. 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 saddle and the bowl. 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 freak. 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-

SAND THE SWOOPS

The wooden template that marked the swoops also shapes them. Wrap it with #80-grit sandpaper.

NO POMMEL

Here's a saddle without a pommel. No leg holes, no swoops. Just scorp to the center seam from both directions. This walnut chair is detailed later in the book.

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.

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."

SANDING THE LEG SWOOPS

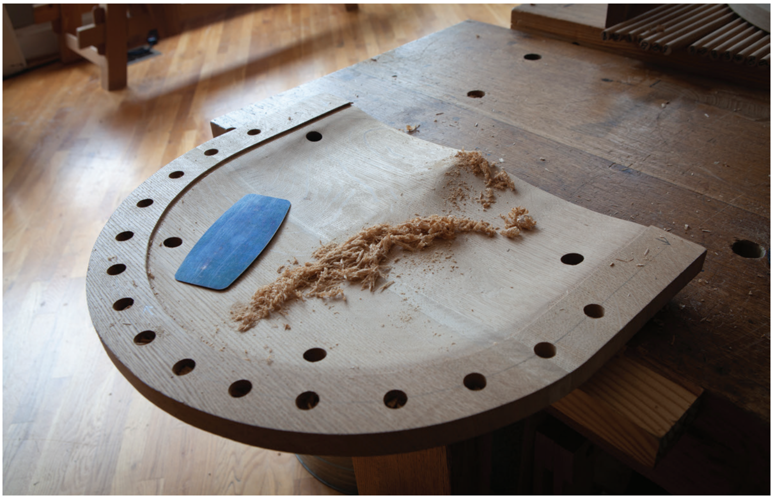
To make the leg swoops crisp and smooth, I usually sand them using the block of wood that I used to lay them out. I wrap coarse abrasive around the block and work until any errant tool marks are gone.

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 18 years 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.

SADDLE THE SEAT



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.

SAND & DELIVER

A few minutes of sanding saves me an hour of scraping and fussing. I make no apologies: I love my little random-orbit sander. It makes my life much easier.

THE SOLUTION

When you hammer a wedge home, the pitch changes from an uncertain "thwack" to a resounding "thud" as the whole structure tightens and takes the blow. This is one reason stick chairs lead long lives.

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 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.

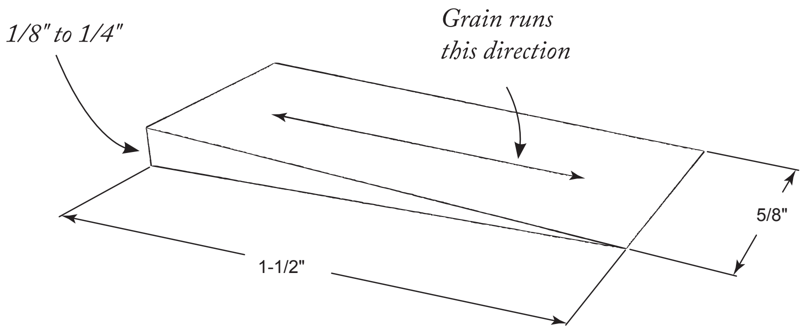
MATERIALS, SIZES & ANGLES

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 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 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" 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

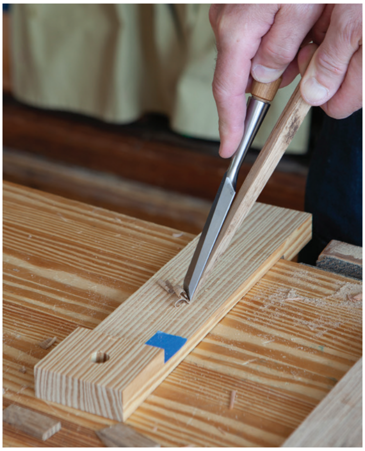
If you want to make wedges by hand, shave them out from a long sliver. Try a 3/8"-thick, 5/8"-wide and 16"-long oak sliver. Taper one end with a jack plane. Shave the tip with a wide chisel and crosscut the wedge free. I usually work on my bench hook when I do this.

Because I make a lot of wedges at a time, I prefer to use the band saw.

You can make wedges without a jig on the band saw by using the saw's miter gauge. Crosscut a 5/8" x 2"-long chunk off a board that is about 6" wide. Set the saw's miter gauge to cut on-half of the angle you desire (i.e. 4° off 90° for a 8° wedge). Put the chunk on the miter gauge and cut off a thin sliver. Flip the chunk over – end grain-for-end grain. Slide the chunk toward the blade and make another cut.

You will quickly figure out where to place the chunk so that you

WEDGES

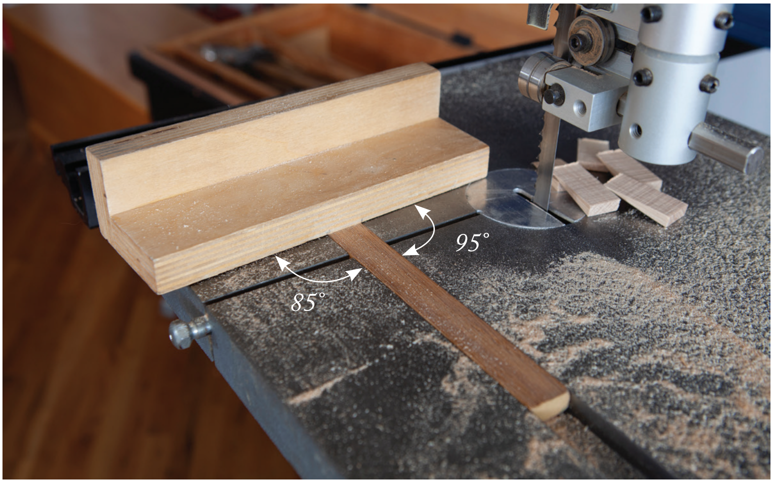


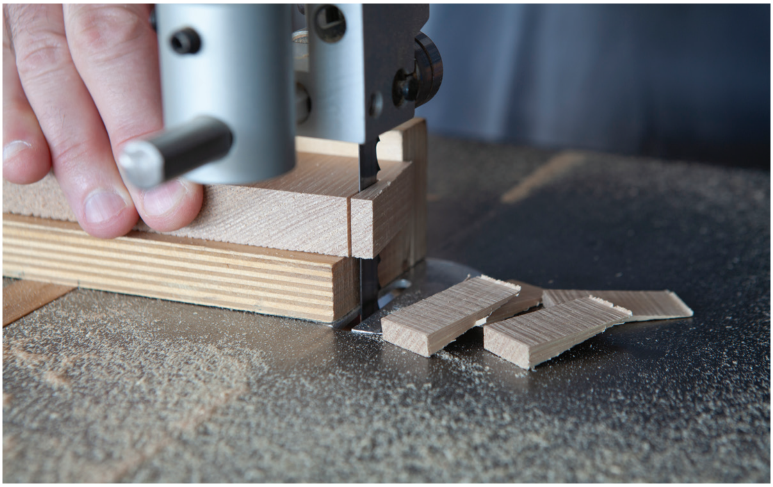
WEDGES BY HAND

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.

JUST THE GAUGE

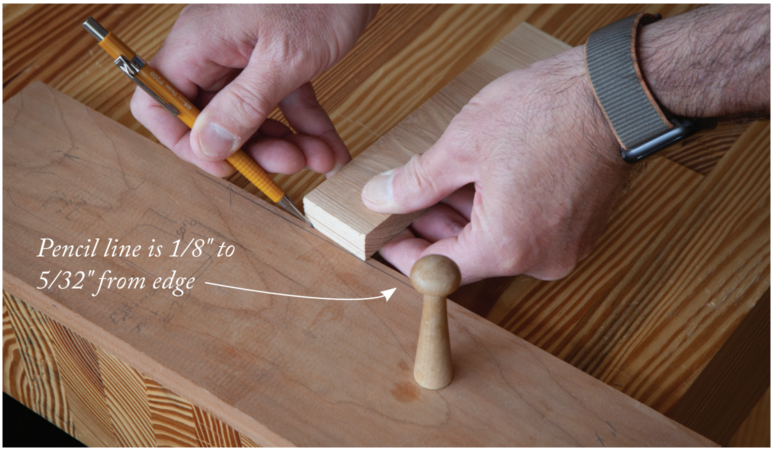
Set the miter gauge to about 4°. Cut a thin sliver off the blank. Roll the blank forward – end grain-over-end grain. Place it against the gauge and make a second cut.





DEDICATED TO WEDGES

This jig makes wedges with little fuss. It's a wooden miter gauge that is permanently set for 5° off 90°. To use it, slice the end off the chunk, flip the chunk over and position it so the wedge overhangs the jig enough for the saw's kerf. Make a second cut.



EYEBALL THE LAYOUT

Mark a line on the jig that represents the fat end of the wedge you want to make. Show the notch to the wedge and rotate it as shown. Trace the shape on the jig and remove the waste.

make a perfect wedge. You can make wedges with thin points and blunt points.

Keep flipping the chunk over and over. Make wedges until your chunk is so small that it feels dangerous to make the cut while so close to the saw's blade.

You can also make a dedicated wedge jig for the band saw's miter slot that has zero clearance to the blade. This jig is shown at left. It is permanently set at 5° off 90° and makes it easy to position the chunk of wood and slice a perfect wedge.

The disadvantage to both of these miter-gauge methods is also its advantage. The technique makes it easy to make different wedges. By moving the chunk of wood left or right on the miter gauge, you can make wedges that are fatter or skinnier.

A DEDICATED WEDGE SLED

If you want to make your wedges identical, a wedge sled is the answer. This 3/4" x 6" x 16" piece of wood slides between the band saw's blade and the saw's fence. The sled has a wedge-shaped notch cut into it.

PRESS, SAW, REPEAT

A wedge sled makes consistent wedges all day. You press the chunk into a notch. Push the jig forward. The wedge is cut and will fall away (or can be nudged away).

Just like the previous method, you make a 2"-long x 6"-wide chunk of wood to make the wedges. You press the chunk into the notch and push the sled forward. The saw cuts the wedge, which falls away. Flip the chunk end grain-for-end grain. Press the chunk into the notch and make another cut. Flip. Repeat.

Making the wedge-shaped notch is easy. Decide how fat the end of the wedge should be (1/8" to 1/4"). Mark a line parallel to the long edge of the jig that equals the fat end of the wedge. Take your 2"-long chunk of wedge stock. Touch one corner to the line and rotate it until a second corner touches the edge of the jig. (The photo on the previous page explains this far easier than words ever could.)

Trace this shape onto the jig. Cut the wedge-shaped notch out from the edge of the jig. You can use a band saw or cut it out with a handsaw and a chisel.

Because we make hundreds of wedges at a time, I have added a knob to the jig to make it easier to slide it forward and back. After a lot of use, the edge of the jig will get chewed up. (Either "someone" will feed the jig too fast, and the blade will flex and chew the jig, or the jig will be set too close to the blade.)

When this happens, rip off the chewed-up section from the jig's edge and make new notches in the jig for the wedges.

Now make wedges – lots of 'em. I make tons of 5/8" x 2" wedges, which I use for sticks and the ends of tapered leg joints. I also make a healthy supply of 1" x 2" wedges for leg tenons that aren't tapered.

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 put this question in the "It's your call" file.

WHERE YOU WANT IT

A paper cup and a modified acid 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.

MODIFIED ACID FLUX 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 geegaws 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 is ideal for grabbing a decent amount of glue and putting it exactly 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). When it's time for another glue-up, first inspect the brush. If there are stray bristles, snip them off.

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.

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 out 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.

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.

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 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

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).

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 biger 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 bouncing out of their mortises. 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 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 liquid at room temperature. It allows me about 40 minutes to get a chair together (as opposed to 10 minutes for yellow glue). And if I fail to get my parts together in that time, 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. Some old chairs used no glue – only wedges.

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 so it flows easily.

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.

• Lay down paper on the workbench.

• Place the seat upside down on scrap pieces of softwood. 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 the stretchers apart. Brush glue into the mortises for the stretchers. Use enough glue to wet both the mortise and the tenon. Assemble the

GLUE & TWIST

Put glue in the mortises and drive the stretcher tenons home. Twist the assembly (left) until it will sit flat on the workbench. Then twist the stretchers onto the leg mortises (right). If they won't seat this way, I'll knock them home with a mallet and a backing block.

stretchers and twist the assembly so it lies flat on the benchtop.

If glue has squeezed out of the joints, clean it up 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 the leg mortises for the stretchers. Drive the tenons on the stretchers into the mortises in the legs. You might need to use a mallet and a backing block (to avoid denting the legs).

Once you get all four legs attached to the stretcher assembly, roughly position the legs so they will go into their seat mortises. Look for squeeze-out on all the joints. Clean it up with hot water and a toothbrush. Set the leg/stretcher assembly 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. These joints are critical and should be well-glued.

Wrangle the tenons into their mortises. This might take some twisting. The legs might want to pop out of the mortises because of the tension in the undercarriage. Just keep pulling them down until they are as far as you can go with just your bare hands.

Now get the legs to stay in 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.

Flip the chair over so its legs are on the benchtop.

ASSEMBLE THE UNDERCARRIAGE

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.

DRIVE THE WEDGES

Attempt to 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.

WEDGES & THEIR TROUBLES

Now wedge the tenons on the legs. Paint glue on both faces of the wedge. Make sure the wedge is perpendicular to the grain of the seat. Drive in the wedge with a hammer.

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.

CLEANUP

Cleaning now ensures you won't have drips and smears of glue all over your chair. If that happens, however, remember that hide glue cleans up with hot water – even 100 years after it has dried.

• 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.

After the wedges are seated in the seat, drive in any wedges on the stretchers (if you have through-mortises). To do this, I turn the chair on its side and work against a scrap block of wood. 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.

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

You'll need to pull the sticks into their mortises a bit. If the grain in the stick isn't straight, or the mortises aren't aligned, the stick or arm might snap in your hands.

ASSEMBLE THE UPPERCARRIAGE

If assembling the chair's undercarriage is like beating a spring, then getting a chair's sticks into their mortises can feel like thumb wrestling an octopus.

This fact might seem distressing if you've built a lot of casework because cabinet parts are supposed to slide together easily. Handmade chairs, on the other hand, should put up a bit of a fight when you knock them together. The slight variations (a nice name for "inaccuracies") that result from drilling the sticks by eye add tension to the assembly. The tension helps keep the top half of the chair intact if the glue fails.

When there is too much tension, however, parts snap.

So the goal when assembling the uppercarriage is to do everything you can to keep the sticks under control and to not add additional tension during the glue-up.

The following instructions show how to glue up a stick chair with an armbow. If your stick chair has two separate arms, the procedures are the same – just easier. Glue one arm and its sticks in place. Glue the second arm and its sticks in place. Make sure the two arms are in the same plane. Then glue the back sticks. The chapters on the armchairs later in the book illustrate this assembly process.

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 receive a wedge.

3. To place all the sticks – long and short – into the armbow. I number each stick when I cut it to length and marry it to a particular mortise in the arm. Rotate them so that the kerf in the short sticks is per-

READY FOR WHATEVER

Note how the sticks are threaded into the armbow. The long sticks are wedged upward into their mortises to make assembly easier.

pendicular to the grain of the armbow. Slide the long sticks upward until they wedge in their holes in the armbow.

Pour some glue into a paper cup and begin the glue-up process by painting 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.

Now move to the armbow. If the sticks are a close fit in the arm, you can pick up the armbow as you add glue. If the sticks are a loose fit, it's best to leave the armbow on the bench as you glue the mortises.

Note that you will put glue only into the arm mortises for the short sticks. The chair's long sticks are glued only into the seat and into the comb or backrest – not the arm.

To glue a short stick into the arm, I retract the stick almost entirely from the arm, creating a little cup in the mortise. I paint glue on the mortise walls. The stick serves as the bottom of the cup and prevents

GLUE THE MORTISES

Hold the lip of your glue cup over each mortise. If a drop of glue escapes from the cup it will drop into the mortise instead of onto the seat.

glue from running out of the mortise.

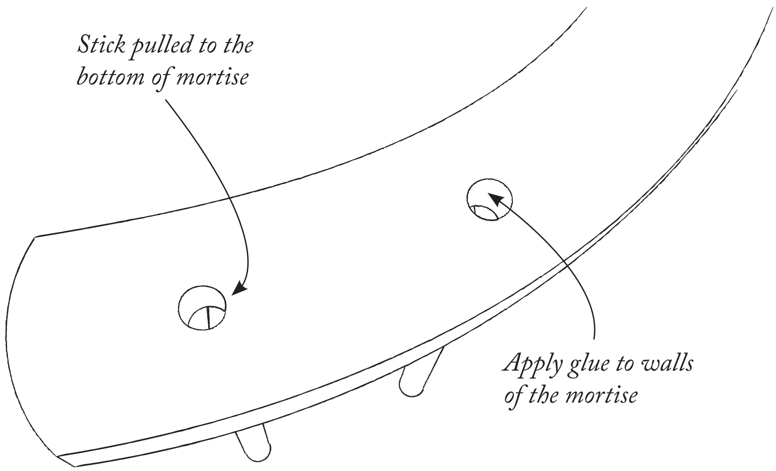
Paint a thin layer of glue on the tenon below the arm. Then push the short stick into the mortise in the armbow. Rotate it back and forth in the mortise to get glue all over the tenon. Now orient the stick back into its correct position with the kerf perpendicular to the grain in the arm. Also, the tenon should stick up about 1/4" above the armbow.

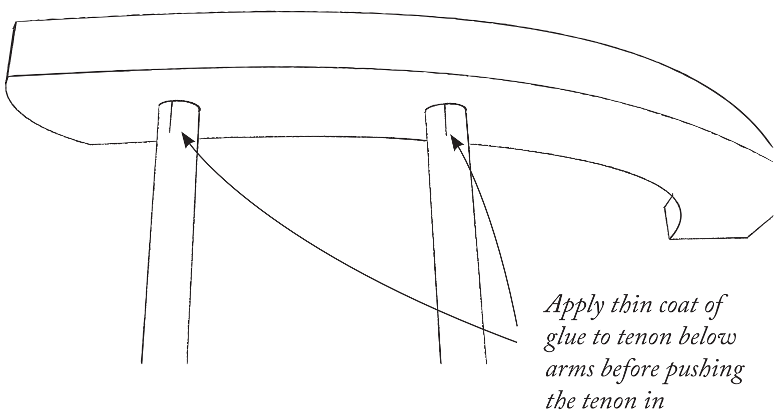
Glue each mortise for the short sticks the same way. When you are done, put the glue aside for a moment and get ready to wrestle the sticks into their seat mortises.

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





GLUE, TWIST & PUSH

Pull the stick down so it's almost out of the mortise. Paint glue in the mortise and on the tenon below. Twist the tenon in the mortise to get glue on both components and push the tenon up in place.

DOCK THE STICKS

Put the armbow in place so you can start pulling the short sticks into their mortises. Note how the long sticks are out of the way during this stage.

FIRST ARM TAPS

You'll need to knock the arm down a bit as you tap the short sticks into their mortises. A backing block protects the arm.

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. I try to get the two front sticks started in their mortises, then I pull the short sticks into the mortises one by one. First, I seat a stick on the right side, then I do one on the left. Back and forth until all the short sticks are started in their 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 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 and the tone will change). You also might have to tap the arm down some as you sink the tenons.

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

DRIVE THE LONG STICKS

With the short sticks in place, it should be easy to knock the long sticks down and into their mortises.

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 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

CHECK, CHECK, CHECK

Measure the arm's height off the seat at the hands and at the rear of the armbow. Tap the arm to get the height as consistent as possible.

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, 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.

DRIVE THE WEDGES

Wedge one tenon at the front. Then wedge the front tenon on the other side of the armbow. Work back and forth – left side then right side.

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 faces 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 rasp the arm to its final shape, blending in the tenons and wedges to that shape.

TROUBLE-SHOOTING

The previous chapter on assembling the undercarriage has a section on dealing with wedges that bounce, split or enter the tenon all crooked. Here are a couple additional problems you might encounter with the uppercarriage.

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 to sneak glue into the crack. If the crack passes through the thickness of the arm, I'll use a shop vacuum to help me. I put glue on the top of the crack and vacuum from below to pull the glue into the arm. 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 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

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.

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.

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.

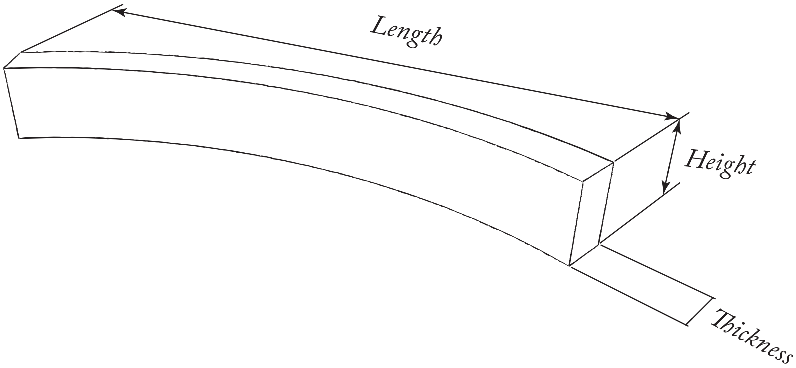
• Height: The measurement of the part up and down on the assembled chair.

• 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.

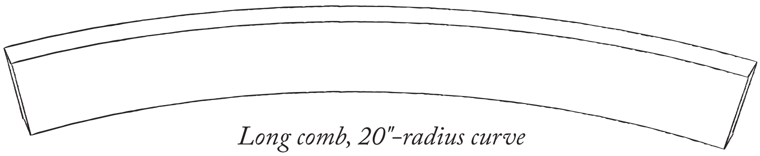
FIND THE COMB

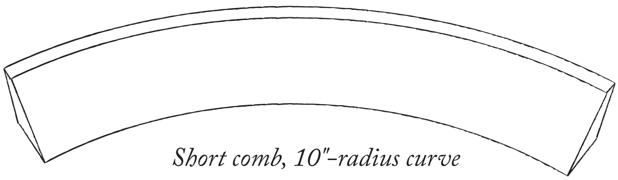
A curved comb with angled ends and a curved bevel is easy to create using a series of simple steps. The end result always looks more complex than it is.



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, 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 (obviously) longer than the spread of the back sticks. How much overhang on each end of the comb is a real consideration. You would think there is a lot of variation, but in my chairs there is not. In looking over my notes from the last 18 years, my combs have an overhang that ranges from 1-1/8" to 2" at each end.

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 have settled on 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). Spacing them out more than 1/8", stresses them quite a bit.

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

MAKE THE COMB OR BACKREST

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 crest that is 1-1/2" thick.

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.

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.

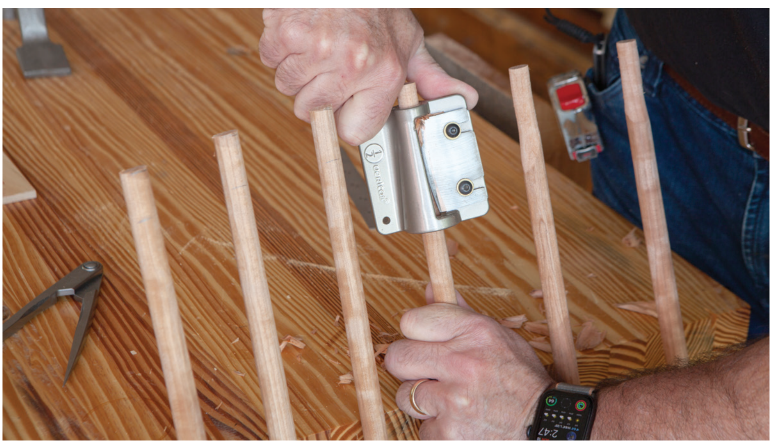
I know this seems like a lot to juggle. Here's my advice: If you are bending your comb, then it is pretty thin and typically you should drill your mortises straight down – 90°. If you are sawing out your comb from solid, it is thicker and the mortises should be angled.

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

MAKE THE COMB OR BACKREST

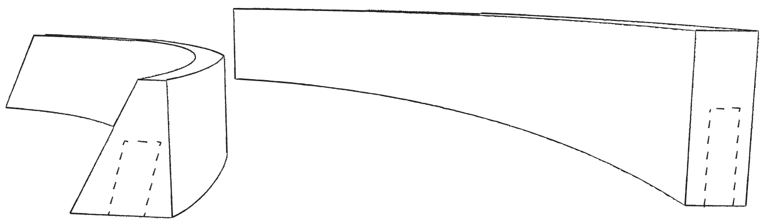
PROTOTYPE YOUR COMBS

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.

bit at 20°. I usually make these mortises about 1-1/4" to 1-1/2" deep.

After you drill the holes, knock the sample comb onto the back sticks 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 the easiest 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 straight board.

The ends of the comb can also be decorated with curves, angles or whatever else you got.

MAKE THE COMB OR BACKREST

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.

SAWN FROM SOLID

Most of my combs are sawn out from solid material. Why? It's faster and easier to saw out a comb than bend a comb (and wait for it to dry, or replace one that split on the bending form).

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 good 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 to keep around. 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 added to 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 short grain. Many times I cut a big bevel on

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.

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.

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 CRESTS

Bent combs are easier to make than bent armbows. Combs are shorter overall than armbows (usually less than half the overall length). And

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.

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.

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 days or weeks) or put it in a kiln powered by a light bulb (this takes a day or two).

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.

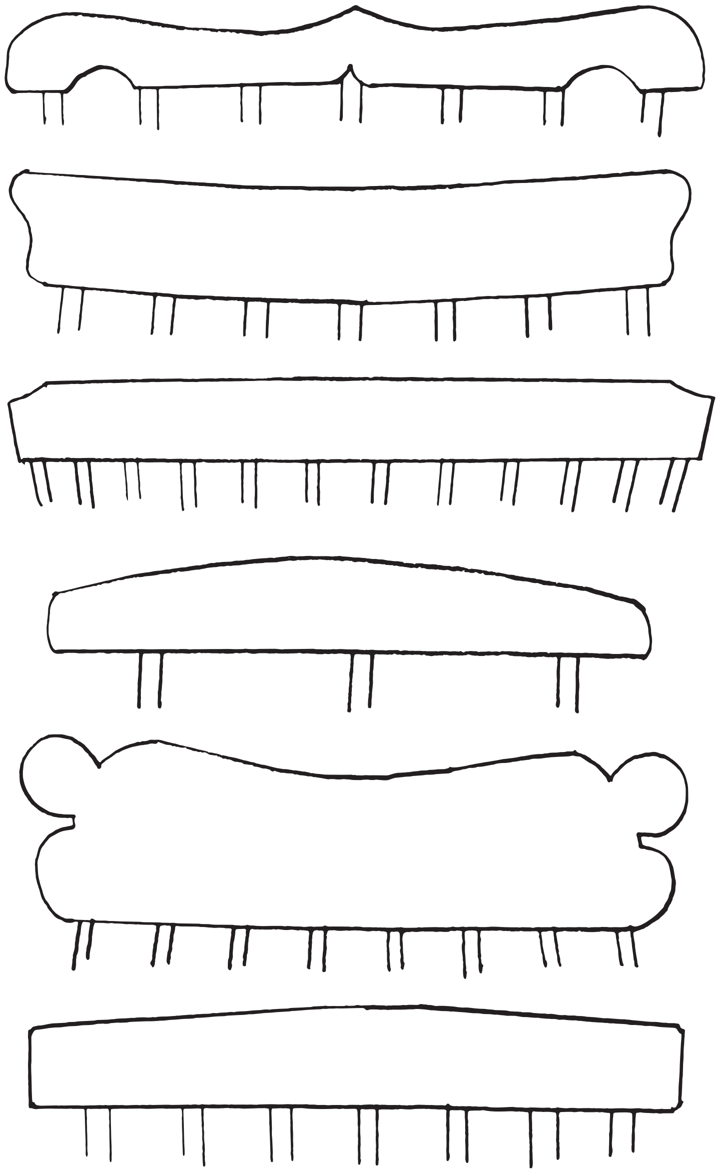
ORNAMENTATION

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.

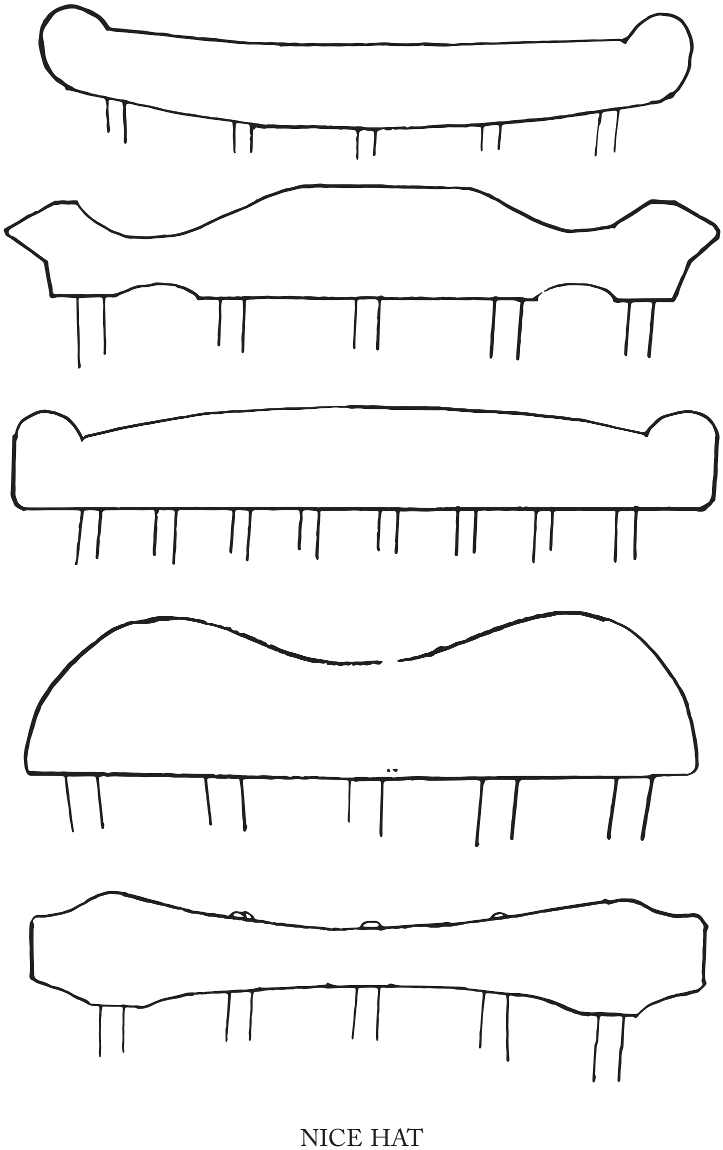
Most combs on stick chairs are simple and utilitarian. The front face might be rounded so that no sharp corners can touch the sitter. The ends might be angled or simply curved to echo some other part of the chair – perhaps the curve of the hands or the splay of the front legs.

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. It's easy to make a simple chair – then go overboard with a sequined Liberace chapeau.

The illustrations on the next spread show some of my favorite combs



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.

that I have encountered during the last two decades. These only scratch the surface of what is out there.

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 to glue the comb to the sticks is to paint glue in the mortises and drive the comb onto the sticks while the chair is sitting 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 VIEW FROM THE OTHER SIDE

Here you can see the back legs braced against a piece of scrap (it's actually the scrap that attaches to the underside of the seat when I saddle the seat). This scrap allows me to knock the comb in place with ease.

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.)

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. Here's how I see it: It takes two minutes to pin two sticks. Six minutes to pin six sticks.

I pin my sticks with bamboo barbecue skewers because it's fast and easy. These skewers cost pennies at the grocery store. I use a 5/32" drill bit to bore through the comb and the stick (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 behind it

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.

with a small hammer. When it hits the end of the hole, I put down the hammer and pick up the saw. I saw the bamboo flush then move to the next stick.

If you don't like barbecue skewers you can pin the sticks with 3/16" dowels or make pins with a dowel plate.

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.

FIRESIDE CHAIR

Most comb-backs look at home by a fireplace. This one, made with bog oak, has lots of facets that catch the firelight.

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.

There are about five or six ways I know of to level the legs of a chair. I have tried them all. The following method is the easiest to teach. Most students grasp this method, in my experience. If, however, you read through this technique and say: But why don't you do ...? My answer is simple: Try your theoretical method and see how it goes. There are lots of ways to do this operation.

SET THE STAGE

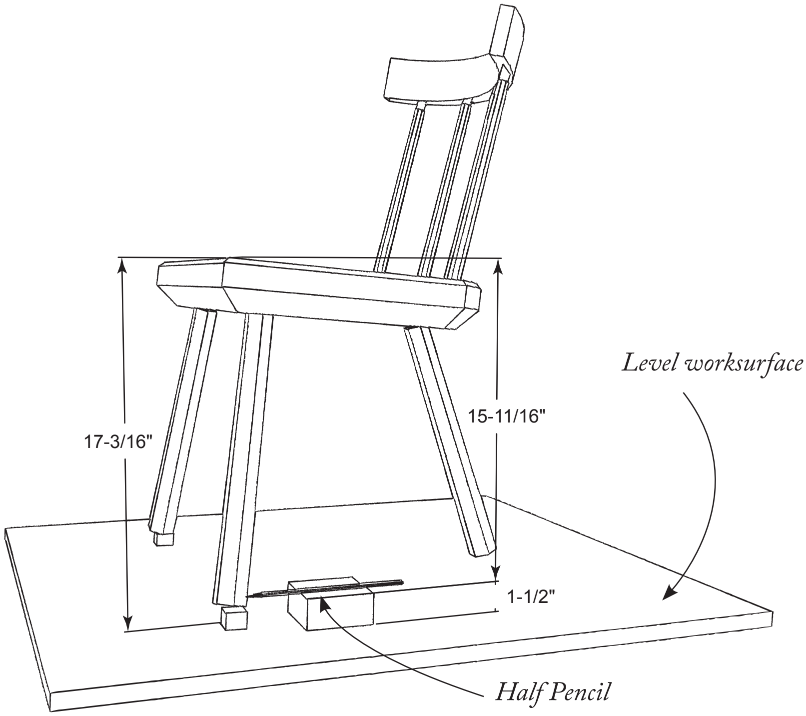
To trim the legs of your chair you need a flat worksurface that is level. This can be a piece of plywood that you have shimmed with wedges, the top of a table saw, your workbench or that one patch of floor in your shop that is inexplicably level.

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.

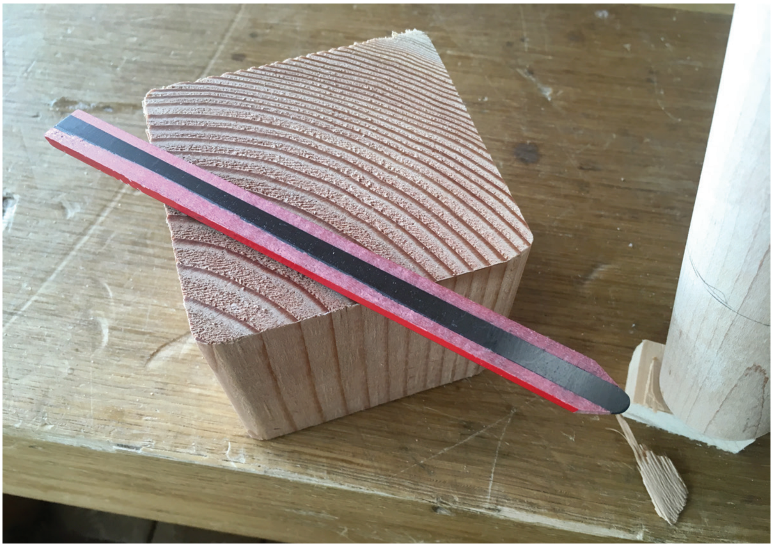
THE MODIFIED CARPENTER'S PENCIL

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.



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.

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 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. This is how all that gets fixed.

The goal is to prop up the legs so the seat is:

LEVEL, LEFT TO RIGHT

Use shims to level the chair's legs from left to right. Make sure the legs don't wobble.

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 back isn't ideal. The sitter will feel like she is being pushed forward a tad. The seat needs to slope backward.

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.

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

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.

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 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 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.

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 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 and see how 17" feels. Prop that block 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.

SAW THE LEGS

The trickiest part of sawing the legs to length is holding the chair while you do it. Most chairmakers use a vise or clamp that has jaws that stick up above the benchtop, such as a Hi Vise, a machinist's vise or handscrews. I place a moving blanket on the workbench to protect the chair. Then I place one leg into the vise (or clamp) and tighten it.

Sawing the legs is then easy. I usually 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.

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.

If the leg is round, the procedure is similar. I start a shallow kerf, 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 sharp sawn corners of the foot with some #80-grit sandpaper. This will prevent the legs from splintering.

COMPLETE THE FEET

For stick chairs, 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.

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.

WOOL PADS

These woven wool pads (sold under the Flexi-Felt name) have a tough adhesive that can last a couple years (at least). Hardware-store pads last days or weeks (in my experience).

CHECK YOUR FEET

Put a straightedge across the two long legs. You should be able to see the high spots that need to be cut away. Above you can see a high spot touching the straightedge.

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 wobble. 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. The legs that are touching need to be reduced in length. Mark those two legs.

Place the chair upside down on your workbench. Place a yardstick or straightedge across the two legs that are too long. You should be able to see the high spot that is causing the problem. Use a block plane or rasp to remove the high spot. Repeat the testing process and planing/rasping until the chair does not wobble.

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 I call: 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 that are covered with #100-, #180- and #220-grit sandpaper (basically shop-made emery boards). The wood backing makes crisper lines than hand-held sandpaper.

• 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.

SANDING STICKS

These bits of oak are about 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 an adjacent one.

For me, Make Pretty begins with the smallest 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 commercial work, 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.

But I like to go one step further. On the most visible surfaces – the crest, the hands and the 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 crest 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.

Once I complete Make Pretty, I decide how to 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

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.

unforced error in the piece that nags at me. These are a reminder that 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.

CHAIR 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 real 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.

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, beeswax – and would do little harm if you ingested them.

MILK THAT NEVER SOURS

This chair is finished 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. Unfortunately, the onus is on us to decipher the silly 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.

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.

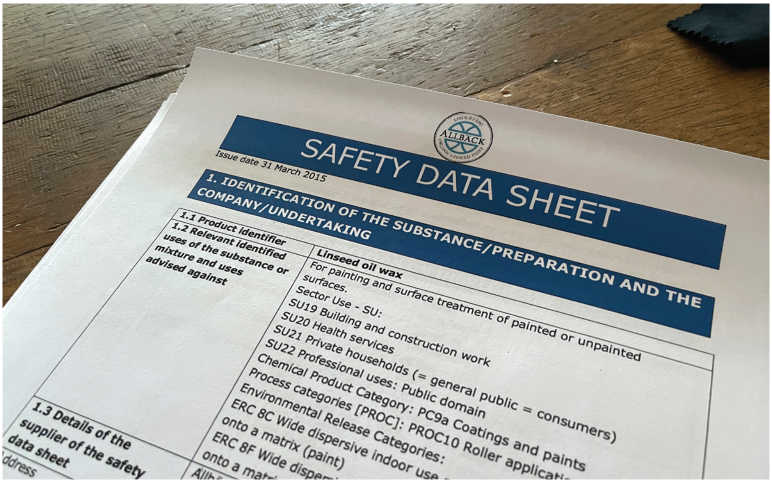
I wish I could list every brand of every finish here and rank them from mostly harmless to a hazmat. Unfortunately, finish formulas change, environmental laws change (for better and for worse) and commercial brands come and go. When you consider buying a finish that is new to you, my advice is to look 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 maintenance (if the finished object is regularly handled). And they might

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.

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 com-plain 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 while finishing, know 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.

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 by finisher and woodworker Jeff Stafford. 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.

The only difference among the products I have found is their viscosity. Some, like the Allbäck are like peanut butter. Tried & True is like

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.

snot. And BeesBlock is like a thinned linseed oil. I suspect the difference is caused by how much wax is in the mix, but I can't say for sure.

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.

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

MILK PAINT

I like milk paint, but it is a lot of work. My best advice is to choose a milk paint guru and stick with that person. Don't try to make sense out of all the conflicting instructions out there.

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.

PAINT

Many stick chairs were left raw or painted, probably with a pure linseed-oil paint (just oil and pigment) or an oil paint with lead driers. Pure linseed oil paint can take a week to dry, though it looks fantastic. And lead paint is not good for your health.

Many chairmakers instead use a commercial casein paint – commonly called milk paint. There is ample evidence that milk paints were used on home's interiors and woodwork. But I've never been thrilled by the way they look and the fact that they take a lot of time to execute well.

Like French polish, there have been hundreds of articles published on how to apply milk paint, and they don't all agree with one another. This confuses a lot of beginners.

On the other hand, I can't think of a single magazine article out there on how to apply a linseed oil/wax finish. That's because it would be a really short article. Maybe six paragraphs (see above).

I use milk paint on chairs and tool chests when the customer requests it, but it always increases the price significantly. Instead of one hour of work for a linseed oil/wax finish, milk paint is about six hours of mixing, straining, applying, buffing, repeating, repeating and topcoating.

When I paint chairs, I prefer to use a dead-flat acrylic paint. The brand I use is the General Finishes Milk Paint line, which has no milk in it that I know of. The paint is easy to apply and is self-leveling, so you get a smooth surface with no brush marks. Usually, two or three coats of paint does the trick. And the finish is tough and elastic.

I paint on the first coat and let it dry for four hours. Then I sand the entire surface with a #320-grit sanding sponge. Repeat with a second coat of paint. If there are dry spots or spots you missed, sand the chair again and apply a third and final coat.

The paint is water-based and is safe (as long as you don't drink it).

YOU CAN'T HIDE

The grain of the wood can usually hide a little fudging. Paint exposes your hard lines – such as this pommel.

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 source: Print maker Jan Luyken, 1711, Amsterdam. Now in the collection of the Rijksmuseum

CHAIR COMFORT & DESIGN

As a budding chairmaker, I would read every book and article I could find on chair design. And to be honest, I still do.

The difference is that today I learn about chair design mostly by looking at chairs every day and reading about how they were made. Back in the late 1990s, I was looking for magic formulas to ensure my chairs were beautiful and comfortable.

There are gallons of snake oil out there. One woodworker who had been in the trade his whole life told me about the "Rule of Seven." It goes like 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 always 7°.

This is, of course, not a good rule.

Making a stick chair that looks good and sits comfortably is more complicated than obeying one odd rule. 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 little 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. Sorry to say, however, I think 18" is too high to be the general rule. Old chairs were typically a little lower.

Tall seats are punishing for 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 agonizing after 30 minutes or so.

Slightly shorter seats, however, are just fine for tall sitters. Their feet can still rest on the floor, and their thighs hover above the seat – allowing blood flow. The only downside to a tall person sitting in a shorter chair is the short chair is a little more difficult to get out of.

So, if 18" is too high as an overall rule, what should the height be? The answer is not cut and dried. Here are the questions I ask myself to calculate the seat height when I build a custom chair for a single sitter:

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 use? Work boots, 3"-high heels and moccasins can change the equation.

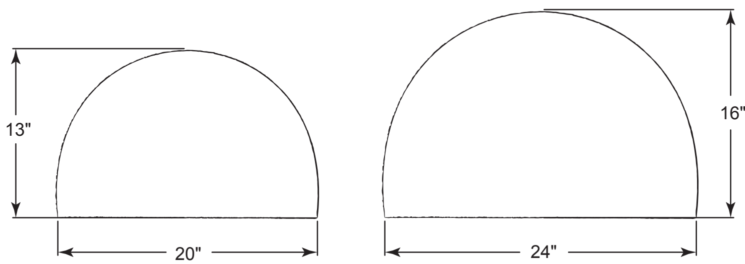
3. What is the chair to be used for? If it's for dining or keyboarding, it should be a little higher so it is easy to mount and dismount. If it is for relaxing, it should be lower. How low? Seats can be as low as 12"-13" for lounging. Low seats allow you to stretch your legs – a luxury. Low chairs are 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. So you should consider those things when deciding on a seat height and perhaps lower the seat a bit.

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 DEPTH & WIDTH

A typical seat depth for one of my 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 disastrous



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.

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 a 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". People have asked for 11" – this height makes some people shrug their shoulders as they sit, and that can be uncomfortable after a time. My rule of thumb is 8" for shorter torsos and 9" for taller ones.

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 are fatiguing to me. 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.

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. As mentioned earlier, 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.

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 "shoe."

I tend to tilt the back sticks about 15° to 20° backward, but I will tilt it 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°. That's about three times as much as normal.

It wasn't as different as expected. This chair was historically used as

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.

a chair in the kitchen – even though it looked more like a chair for sunbathing. Your eyes and expectations can deceive you. So don't believe your eyes, this book or your vicar. Work it out for yourself.

COMB & BACKREST HEIGHT

How high should the comb (aka the crest) or backrest be? It's a trick question. It's quite rare that a sitter's head will ever touch the comb of a typical highback chair. The shoulders usually hit the back sticks, then the sitter's neck brings the head forward. Even some experienced chairmakers position the comb too high.

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 our buttocks. When I started building chairs and examining them closely, I was surprised to find 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 the 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 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 never been 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

THE UNTOUCHABLE COMB

In many comfortable chairs, your back hits the sticks – not the comb. This knowledge allows you to decorate the comb without worrying if the ornament will be uncomfortable. In armchairs, however, the backrest is integral to the comfort of the chair. Best to make it curved (like the human back) 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.

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 in the department of butt comfort.

OVERALL PROPORTIONS & DESIGN

The above numbers and guidelines can help you 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 phrase-

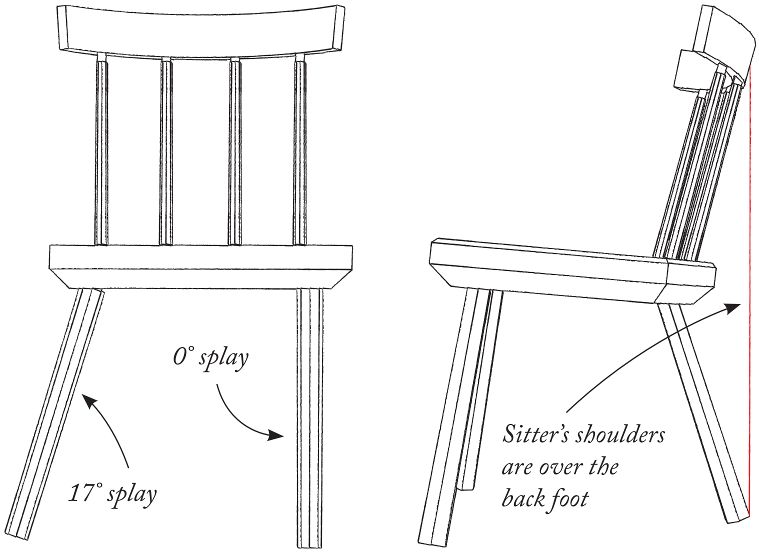
NUDGE THE DESIGN
In the blue lowback, the back sticks are pitched back at 15°. When I decided to make the cherry lowback, I added an undercarriage and pitched the sticks back at 20°. Small changes matter.

book ("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 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 determine 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 …*



CHANGE THE RAKE & SPLAY

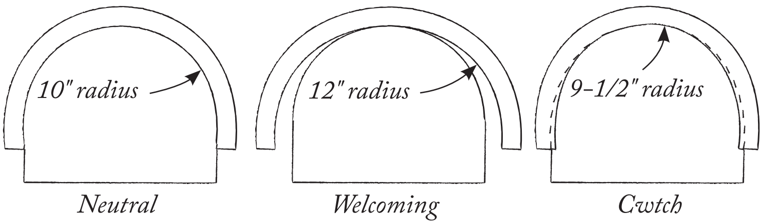
The splay of the front legs changes the entire character of the chair. The rake of the back legs should put the sitter's shoulders directly over the rear foot – for stability

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 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 will collapse? The simple answer is that if the half-scale model or drawing of your chair looks stable and strong, then it most certainly is. And if you are uneasy, then add an undercarriage.

Personally, I like a fair amount of rake and splay. On a typical comb-



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".

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 go 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 don't 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.

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).

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" – 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. I find them to be hard on my spine.

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.

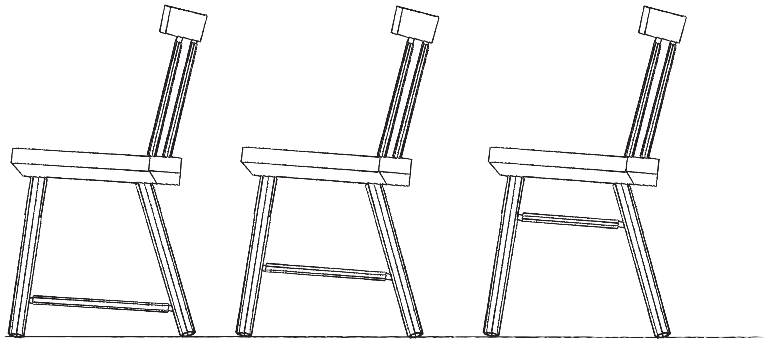
For an oak chair with an undercarriage, I think 300-350 lbs. is the safe upper limit. Again, I'll try to design the arms to suit how stout the chair is. In an oak chair with an undercarriage, I might make the arms a little more "welcoming."

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



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.

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 lifeless, 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 are rare in countries that tightly regulate 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 plane 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 sitter'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.

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.

10. … the back angle needs to be increased/decreased."

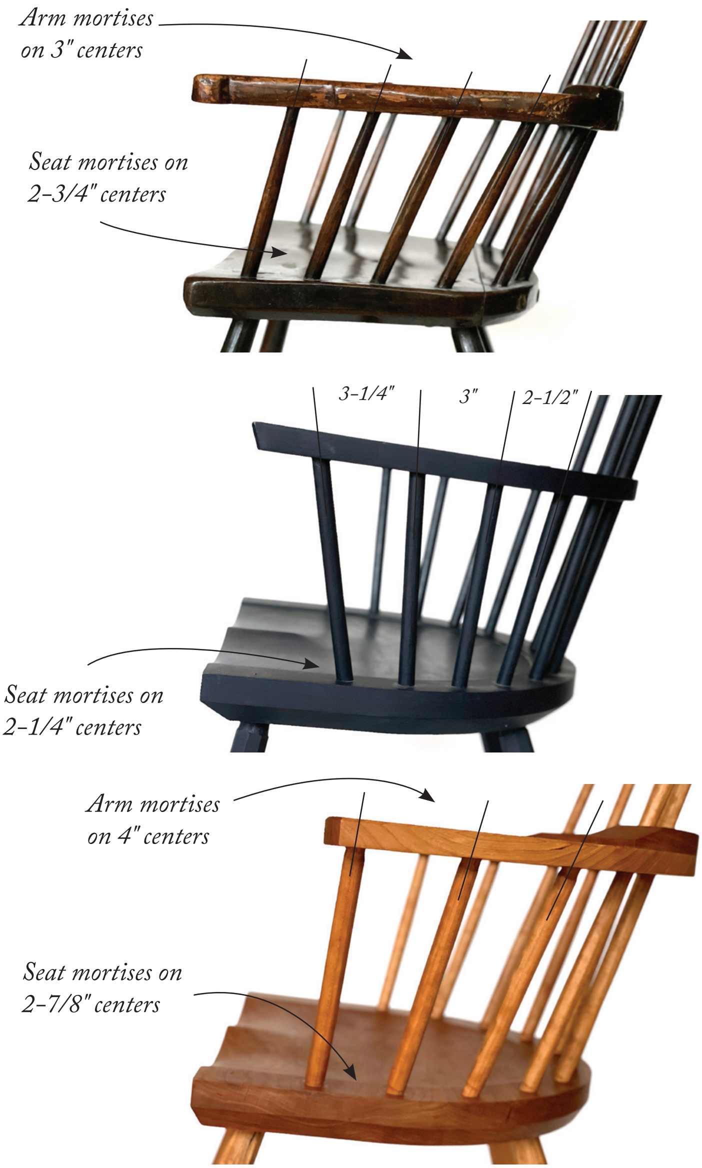
As mentioned earlier, the back angle can be greater than what is typical in modern chairs. If a 20° lean seems too much, first try 15°. After I ventured past 15°, there was no turning back for me.

You might think that chairs with a 20° back would be unsuitable for 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



DIFFERENT STICKS

Spacing the short sticks is one of the ways you can change how the chair looks overall.

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 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

FAN THE BACK

Small changes in the spacing of the back sticks changes the character and comfort of the chair's back.

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 completely. (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 best 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

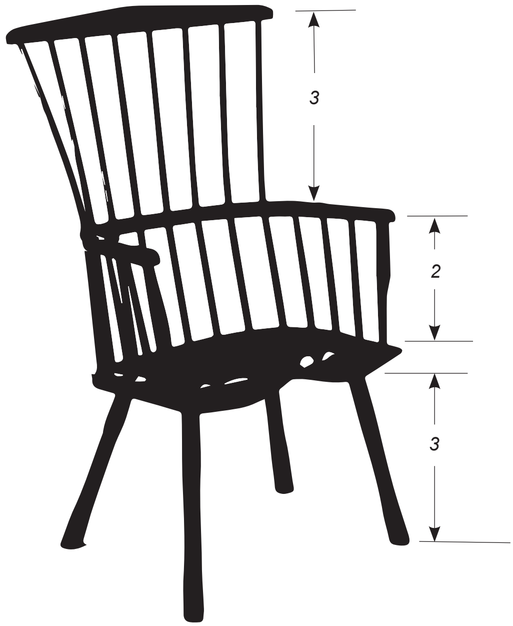
As I drift off to sleep each night, my mind often crawls over the images of chairs that I've seen that day. How did they drill that angle? How did they make those blind mortises in the arms? Stuff like that. One night after looking at every early Forest chair I could find, my mind fixated on why these early Forest chairs looked so harmonious compared to John Brown's early comb-back chairs.

Without thinking, the answer came to me: Forest 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 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. That chair's arm-height to comb-height is close to 1:2 – like a sheet of modern plywood. I always thought the



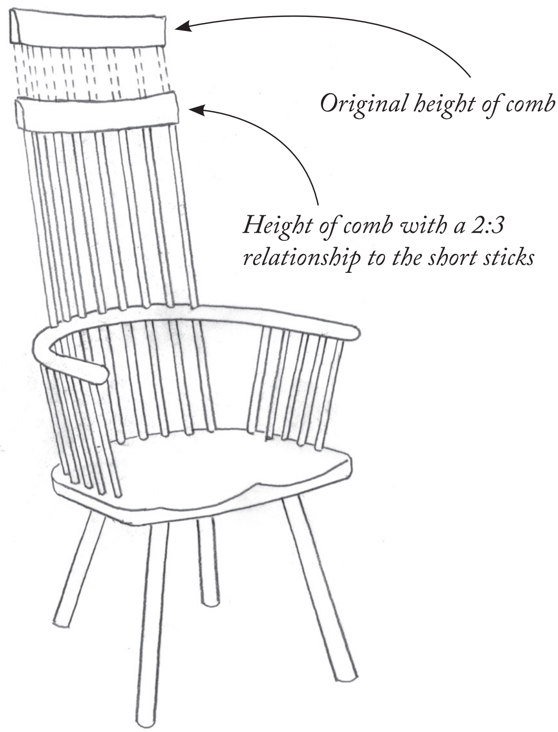
WHOLE-NUMBER RATIOS

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.

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 arm-



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.

chairs 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 are helpful and they do 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 of the tools in your kit. Don't abuse them. If you try to build a cabinet with only an awl, you'll encounter a rough road. 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 human body – chairs are an exoskeleton for people, so there are lines you shouldn't cross (a 24"-high seat, for example).

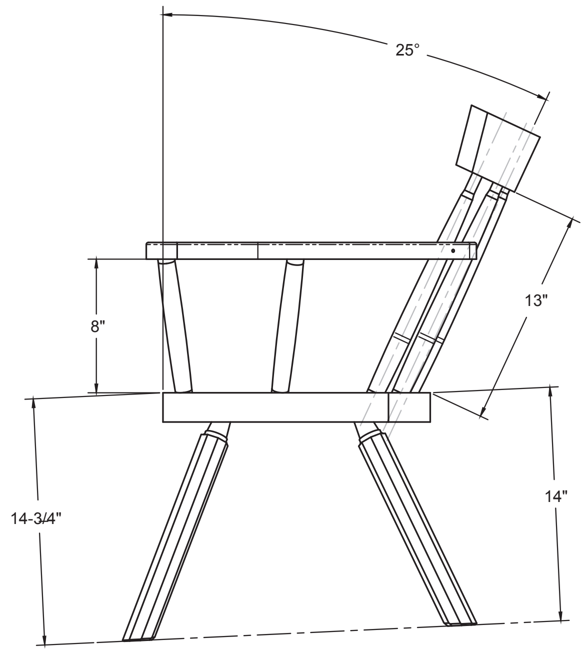
• Common furniture thicknesses and widths, which control the rough size of your lumber.

• The species of wood available, and the mechanical constraints of wood as a building material.

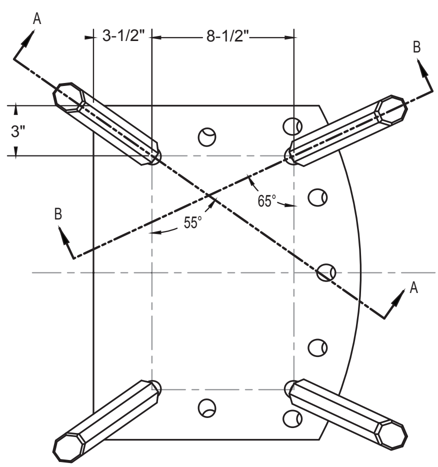
• The joinery that you and your tools can reliably make.

Finally, you have the entire history of chairmaking under your feet. 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.



25°
13"
8"
14-3/4"
14"



A
3-1/2"
8-1/2"
B
3"
65°
55°
B
A

PART III:

5 Chair Plans

There are lots of ways to use chair plans. You can build the chairs exactly as shown so that you can feel the intent of the designer and end up with the chair you expected at the start. Plans can also be a jumping-off place for new designs. Or they can be a peek into the engineering behind the chair – the sizes of the joints and the particular angles that work together.

The following five plans are original works that I have developed during the last 18 years of building and designing chairs. You are welcome to use them any way you like. Make the chairs for your family, sell your chairs to others or ignore this section completely.

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.

This chair is not a copy of an antique. Instead, it 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 chair's 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 1-1/4" at tenon shoulder, directly below the seat.
• Tenons are 1-1/4" 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 barbecue skewer (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°.

THANKS, TESLA

I like using a brace and auger bit whenever possible. But when it comes to 1-1/4"-diameter mortises in maple or oak, a 10"-sweep brace is not going to do it (not with my stick-bug arms).

- Four tenons are mortised into the backrest and pegged with bamboo barbecue skewers (5/32" x 3/4").

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 1-1/4"-diameter holes. I used a 1-1/4"-diameter auger powered by a corded drill. Pushing 1-1/4" 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 hollow auger to cut the 1-1/4" 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. Then use a block plane to shave the shoulder away, blending the facets into the tenon.

(If you don't have a hollow auger, 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 drill-

EASIER THAN THE MORTISES

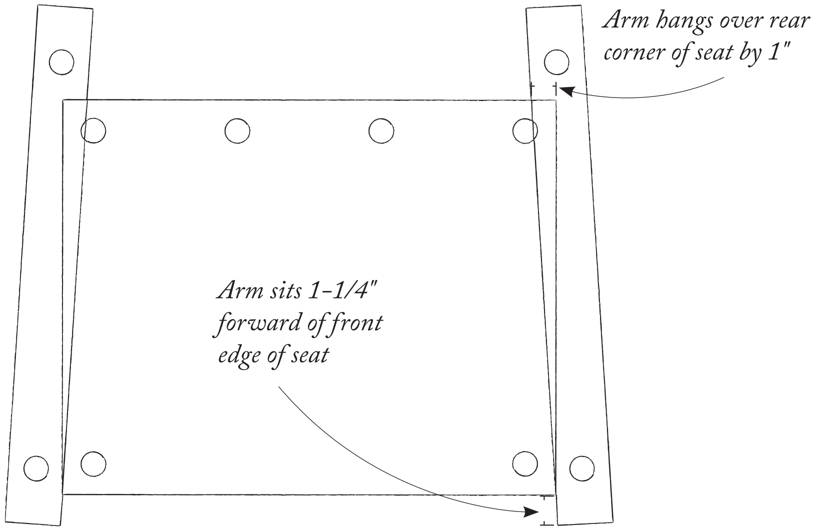
Cutting the tenons by hand is easy with a hollow auger and a brace. The hollow auger's cutter slices across the grain of the leg, which makes the cut almost effortless. The leg shown here is round (not octagonal) because it was for an earlier iteration of this chair.

ing 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 prop up both arms over the seat.

Positioning the arms over the seat is pretty simple using the drawing 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



POSITION THE ARMS

The position of the arm over the seat determines the pitch of the back and the splay of the front post.

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.

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.

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.

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.

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 a dozen human-error factors. 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.

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.

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.

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.

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.

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.

Glue up the chair. I do this one arm at a time. I knock the arms up and down on the back sticks until the arms are dead parallel. Then I wedge the tenons on the front posts.

Take a breath. Glue the two interior back sticks into their mortises in the seat and add the backrest. Make sure the backrest is parallel to the seat. Then use bamboo skewers to peg the arms to the back sticks.

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.

Peg the backrest to the tenons on the back sticks.

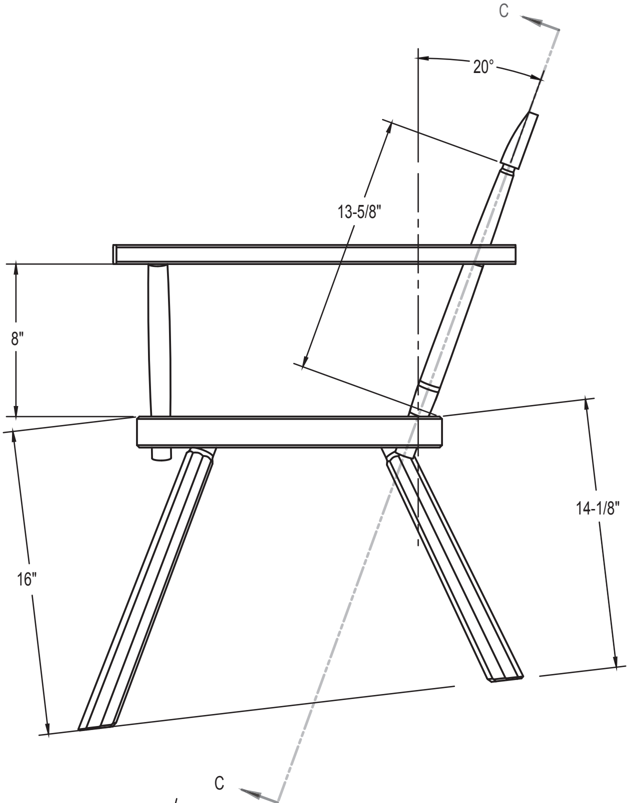
After the glue is dry, saw all the pegs and tenons flush. Level the legs (if you haven't already) and clean up the entire chair.

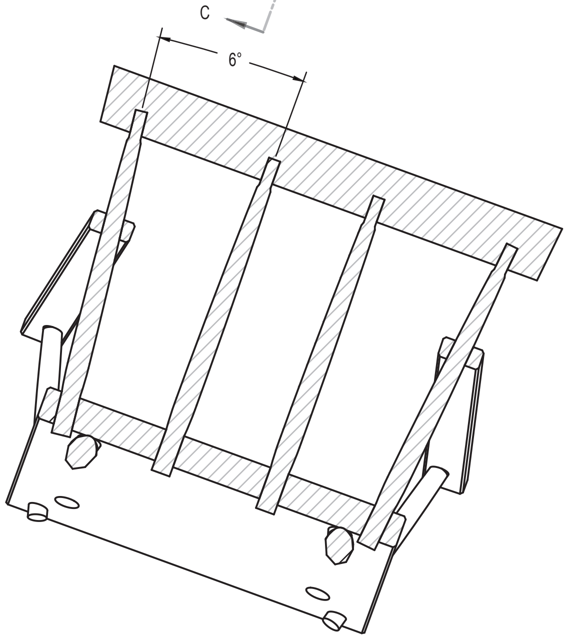
The chair shown here is painted with two coats of General Finishes Milk Paint in Basil.

•••

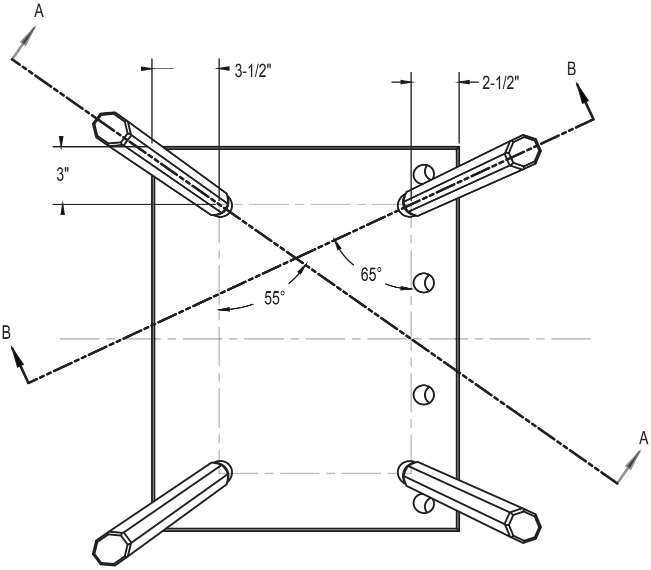
A note on the construction drawings: The following excellent construction drawings were prepared by Josh Cook, a mechanical designer. Drafting a stick chair, however, is like trying to make a construction drawing of a jellyfish. Handmade stick chairs have an organic quality. As a result, use these drawings 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.

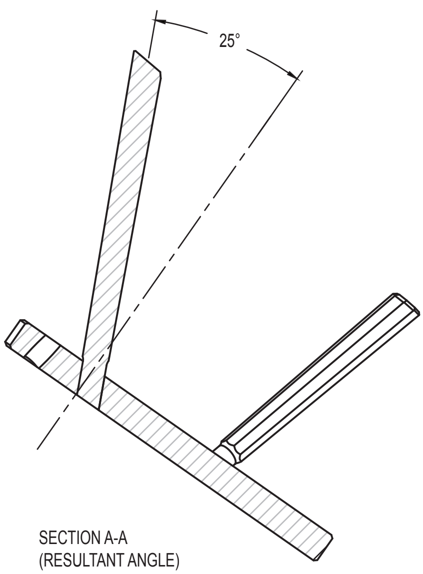
SIMPLE IRISH-Y ARMCHAIR



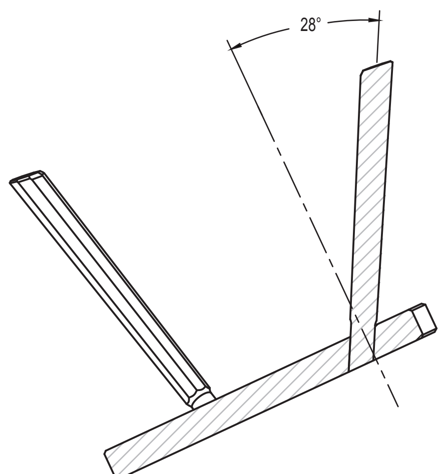


SECTION C-C



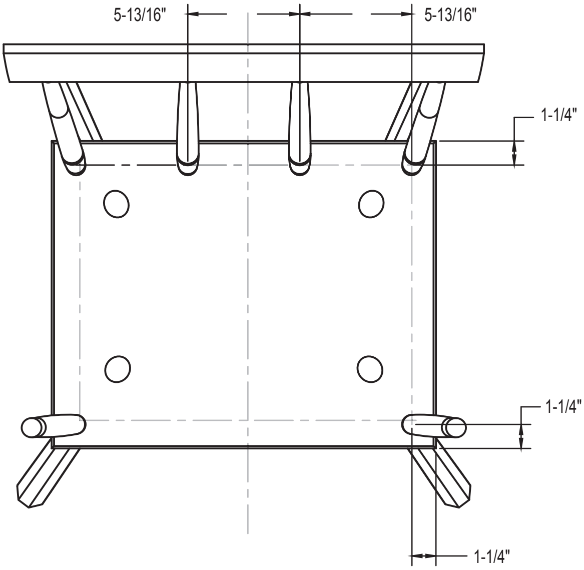


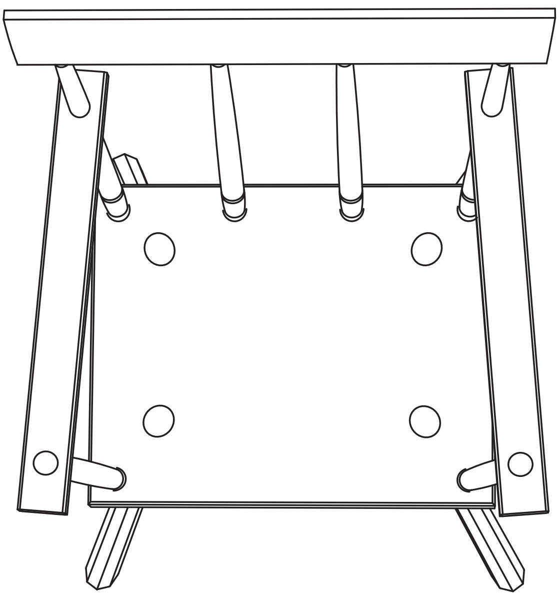
SECTION A-A
(RESULTANT ANGLE)

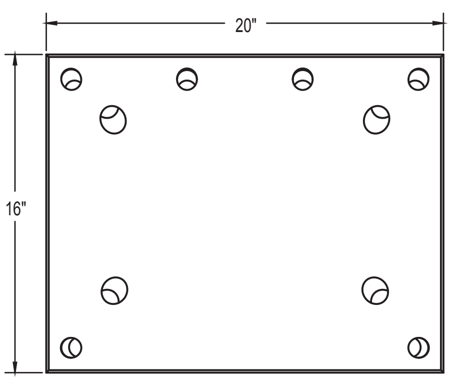


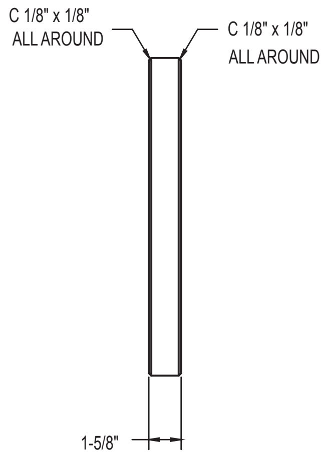
SECTION B-B
(RESULTANT ANGLE)

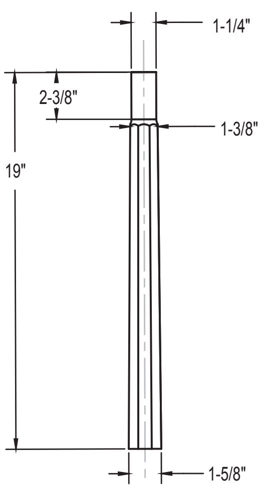
SIMPLE IRISH-Y ARMCHAIR



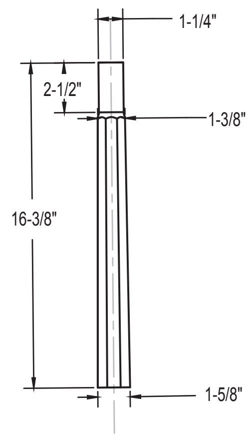




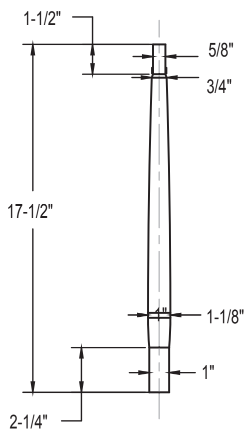


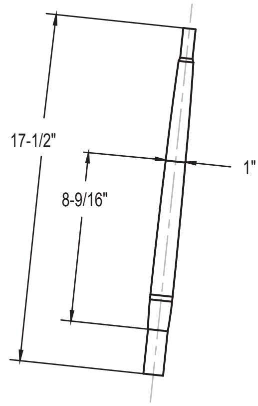


FRONT LEG



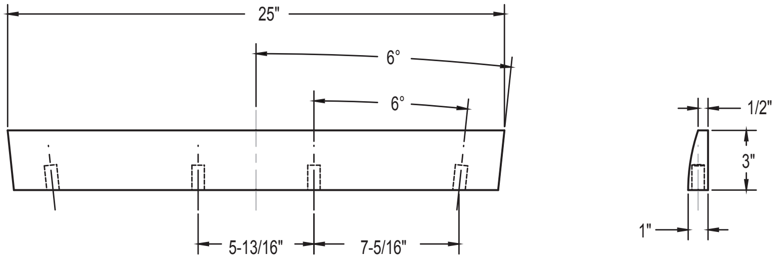
REAR LEG



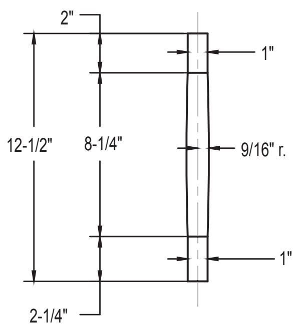


BACK STICK

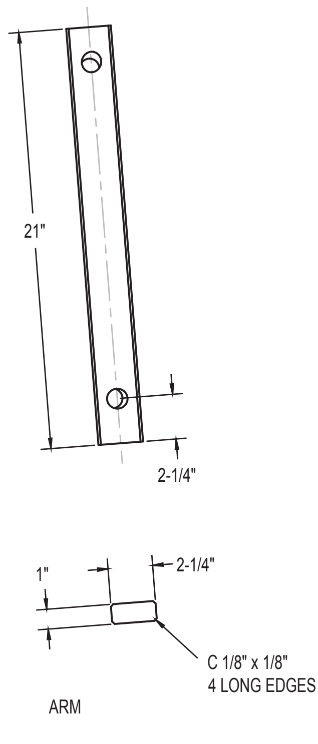
SIMPLE IRISH-Y ARMCHAIR



BACKREST



FRONT POST



ARM

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. This is a luxury the original makers never had.

CURVED-BACK ARMCHAIR

After making several 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, shown here, is a bit of a stylistic 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 some of its details have been pushed in different directions.

The legs are straight octagons – untapered. These legs offer a stoutness that gives the chair some visual weight below the seat. They have the rake and splay of some Irish Gibson chairs I have measured, so they don't look too foreign. The joints that join the legs and seat are tapered cones, which is uncommon in vernacular stick chairs.

The seat is saddled, which is rare among Irish chairs. This saddle has no pommel, which gives it a contemporary look. Removing the pommel also allows the sitter to shift left or right in the seat without interference.

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 curved the backrest and gave it a dramatic sweep with angled ends.

Finally, I built the chair out of American black walnut, which is one of my favorite domestic hardwoods. In the Ohio River Valley where I live, it was once so common that people built frame houses with it (then painted them).

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. And the simple saddle is a good shape for beginners.

For reference, I split the sticks out of kiln-dried walnut. The other

A LITTLE METAL

After cutting the seat to size, I noticed a little bit of honeycombing at one back corner. Nothing structural. Yet I had blacksmith Mark Gilsdorf make two iron brackets – just in case.

components were sawn out of walnut boards from the lumberyard. You should, of course, use whatever wood you have on hand. And if you have to mix wood species, paint will unify the chair's form.

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: 1-5/8" x 1-5/8" x 19" (over-long and cut to length after assembly)

• Legs are straight octagons (no taper).
• Tenons are tapered cones (12.8° included angle). Tenons are 1-1/4" diameter at their base. Where the tenons enter the underside of the seat, they are a smidge more than 1" in diameter.
• The transition between the octagon and tapered tenon is a 5/16"-high cove.

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 no pommel.
• As built, the front edge of the seat (at the saddle) is 14-3/4" from the floor. Rear edge of seat is 14" from the floor (measured from the top of the spindle deck). So the seat tilts 3/4" from front to back.

4 Short sticks: 1-1/8" diameter x 12-1/2"
• The front posts are shaved with entasis to blend into 1"-diameter tenons on both ends. See the illustrations for lengths.
• 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. 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)
• Top edges of arms are rounded over with rasps; it's an 1/8" x 1/8" roundover.
• Back sticks that pass through an arm are pinned with barbecue skewers (5/32" x 2").

5 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 the shoulder of the top tenon.
• Tenons on the bottom of the back sticks are 1" diameter x 2-1/4" long. These tenons pass through the seat and are sawn flush. No

wedges – though some old chairs are wedged from below.

• Tenons on the top of the back sticks are 5/8" diameter x 2" long.

• Shoulders at the tops of the sticks are shaved to blend into the tenons.

• All back sticks tilt 25° back and are vertical in elevation.

• The back sticks that pass through the arms are tapered to 1" at the location of the arm to pass through a 1" hole in each arm.

1 Backrest: 1-1/4" x 3-5/8" 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 at 20°.

• The tenons of the two exterior back sticks are pinned with a barbecue skewer (5/32" x 1"). 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 at least two boards. I recommend you add three loose tenons to the edge joint and peg them on the underside of the seat. This traditional Roman construction will outlast the glue.

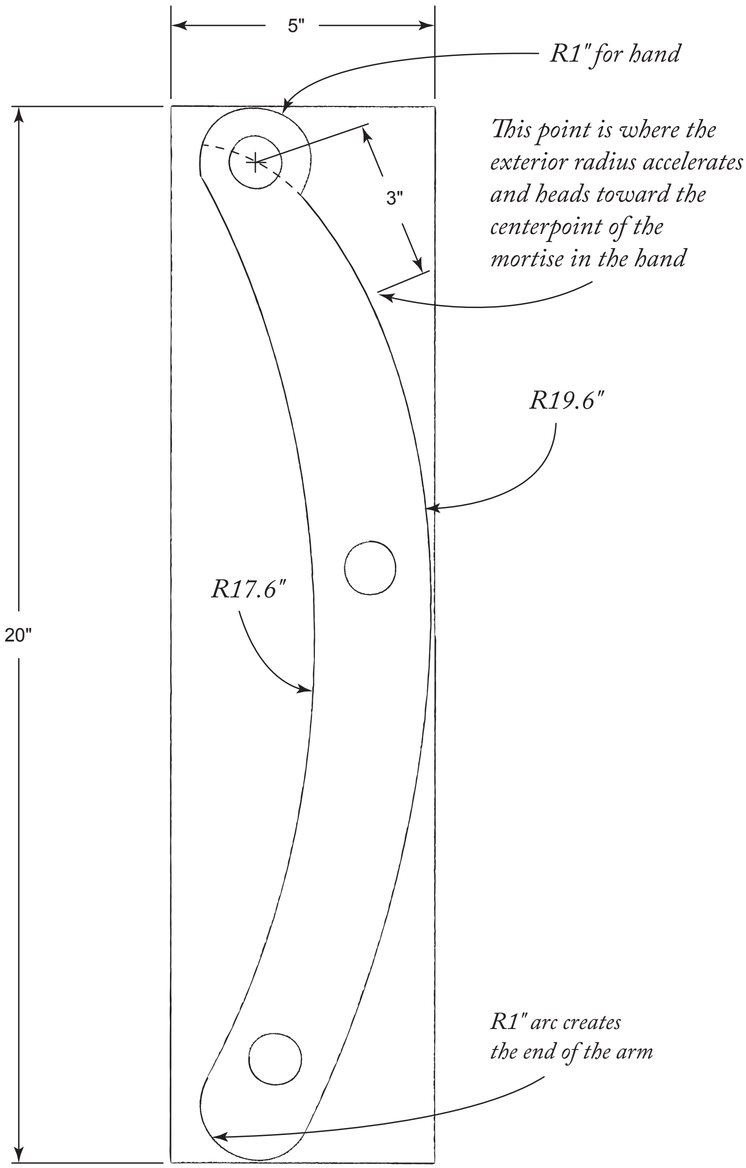
Cut the seat to size and lay out the locations of the leg mortises and the sightlines. Because this chair uses tapered tenons, you will first drill a 5/8" pilot hole for each mortise then ream it to a cone shape. The resultant angle for the front legs is 25°. The resultant for the rear legs is 28°.

After drilling the pilot holes, ream the four leg mortises using a tapered reamer. Check the angle of your joint with a dummy leg. Make adjustments if needed. Try to ream the mortises all to the same depth so that the tenon shoulders on the legs will be at the same height.

MAKE THE LEGS

The legs are straight octagons. The tapered tenon on the top of each leg was turned rough on the lathe – about 3-1/8" long. Then I turned a 5/16"-tall cove at the shoulder. I don't use the lathe much when making stick chairs, but I wanted the transition between the tenon and octagon to be crisp. For a more traditional look, skip the lathe and blend the octagonal facets into the tenon with handplanes.

CURVED-BACK ARMCHAIR



ARM PATTERN

Then finish shaping the tenons on the legs with a tapered tenon cutter. 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.

MAKE & DRILL THE ARMS

The arms are sawn from solid stock. Because of the curve, you will have some short grain. If you take care during assembly, the arms will survive just fine. If you prefer, you can bend the arms to eliminate any potential for short grain, or 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.

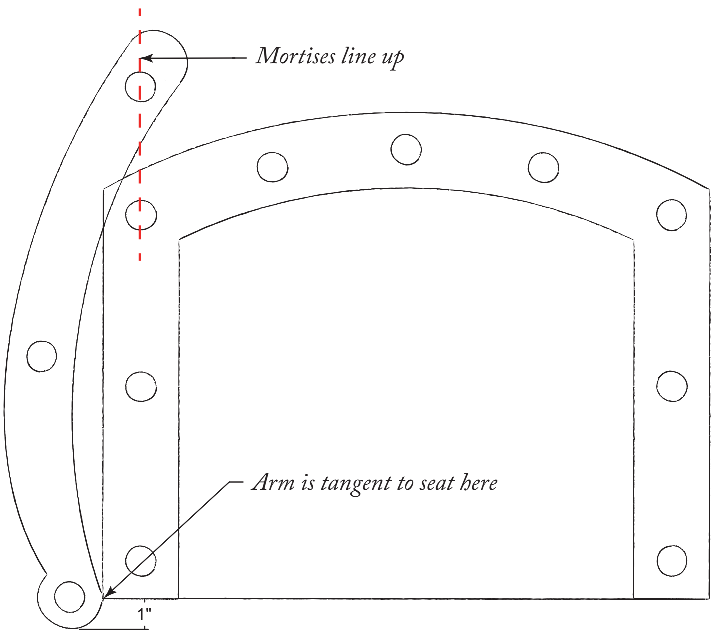
Position the arms over the seat using the 8"-wide drilling jig plus a scrap to hold them in place (see the photo on the facing page). Looking down directly from above, the front of the arms should be tangent to the front corner of the seat with 1" of the arm forward of the seat. The rear mortise in the arm should be in line with its rear mortise in the seat. Shift the arms around until both are in position. Then clamp the arms in place so they won't move during drilling.

Drill the mortises through the arms and through the seat. All these mortises are 1" in diameter. Use a backing block to reduce spelching on the exit side of your holes. Don't, however, drill the three center mortises for the back yet. Those require a simple drilling jig to make sure you drill them dead-on. That drilling jig needs to attach to the back sticks, so it's time to make sticks.

MAKE THE STICKS

Make the sticks from octagonal pieces. After sawing or planing your sticks octagonal, cut the 1"-diameter tenons on both ends of the short sticks and on the bottom of the back sticks. Then cut the 5/8"-diameter tenons on the tops of back sticks. If you are unsure how high your backrest should be, you might want to wait to try out the dry-fit chair before deciding the final length of the back sticks.

With all the tenons cut, shave the octagonal sticks round and taper them toward their tenons. I use a jack plane and block plane. The back



READY FOR DRILLING

The arms are in position over the seat. After a few more clamps It'll be ready for drilling. The photo shows how the drilling jig and a scrap hold the arms 8" off the seat. The illustration shows where the arms are positioned in relation to the seat below.

sticks that pass through the arm need to be shaved more near the top so they will pass through the 1" hole in the arm and have 8" of stick (plus the tenon) sticking out below the arm. Sometimes lightly reaming the hole from the underside of the arm helps fit the back sticks.

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.

DRILL FOR THE BACK STICKS

Make a plywood template for the backrest. This template will both lay out the shape of the backrest and serve as a drilling jig for the three remaining mortises in the seat.

The template has a 21-1/4" radius for the interior curve and a 22-1/2" radius for the exterior curve. And the template is 24" long.

Find the centerpoint on the tenons of the two back sticks in the dry-fit chair. The centerpoints should be 17-1/2" apart from one another. Confirm that number. The idea is to attach this template to the back sticks with screws. Then use holes in the template to guide your drilling, much like using a doweling jig.

First drill clearance holes in the template for screws that are 17-1/2" apart and centered on the template. Then use the construction drawings to lay out the locations of the three mortises in the template. At these three locations, drill a hole that is slightly larger than your drill bit's extension shaft. The idea is to thread the extension through the template and use these holes to guide your drilling.

Drill pilot holes into the back sticks in the dry-fit chair. Then screw the template to the back sticks.

Attach a 1"-diameter drill bit to your extension shaft. Thread the extension shaft through the template from underneath and chuck it in your drill. Clamp a backing block to the underside of the seat. Now drill the three through-mortises in the seat. Thanks to the template, the holes will be at the correct angle.

MAKE THE BACKREST

The backrest is cut from solid stock. I first glue two layers of 8/4 stock face-to-face to make a block that is thick enough to make a backrest that is 3-5/8" high. Use the template/drilling jig to lay out the

CAN'T MISS

By screwing the template for the backrest to the back sticks, you create a jig that makes it easy to drill the mortises in the seat at the correct angle.

shape of the backrest. The holes already in the template allow you to easily lay out the location of the five mortises.

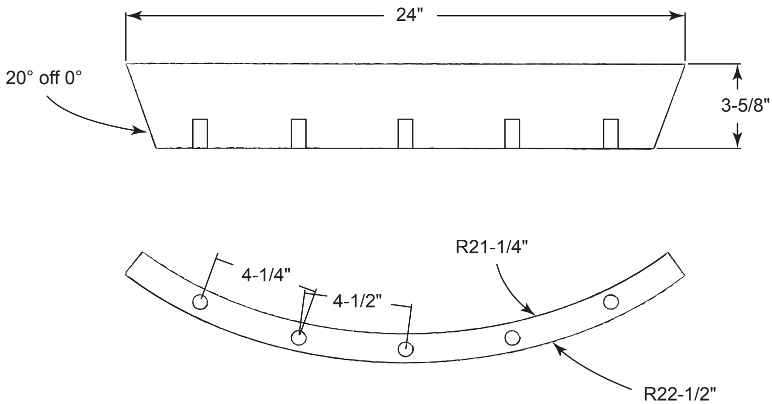
Saw out the shape. Then drill the five 5/8" mortises in the backrest. These holes are vertical. Cut the 20° angle on the ends of the backrest and clean up the part with spokeshaves, scrapers and sanding. Then fit the backrest onto the back sticks. If everything looks good and fits, disassemble the chair.

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. There is no pommel to this seat, so you are trying to create a flat saddle that curves up to the spindle deck.

CUT FROM SOLID

By matching the grain and color, you can make a laminated backrest that looks like one solid chunk of wood. I do this by cutting the curved pieces right next to each other in a board.



BACKREST PATTERN

Then finish up the saddle with a travisher, scraper and sandpaper. The finished saddle is 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 a rasp, scraper and sanding. Ease all the top edges of the arms. I left the bottom edges of the arms square. Clean up all the sticks. Look for tear-out using a low, raking light and remove it with a scraper or sanding.

Assembly is in three stages. I glue and wedge one arm and its sticks in place. Then I glue and wedge the other arm and sticks in place, making sure the arms end up parallel. Then I glue the backrest onto the back sticks and peg the tenons with bamboo skewers. I don't recommend gluing everything in one go.

Finally, level the legs. These armchairs don't need a lot of tilt to the seat to make them comfortable. A tilt of 3/4" or a little more is plenty.

After the glue is dry, cut all the tenons, wedges and pegs flush

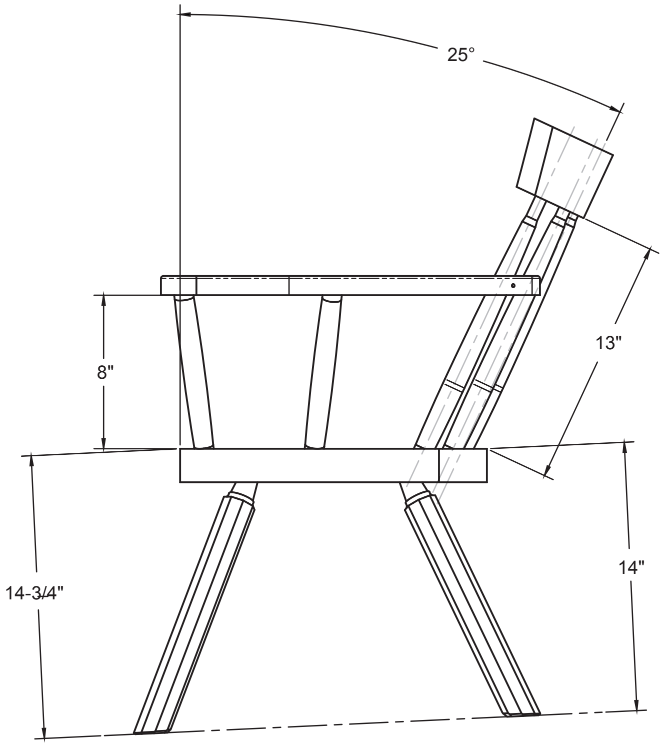
SIMPLE SADDLE

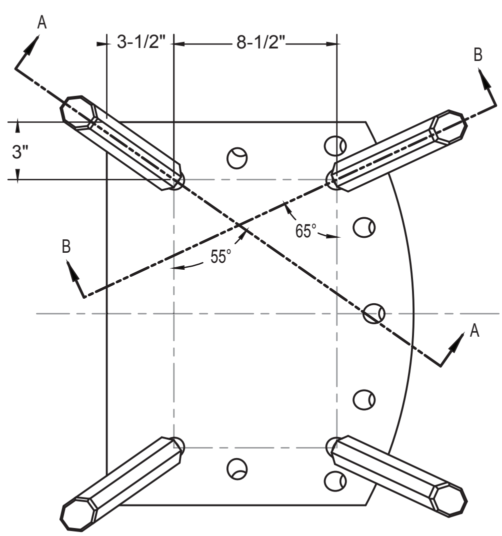
Without a pommel to deal with, the saddle is simply an exercise in leveling the wood with a scorp and travisher. This is great practice before tackling more complex saddle shapes.

CURVED FOR COMFORT

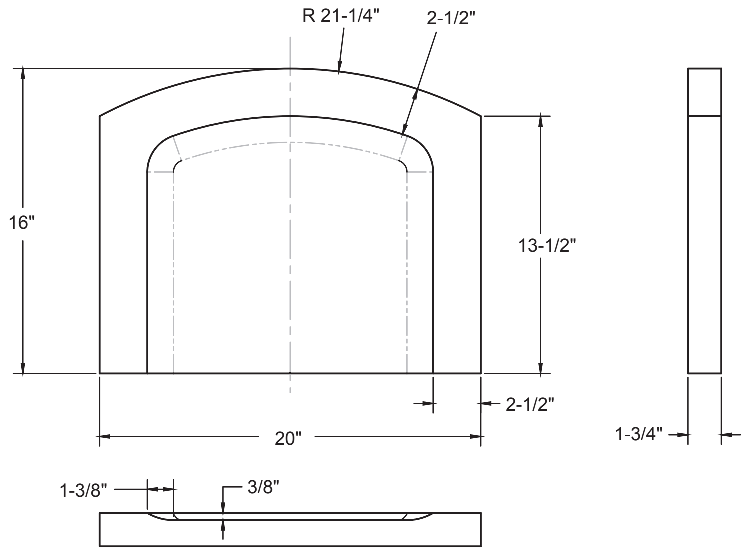
Ease all the sharp corners of the arms with a cabinet rasp. Follow up with scraping and sanding to make the arms as comfortable as possible.

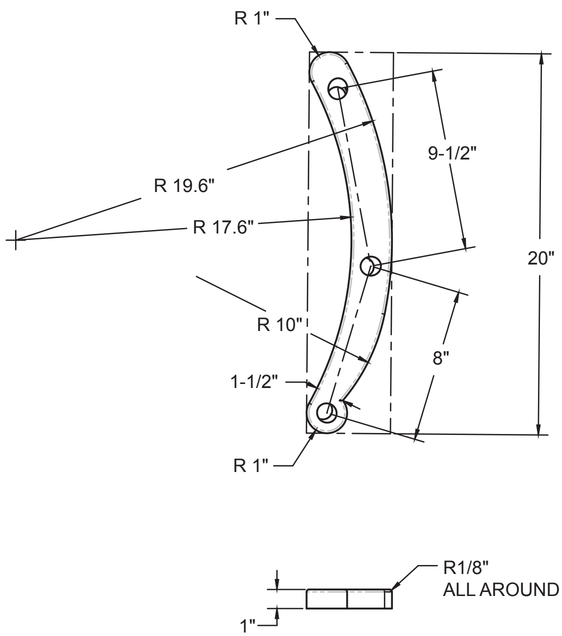
(including the tenons on the underside of the seat). Clean up any tool marks and finish the chair. I used a linseed oil/wax finish. I apply the goop with a 3M woven gray pad then buff the chair dry with a huck towel. Three weeks later I add a second coat and buff it off. This finish will last a good two years 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.

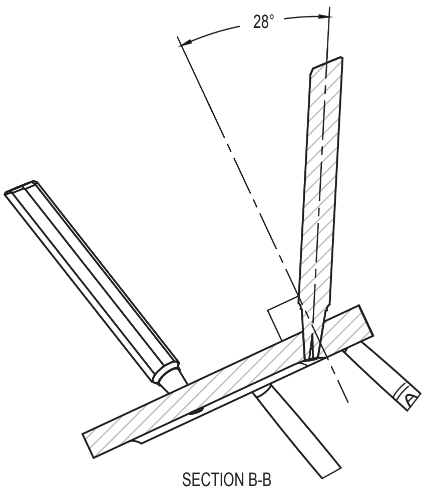

25°
13"
8"
14"
14-3/4"


A
3-1/2"
8-1/2"
B
3"
65°
B
55°
A

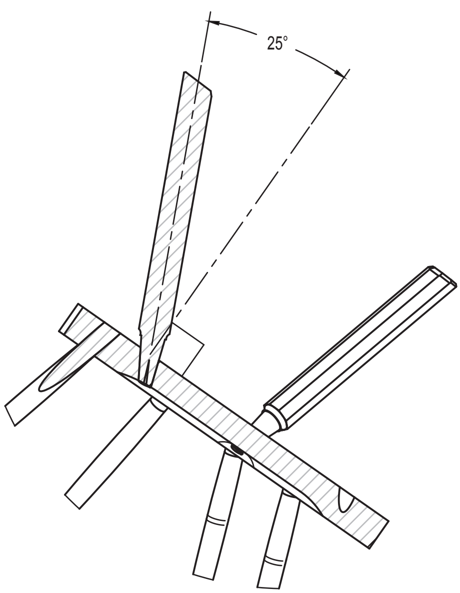
CURVED-BACK ARMCHAIR





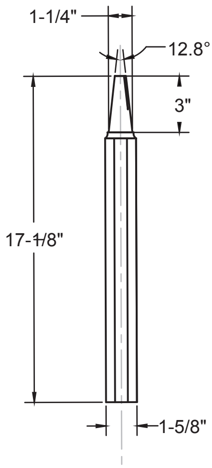


SECTION B-B
(RESULTANT ANGLE)

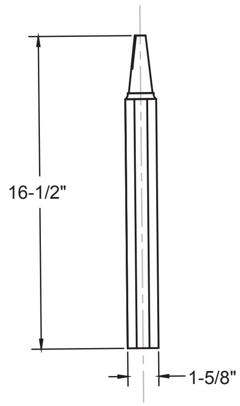


SECTION A-A
(RESULTANT ANGLE)

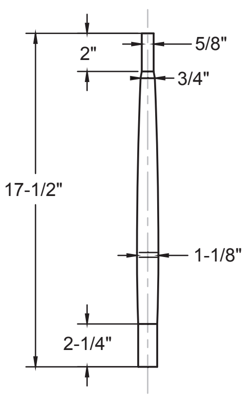
CURVED-BACK ARMCHAIR



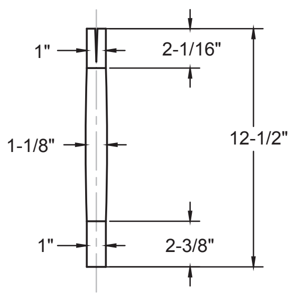
FRONT LEG
(PRE-TRIM)



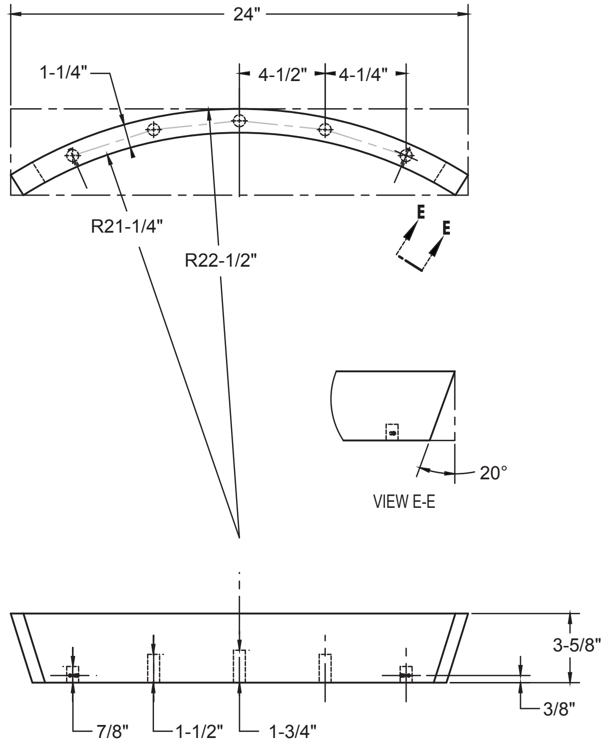
REAR LEG
(PRE-TRIM)

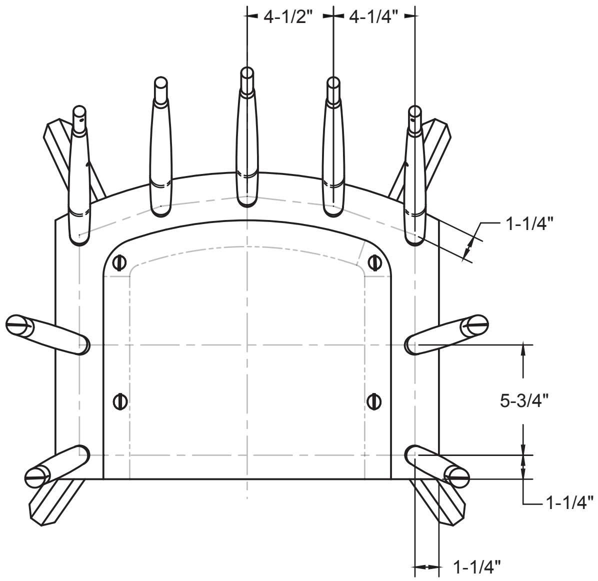


BACK STICK
(PRE-TRIM)

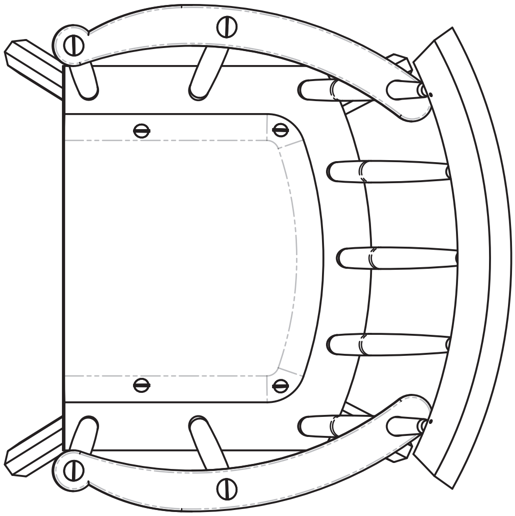


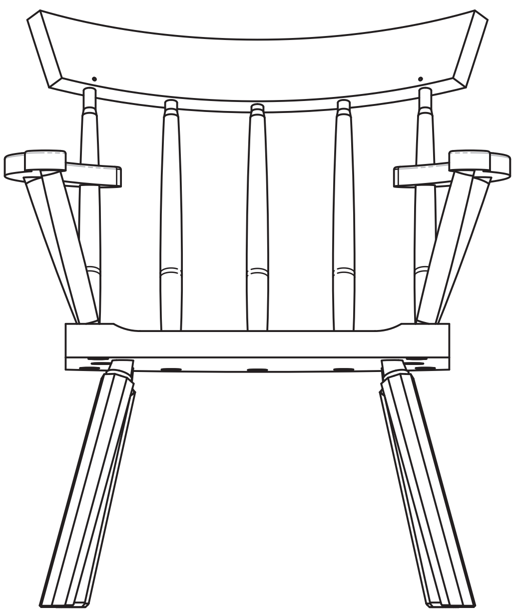
SHORT STICK
(PRE-TRIM)


24"
1-1/4"
4-1/2"
4-1/4"
R21-1/4"
R22-1/2"
E
E
20°
VIEW E-E
3-5/8"
3/8"
7/8"
1-1/2"
1-3/4"


4-1/2"
4-1/4"
1-1/4"
5-3/4"
1-1/4"
1-1/4"

CURVED-BACK ARMCHAIR





PASS ON THE 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 particularly 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 combback, even though a lowback is just as much work. Despite these shortcomings, however, I think lowbacks are worth studying and building.

I set out to design a version that is both comfortable and attractive. Whenever I create a new piece, I first like to examine beautiful historical examples. And while I'm sure there are gorgeous old lowbacks out there, I haven't encountered them.

That's why I turned my attention to the geometry and curves on other chairs I admire.

After building several Irish Gibson armchairs and living with them, my brain has a different take on angles. 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 a lowback. 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 I've studied is about 25° off 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 a longer period of time.

With these numbers in mind, I began designing lowbacks with a tilt and curvature that is similar to those two chairs. Plus – and I think this is key – I made the backrest taller than my eyes 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 a lot more support than a typical lowback, and I think 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 1-1/8" where they transition into round. No shoulder.

• Tenons are tapered cones (12.8° included angle) and are about 3" long. The tenons are about 1-1/8" in diameter at the base and 5/8" at the top. Where the tenons enter the underside of the seat, they are approximately 1" in diameter. 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 front "swoops" are an 11" radius (about 3/4" high).

• Seat has an underbevel that is 3/4" tall at 30°.

• 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 6-1/2" x 20" blanks

• Arm segments are joined with two pocket screws.

• Part of the assembled arm is then covered with the "backrest." The top edge of the areas that are not covered by the backrest are beveled – 1/8" x 1/8".

1 Backrest: cut from 3-1/4" x 6" x 20" blank

• Curved front edge is cut at 30° off 0°.

• Ends have a 3"-radius cove that ends with a 1/4"-tall flat at the ends of the backrest.

• Backrest is glued to arm assembly, centered on the arm.

10 Short sticks: a bit less than 3/4" diameter x 12-1/2" (they start out as 3/4" octagons and are shaved round)
• Sticks are shaved with entasis. Each end has a 5/8" x 2-1/4" tenon.
• Tenons into the seat are trimmed and glued into blind 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.

2 Side stretchers: 1-1/8" x 1-1/8" x 18-1/4" (approximate length)
• Stretchers have 5/8"-diameter x 1-1/4"-long tenons on both ends.
• Stretchers are octagons. They taper from 1-1/4" square at the center to 3/4" square at tenon shoulders.
• Tenon shoulders are not blended into the tenons. There is a hard 90° shoulder.
• Stretcher assembly is 11" below the seat and parallel to the seat.

1 Medial stretcher: 1" x 1" x 18" (approximate length)
• Medial stretcher has 5/8"-diameter x 1"-long tenons on both ends.
• Medial stretcher is an untapered octagon.
• Medial stretcher is centered on the side stretchers.

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 to guide you. Because this chair uses tapered mortises and tenons, first drill a 5/8" pilot hole for each mortise then ream each hole to a cone shape. The resultant angle for the front legs and back legs is 23°.

After drilling the pilot holes, ream the four leg mortises using a tapered reamer. Check the angle of your joints with a straight-sided dummy leg (I use a dowel). Make adjustments if necessary. Try to ream the four mortises to the same depth. Shape the underbevel on the bottom of the seat.

MAKE THE LEGS & STRETCHERS

The legs are tapered octagons that blend into the tapered 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 taper the end of each leg into a cone shape that can be shaved with a tapered tenon cutter. To do this, first drill a shallow 5/8"-diameter hole in the top of each leg. This serves as a target dimension. Use a jack plane to taper and round the top 4" of each leg down to the 5/8" target. Then use a tapered tenon cutter to finish shaping the four tenons.

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 mortises for the stretchers (use a backing block if using through-tenons). Then measure from the bottoms of both mortises 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 bottom of the mortises and make the medial stretcher to fit. Dry-fit the undercarriage.

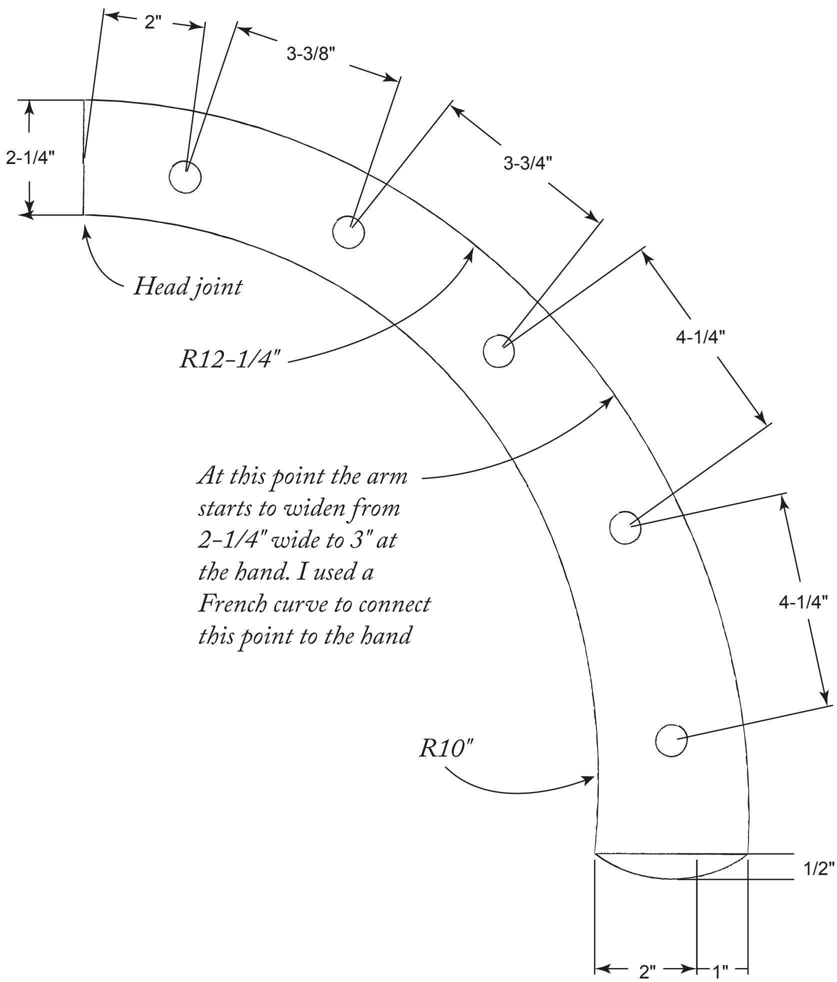
MAKE THE ARMS

The arms aren't as tricky as they might look. Here's a quick overview of the construction and drilling process. First, I saw out the two arm segments 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 screws if you like. No one will see them as they are covered by the backrest.

Then I shape the backrest and glue it to the arms. Once the glue is dry, I deepen the mortises in the backrest from the underside of the arms. Easy.

Begin making the arms by using the pattern on the next page to saw the arms to shape. Avoid short grain in the hands. Clean up the "head joint" (where the two arm sections will be joined) and drill pocket holes in one arm segment. Apply glue to the head joint and screw the two arm segments together.

Once the glue is dry, position the arm assembly on the drilling jigs over the seat. You can position it anywhere from 20° to 25°. The fin-


2"
3-3/8"
3-3/4"
4-1/4"
4-1/4"
2-1/4"
Head joint
R12-1/4"
At this point the arm starts to widen from 2-1/4" wide to 3" at the hand. I used a French curve to connect this point to the hand
R10"
1/2"
2"
1"

ARM PATTERN

SPIRAL CLAMPS

Pocket screws are an excellent way to join the two arm segments together. The grain at the head joint is a long-grain-to-long-grain joint.

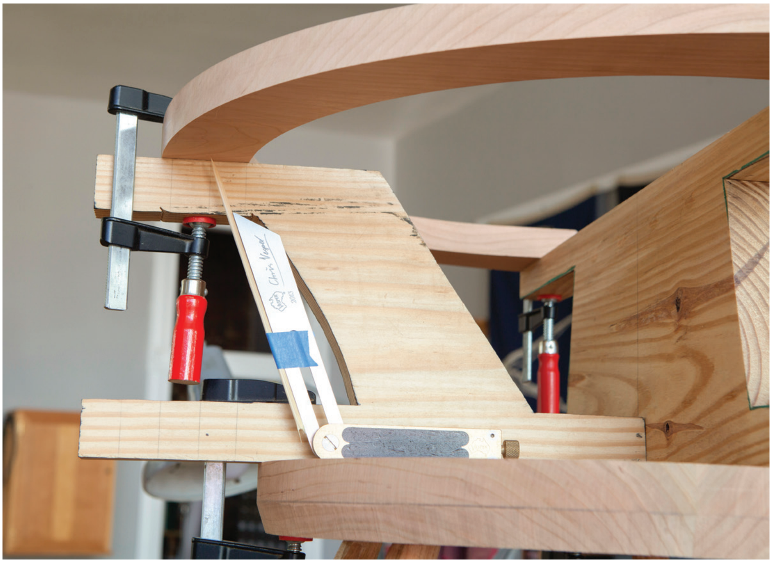
ished photos of the chair show a 21° pitch. If you use more pitch, it will change the way the short sticks look at the front of the chair.

Drill the mortises through the arms and into the seat. The blind mortises in the seat are 1-1/2" deep. After the arms and seat are drilled, shape the hands and remove any ugly tool marks on the two faces. Don't mess too much with the edges because you will clean those up after gluing the backrest on top of the arms.

THE BACKREST

Unless you have some 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.

Tape the waste piece back to the backrest and lay out the cove cuts on the ends. The coves are a 3" radius. You can lay them out with a



SET THE PITCH

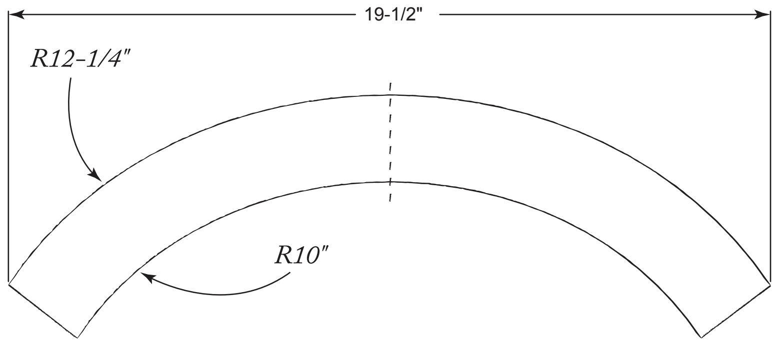
Set a sliding bevel to the pitch you want for the back (this chair is at 21°). A bamboo barbecue skewer extends the tool's reach. Use this to set the position of the arm on top of the drilling jigs.

compass or make a paper pattern. In either case, make some 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 spokeshaves and 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 backrest and arm pieces together using 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. These mortises can't go that deep – maybe 1-1/4". Don't forget to shorten the tenons of the sticks for these mortises.

LOWBACK STICK CHAIR



BACKREST PATTERN

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 – it's important for future steps.

LIKE A CABRIOLE LEG

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.

MAKE THE STICKS

The 10 short sticks are all made the same way. If you are using a hollow auger to make the tenons, cut the tenons first. Then shape the rest of the sticks with handplanes. If you are making the tenons with your handplanes, then shave, taper and tenon the sticks all in one go.

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. Dry-fit the seat, sticks and arm to ensure the chair will go together. Some of the tenons might have to be trimmed so the chair fits together. Then take everything apart.

CUT THE SWOOPS

Use with-the-grain cuts to work down to the line on the front edge of the seat. Clean up the cuts with a spokeshave.

SADDLE THE SEAT

Draw the 2"-wide spindle deck on the seat and draw the 11"-radius "leg swoops" that join the pommel with the spindle deck. Rough out the seat with a scorp or adze. Use a scorp to cut the swoops 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 leg tenons and let the glue sit overnight. The next day, saw the leg 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. Low-

REFINE THE ROUGH

Blend the back of the seat with the swoops up at the front using a travisher. Work until all the scorp marks are removed.

backs 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.

Clean up the sticks and arm assembly. Now glue the rest of the chair together. Glue the sticks into the arms. Then paint glue into the blind mortises in the seat. Push the sticks into their mortises in the seat. Then gently 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.

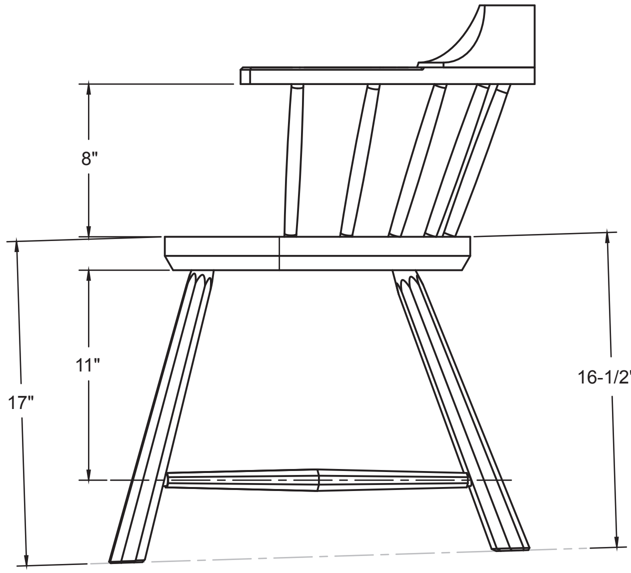
The next day you can saw the tenons flush and do the final cleanup. Shape the arms with rasps or a trim router with a chamfer bit.

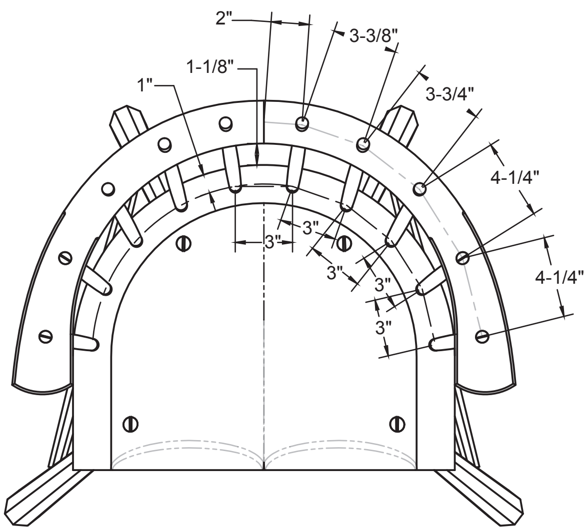
The finish on the example shown here is a mixture of linseed oil and wax. Wipe on a coat with a woven 3M gray pad. After 15 minutes use a huck towel to wipe off all excess finish. If you did it correctly, the surface will be usable in a couple hours. You can apply a second coat in a few weeks if necessary.

LOWBACK STICK CHAIR

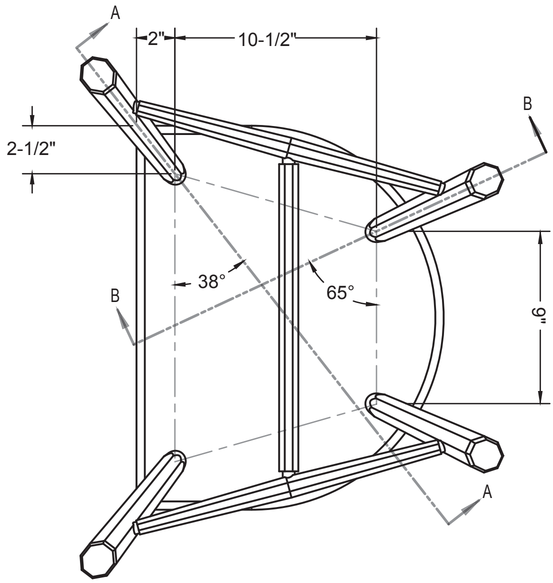
EARLIER EDITION

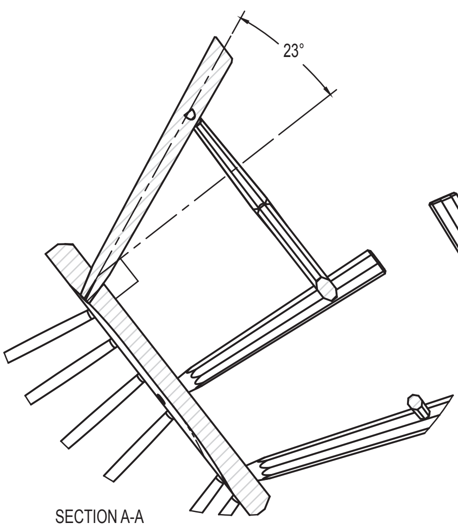
Here is one of my earlier prototypes. No undercarriage, straight sticks, thinner arms and a less-dramatic saddle.


8"
11"
17"
16-1/2"

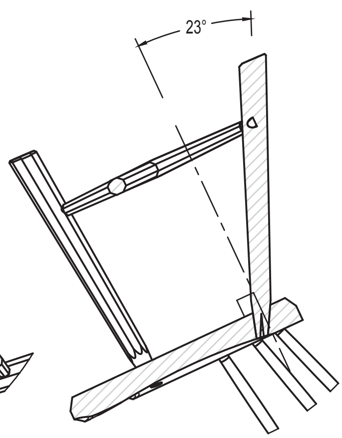

2"
3-3/8"
1-1/8"
1"
3-3/4"
4-1/4"
3"
3"
3"
3"
3"
4-1/4"

LOWBACK STICK CHAIR

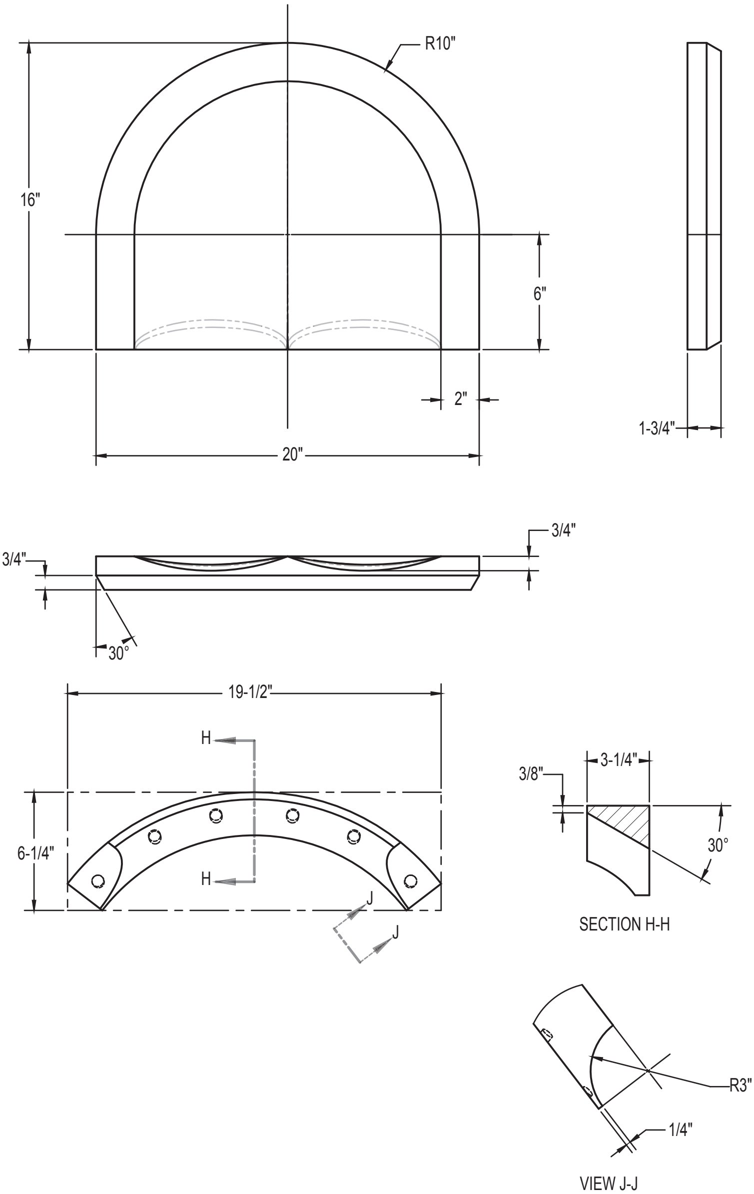




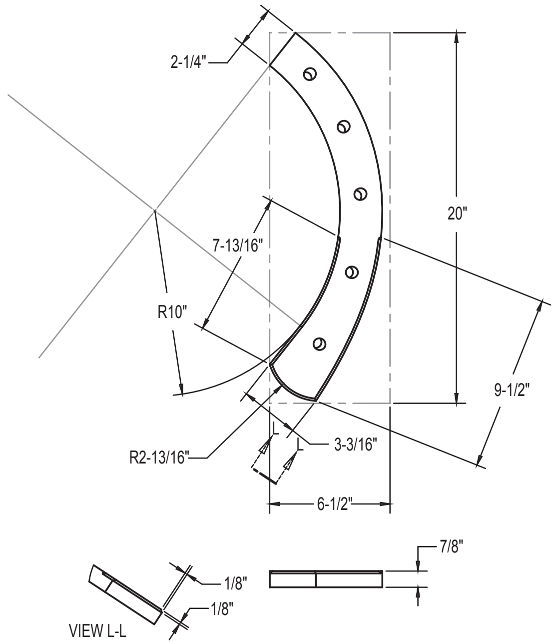
SECTION A-A
(RESULTANT ANGLE)

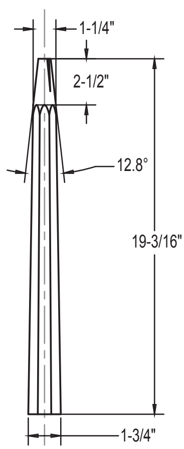


SECTION B-B
(RESULTANT ANGLE)

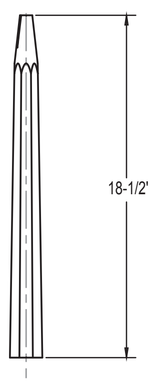

R10"
16"
6"
2"
20"
1-3/4"
3/4"
3/4"
30°
19-1/2"
H
H
J
J
6-1/4"
3/8"
3-1/4"
30°
SECTION H-H
R3"
1/4"
VIEW J-J

LOWBACK STICK CHAIR

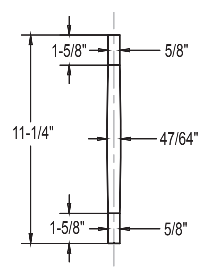




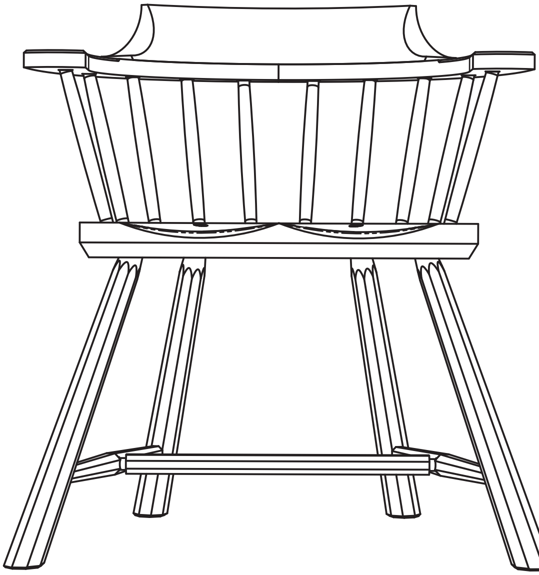
FRONT LEG (PRE-TRIM)

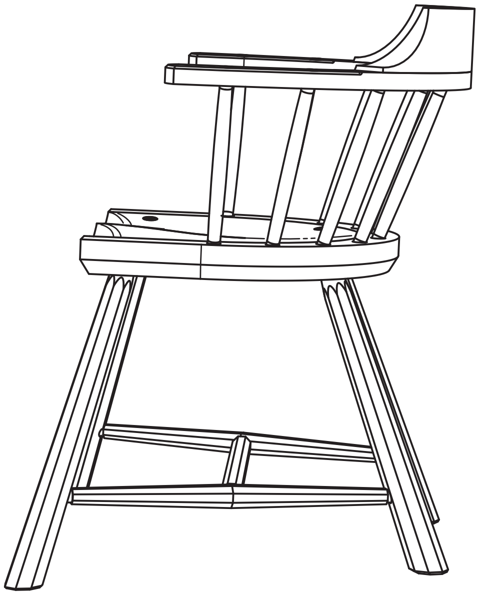


REAR LEG (PRE-TRIM)

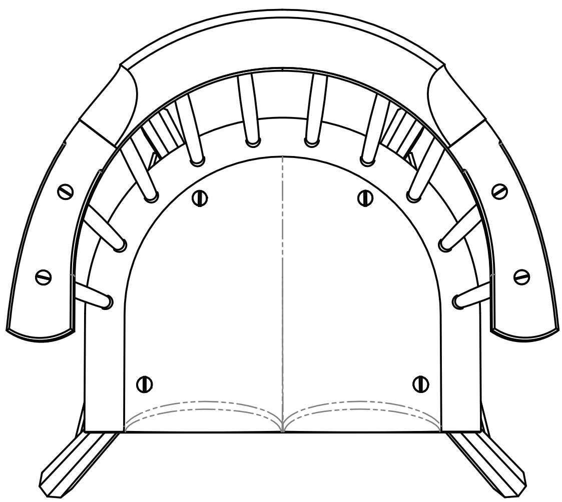


SHORT STICK (PRE-TRIM)





LOWBACK STICK CHAIR



BE SEATED

I love comb-backs. When made properly, they support you in all the right places and let you sit for hours.

SIX-STICK COMB-BACK

Most of the chairs I make for sale are comb-backs. And that's probably because they are the most versatile and comfortable stick chair form I've encountered. When designed properly to fit the human body, a comb-back is a fantastic chair for eating a good meal, writing a letter or just talking with friends around a fire.

I spend several hours of each day sitting in one. And I think about them quite 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 the shoe? That kind of stuff. As a result of all that thinking, I build a lot of comb-backs.

In fact, the first stick chair I ever made was a comb-back, the most recent chair I built was a comb-back and I suspect the last chair I make will be one as well. Here's what I think is important when you build one.

1. Don't put the comb too high. It looks 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. All surfaces that touch the sitter should be relieved, chamfered or rounded. But your chair doesn't have to look like a low-IQ Shmoo. Many beginners go crazy with a rasp and round over every surface so the entire chair looks like a leggy pile of melted Gouda. Your nervous system has difficulty distinguishing between a 45° chamfer and a rounded-over surface. You can use that fact to push your designs one way or another. Most of all: use restraint.

3. 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.

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.

4. 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.

5. 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.

6. The default pitch for the back sticks is 15°-20° in my comb-backs. I will do less (10°) for chairs for typing, but 15°-20° is difficult to beat.

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 of these 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 21" (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 tenon shoulder.

• Tenons are tapered cones (12.8°included angle) and are about 2-1/2" long (after assembly). The tenons are about 1-1/8" in diameter at the base and 5/8" at the top. Where the tenons enter the underside of the seat, they are approximately 1" in diameter. After assembly, the tops of the tenons are cut flush.

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 2" long from the front edge of the seat, measured back. The front "swoops" are an 11" radius (about 3/4" high).

• The seat has an underbevel that is 3/4" tall and cut at 45°.

• 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). So, the seat tilts 1-1/4" from front to back.

2 Arm segments: cut from 7/8" x 13" x 20" blanks (ideal, but narrower boards will work)

• Arm segments are joined with two pocket screws.

• Part of the assembled arm is then covered with the shoe. The top edge of the areas that are not covered by the shoe are rounded over with a rasp – 1/8" x 1/8" or more.

• Arm is 8" off seat.

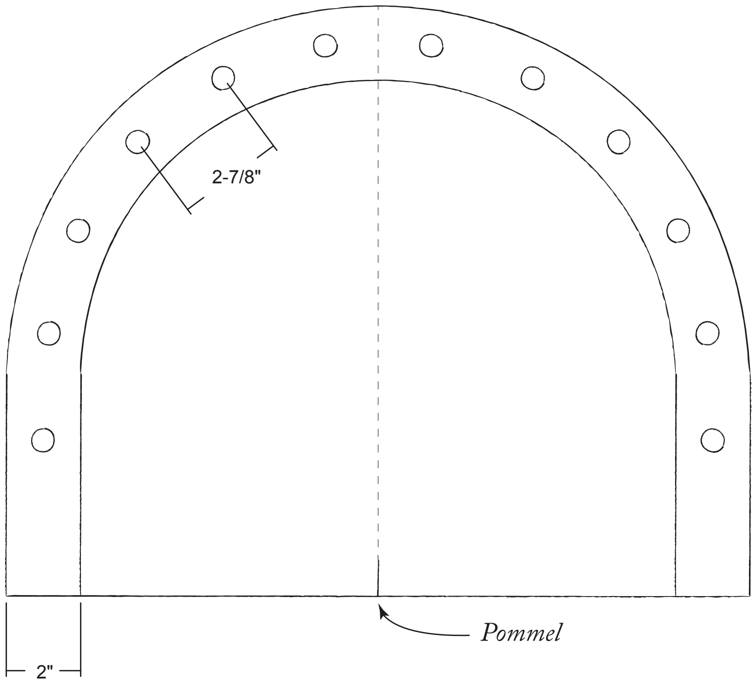
1 Shoe: cut from 7/8" x 7" x 20" blank
• Ends of shoe have a decorative cove detail. Cove is 1-1/2" long and sweeps down 5/8" (the shoe therefore ends with a 1/4"-tall flat).
• Front edge of the shoe is cut at 25° off 90°.
• Shoe is glued to arm assembly, centered on the arm.

6 Short sticks: just under 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 blind mortises and are glued after being trimmed to length.

6 Long sticks: just under 3/4" diameter x 27-1/2" (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 almost 1/2" 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 1/2" diameter x 1" long.
• Long sticks are 5/8" in diameter where they pass through the arm and shoe.
• Back sticks tilt back 20° in example.

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°.
• Mortises in comb drilled at 20° off 90°.
• Each tenon for the back sticks is pinned with a barbecue skewer (5/32" x 1"). Hole is 3/8" up from the bottom edge of the comb.

2 Side stretchers: 1-1/8" x 1-1/8" x 18-1/4" (approximate length)
• Stretchers have 5/8"-diameter x 1"-long tenons on both ends.
• Stretchers are octagons. They taper from 1-1/8" square at the center to 3/4" square at tenon shoulders.
• Tenon shoulders are not blended into the tenons. There is a hard 90° shoulder.
• Stretcher assembly is 11" below the seat.



SEAT DETAILS

1 Medial stretcher: 1" x 1" x 18" (approximate length).
• Medial stretcher has 5/8"-diameter x 1"-long tenons on both ends.
• Medial stretcher is an untapered octagon and is centered on the side stretchers.

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. Because this chair uses tapered tenons, you'll need to make the mortises in two steps. First drill a 5/8" hole through the seat at the resultant angle. Then ream the hole with a tapered reamer to its final shape. The resultant angle for both the front legs and back legs is 23°. Check your angles as you ream the holes and make adjustments. Saw or shave the underbevel on the seat.

MAKE THE LEGS & STRETCHERS

The legs are tapered octagons. After sawing the legs to octagonal on the band saw, taper them using a jack plane so they are 1-3/4" at the foot and 1" at the top. Then taper the top 4" of each leg down to 5/8" at the tip. Round over the facets on the tenons, then cut the final tenon shape using a tapered tenon cutter.

Assign each leg to a mortise in the seat and saw a kerf in each tenon for a wedge. Now mark mortise locations for the side stretchers on the legs – 11" down from the underside of the seat. Drill 5/8" mortises into the legs for the stretchers. Measure from the bottom of one mortise to another to determine the length of each side stretcher. Make and fit the side stretchers into their mortises.

Now mark the location of the mortises for the medial stretcher(s). Drill the mortises and again determine the overall length of the medial stretcher(s). Make and fit the medial stretcher(s). Dry-fit all the undercarriage parts and the seat.

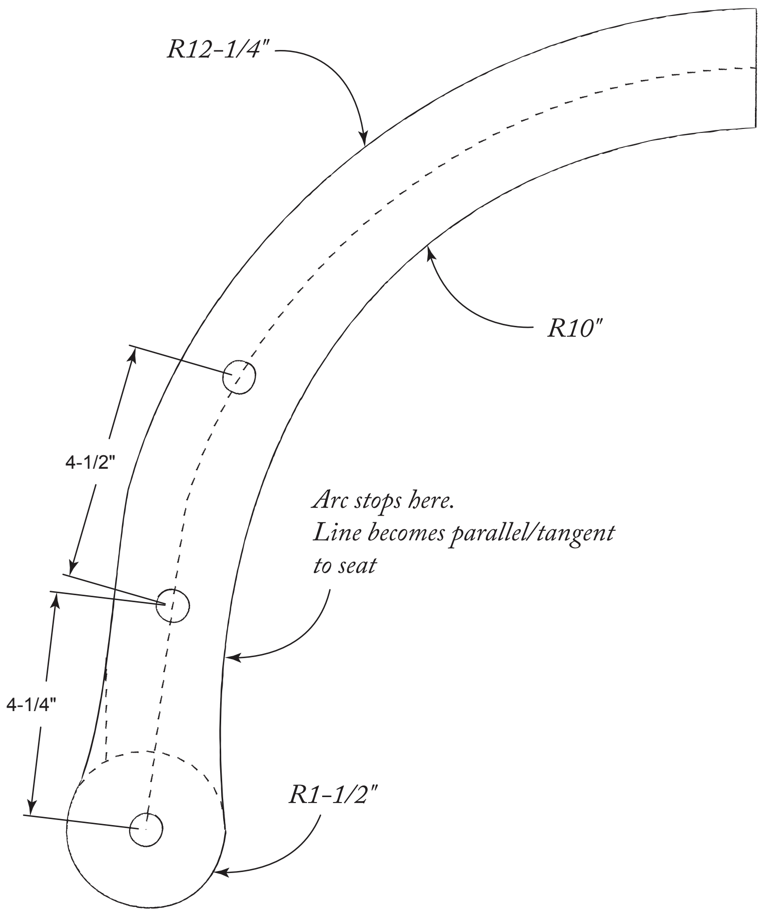
MAKE & DRILL THE ARM

The arm for this comb-back is a "pieced armbow." It is made by gluing and screwing two arm segments together and covering the joint with a "shoe." Saw out the two arm segments; avoid putting any short grain in the hands. Use the pattern at right as a guide. Join the two arm segments at the "head joint" with two pocket screws and glue. After the glue is dry, you can remove the screws if you like.

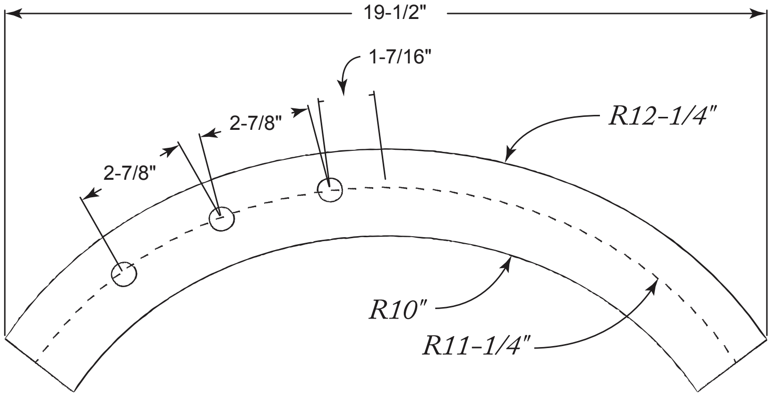
Then saw out the shoe, using the pattern on the following page. Cut the cove detail at the ends of the shoe then glue the shoe to the two arm segments. Now saw the 25° bevel on the front of the shoe. Clean up all the tool marks and blend the shape of the shoe and arm segments together using spokeshaves, rasps and scrapers. I chiseled a relief cut on the hands to add a little life to them.

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

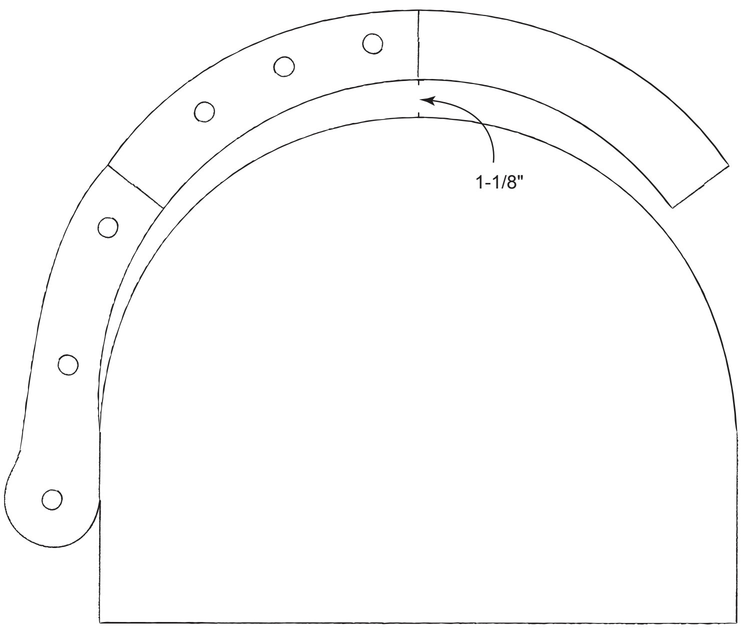
SIX-STICK COMB-BACK



ARM PATTERN



SHOE PATTERN



ARM & SEAT POSITION

CHISEL WORK

For the hands on this chair, I wanted to define the round section from the arm. First I lightly chopped the circle shape. Then I pared away the arm. It's about 1/8" deep at most.

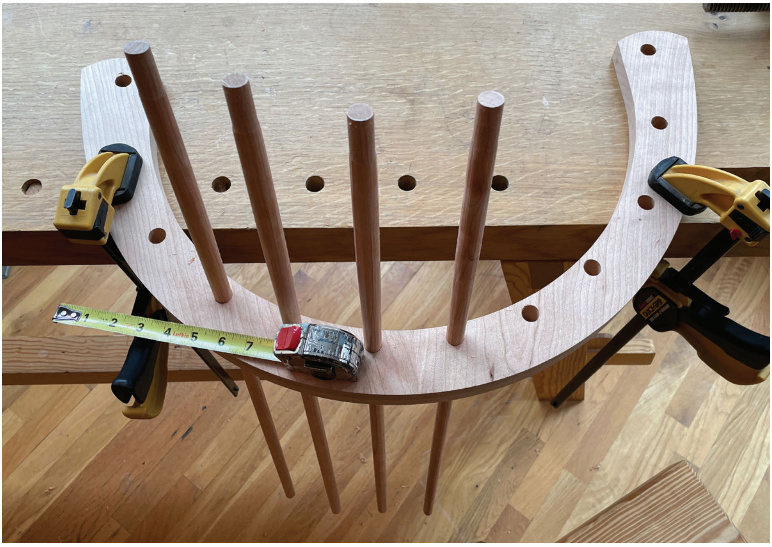
jigs to hold the armbow. The drawing at left shows where the armbow needs to go so the back sticks will lean back 20°.

Clamp the armbow in place over the seat. Drill the 5/8" mortises through the armbow and into the seat. (Don't forget to add backing boards below the armbow to prevent the grain blowing out at the exit holes.) The mortises in the seat are blind and about 1-1/4" deep.

MAKE THE STICKS

All the sticks for this chair start out as octagons. I first cut the 5/8" tenons on both ends of the short sticks and the bottom of the long sticks. Then I shave the sticks with a jack plane and block plane so they gently taper to the tenons.

The long sticks have to pass through both the armbow and shoe, with the right amount of stick below the armbow. This requires some additional tapering on the top half of the long sticks. Usually by the



MAKE THE STICKS FIT

Clamp the armbow upside down to your bench. Plane the long sticks until they fit perfectly into the armbow.

time I am done, the top of the long sticks is just a wee bit more than 1/2" in diameter. (Note: There are lots of ways to make sticks. You can even use dowels. Revisit the chapter on sticks for more details.)

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. Give it a sit and decide where the comb should go. Cut the long sticks to their final length. Use a 1/2" tenon cutter to tenon the top of the long sticks. Take the chair apart.

SADDLE THE SEAT

The spindle deck is 2" wide. Draw that out on the seat. Also draw in the "leg swoops" 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 swoops. Then refine all the surfaces of the saddle with a travisher, a scraper and

LEVEL, THEN TENON

I cut the tenons before shaping the sticks. Level the stick in your vise before cutting the tenon with a hollow auger. This step helps ensure the tenon will be centered on the stick.

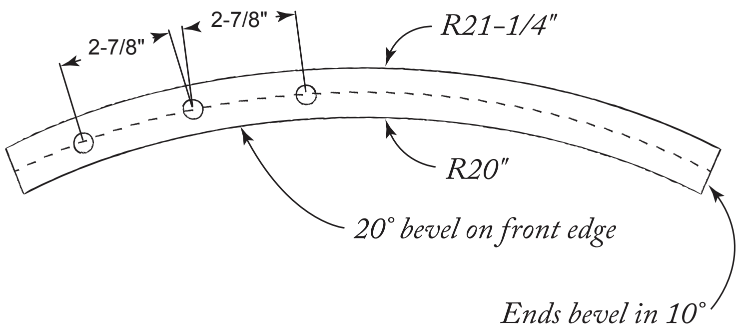
sandpaper. But don't take the saddle all the way to its finished surface. Assembling the chair will usually mar the saddle a bit.

ASSEMBLE THE CHAIR

Clean up all the chair's parts, removing any ugly 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 the leg 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 my 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.



COMB DETAILS

Glue the short sticks into the arm. Push the long sticks into place in 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 1/2" mortises for the long sticks in the underside of the comb (use the illustration above as a guide). These mortises angle 20° back. Now cut a 20° bevel on the front edge of the comb. Trim both ends of the comb at 10° and curve its bottom corner. Clean off all the saw blade marks.

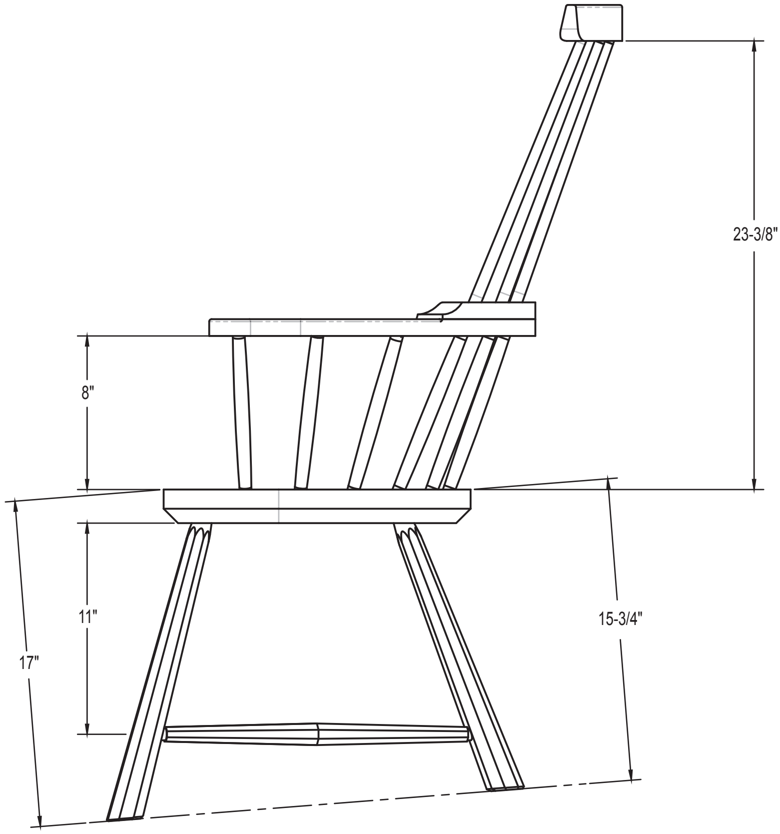
Fit the comb onto the back sticks and adjust the tenons on the back sticks if necessary. Glue the comb onto the back sticks and peg the tenons with barbecue skewers. When the glue is dry, saw the skewers flush to the surface.

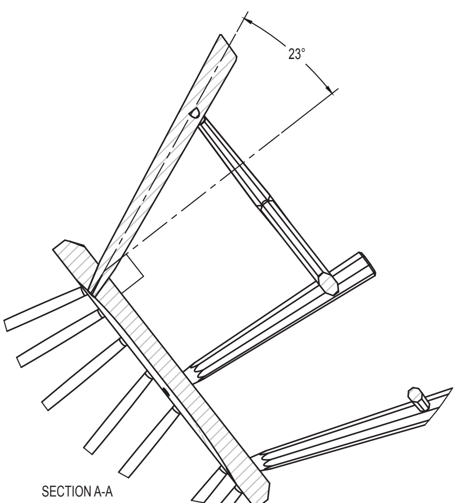
A MORE CONTEMPORARY VERSION

This comb-back design can look more contemporary with small changes: The hands end in the same curve as the lowback in the previous chapter and have a chamfer instead of the organic rounding. Also, the stretchers are untapered octagons and the sticks have less entasis and faceting.

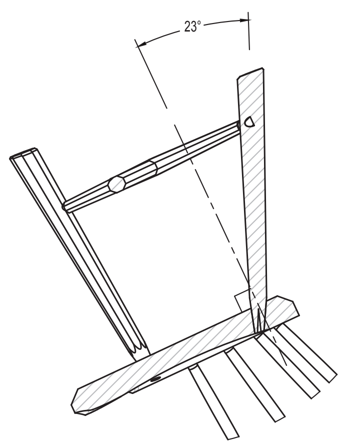
FINISH

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 If necessary, add a second coat of oil/wax in a few months after the oil has fully cured.



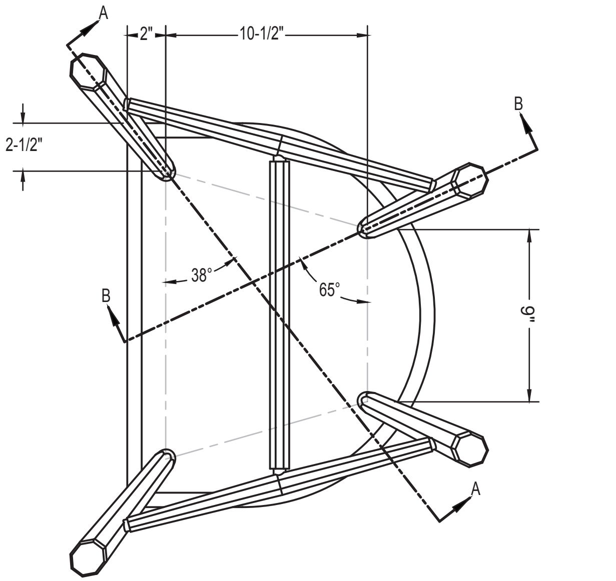


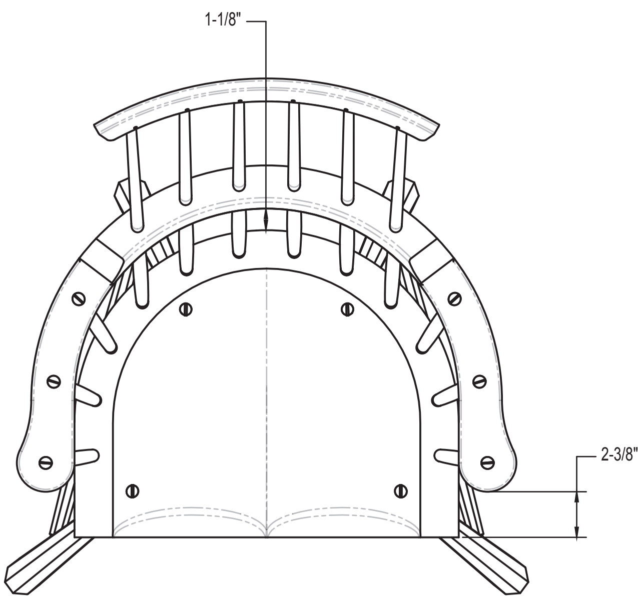
SECTION A-A
(RESULTANT ANGLE)

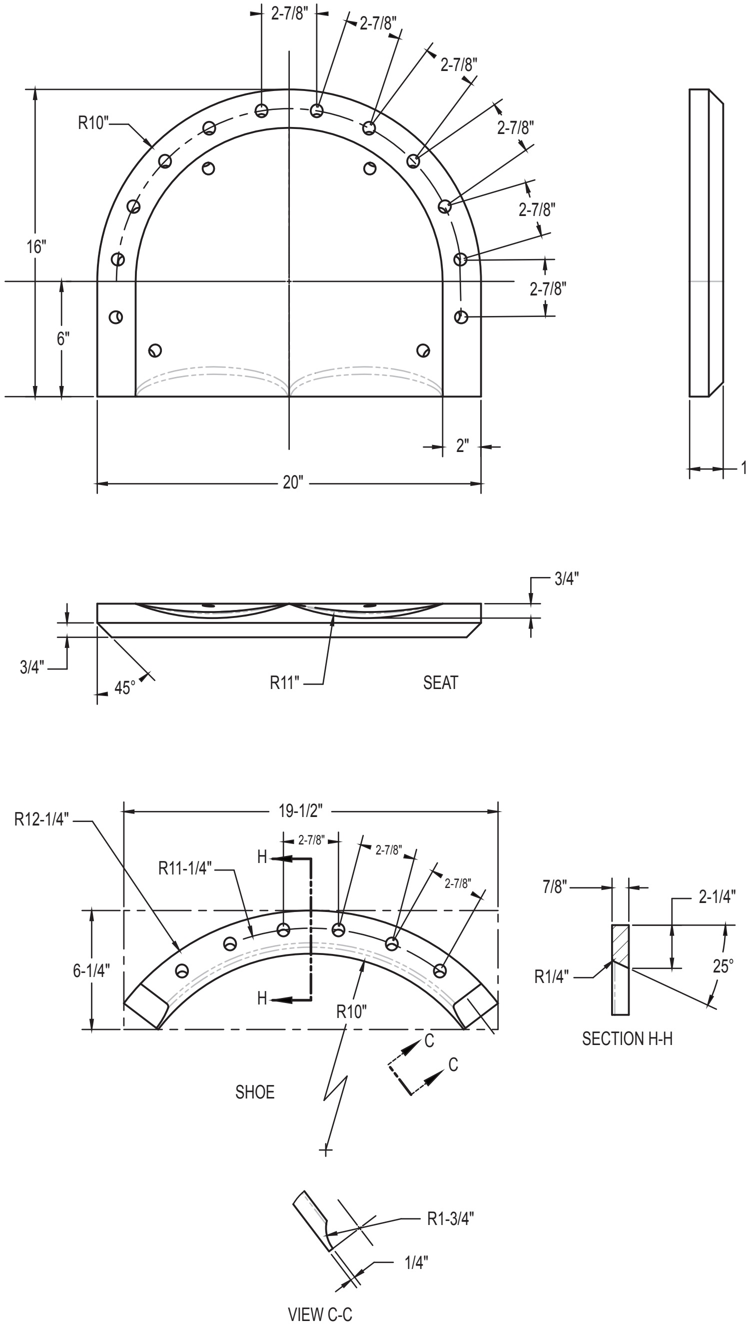


SECTION B-B
(RESULTANT ANGLE)

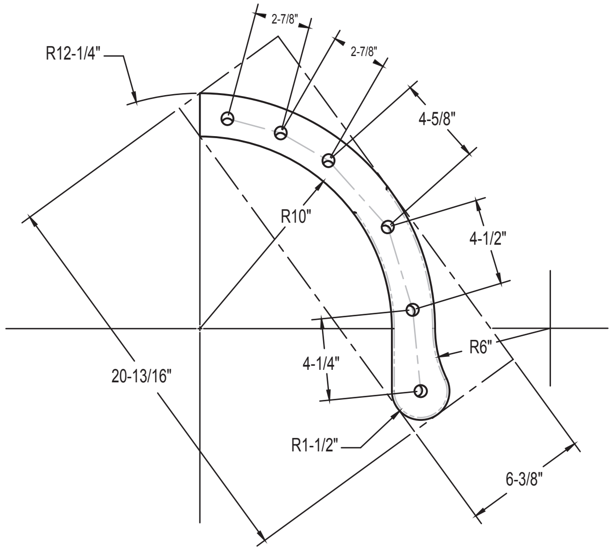
SIX-STICK COMB-BACK



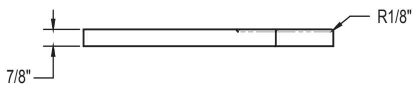


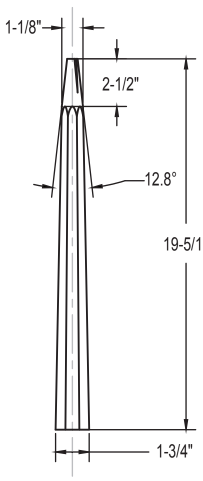

2-7/8"
2-7/8"
2-7/8"
2-7/8"
2-7/8"
2-7/8"
2-7/8"
R10"
16"
6"
2"
20"
3/4"
3/4"
45°
R11"
SEAT
19-1/2"
R12-1/4"
R11-1/4"
2-7/8"
2-7/8"
2-7/8"
H
H
6-1/4"
R10"
C
C
SHOE
7/8"
2-1/4"
R1/4"
25°
SECTION H-H
R1-3/4"
1/4"
VIEW C-C

SIX-STICK COMB-BACK

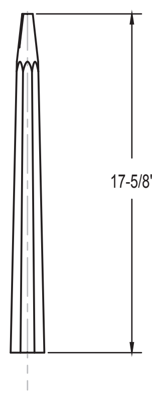


ARM

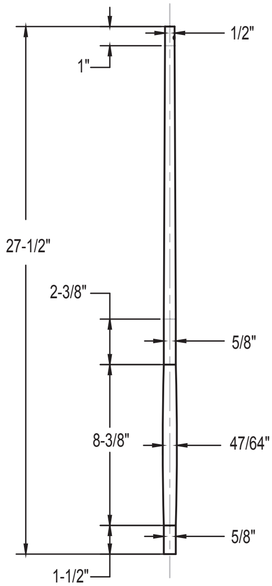




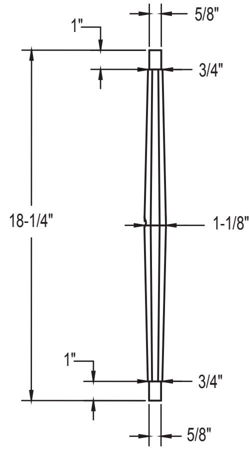
FRONT LEG
(PRE-TRIM)



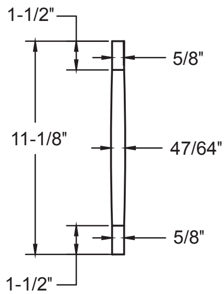
REAR LEG
(PRE-TRIM)



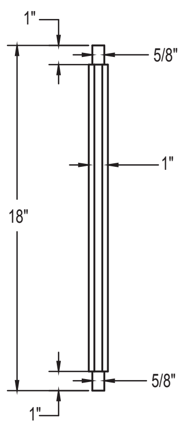
TALL STICK
(PRE-TRIM)



SIDE STRETCHER

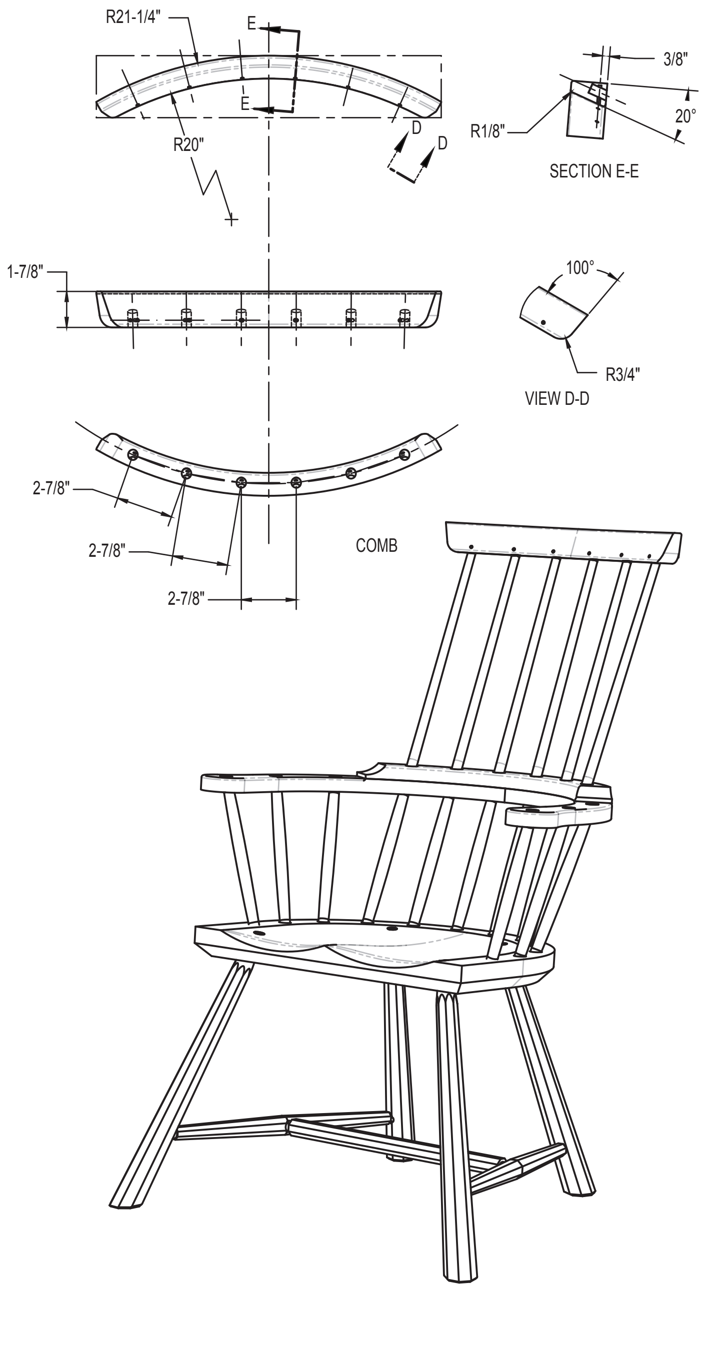


SHORT STICK
(PRE-TRIM)



MEDIAL STRETCHER

SIX-STICK COMB-BACK



AYE, CHAIR

This chair is based loosely on the Scottish Darvel chair. I've always had a soft place in my heart for it.

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.

Someone has to pay 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 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, except for the fact that I added a second medial stretcher.

The version shown in the photos uses cylindrical, un-tapered sticks that are made with the Veritas Dowel Maker. Feel free to use tapered sticks or dowels if that's what you've got.

Lastly, the back sticks tilt only 10° and fan out slightly. If you make them tilt more than that, the back sticks will fan out so much that your comb will end up wider than the entire chair. Also, a tilt of more than 10° will make it tricky to drill through the armbow without blowing out one of its corners.

The 10° tilt of the back sticks isn't as comfortable as 20°, but it is plenty comfortable. My wife says so, and this is her chair.

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 tapered cones (12.8° included angle) and are about 3" long when I make them. The tenons are about 1-1/8" diameter at their base and 5/8" at the top.

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.

8 Short sticks: 5/8" diameter x 12-1/2" (over-long and trimmed to fit)

• Sticks are straight cylinders. No shoulders. You can make them from dowels or shave them to this size.

• Sticks are glued into 1-1/2"-deep mortises in the seat.

• Top of sticks pass through the arm and are wedged then cut flush.

7 Long sticks: 5/8" diameter x 26" (can be trimmed to lower the comb)

• Sticks are straight cylinders. No shoulders. You can make them from dowels or shave them to this size.

• Sticks are glued into 1-1/2"-deep mortises in the seat and pass through holes drilled in the arm.
• Top of back sticks are shaved to 1/2" tenons.
• Back sticks tilt 10°.

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°.
• Each tenon for the back sticks is pinned with a barbecue skewer (5/32" x 3/4"). Hole is 3/8" up from the bottom edge of the comb.

2 Side stretchers: 1-1/8" x 1-1/8" x 18-3/4" (approximate length)
• Stretchers have 5/8"-diameter x 1-1/4"-long tenons on both ends.
• Stretchers are octagons. They taper from 1-1/8" square at the center to 3/4" square at tenon shoulders.
• Tenon shoulders are not blended into the tenons. There is a hard 90° shoulder.
• Stretcher assembly is 11" below the seat, and parallel to the seat.

2 Medial stretchers: 1" x 1" x 19" (over-long; cut to fit)
• Medial stretchers have 5/8"-diameter x 3/4"-long tenons on both ends.
• Medial stretchers are untapered octagons.
• Medial stretchers are on 4-1/2" centers. The medial stretcher assembly is centered on the side stretchers.

AN INTRO TO STEAMBENDING

I've been bending wood since I started chairmaking. But I can guarantee you that there are monkeys out there who know more about the topic than I do.

I'm about to tell you everything I know about steambending, but you might have noticed there aren't all that many pages left in this book. So, if you want to make steambending an essential part of all your chair designs, I recommend you check out a few books from the library on the topic.

SIMPLE SETUP

As you can see, my steambox will not win any beauty pageants. Powered by a simple wallpaper steamer, it gets the job done. Note the bowl on the floor, which catches condensation from the process.

I only steambend two chair components for my designs: the comb (which is easy to bend) and the armbow (which is not). I don't use fancy equipment. I have a plywood-and-drywall screw steambox, a wallpaper steamer to make the steam, a metal compression strap and a PVC pipe to soak my wood.

Here are the important principles:

1. Heat makes the wood bend, not the water. You can soak a piece of wood for years and it won't bend. 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).

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.

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. 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.

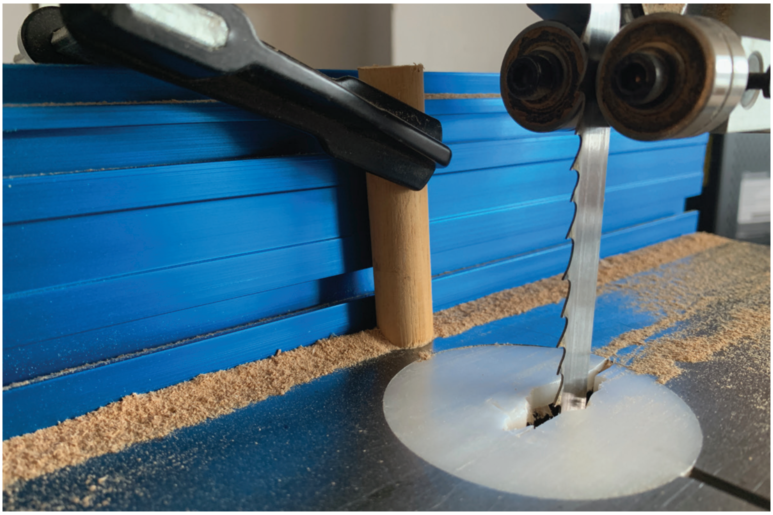
3. A compression strap greatly reduces splits. The metal strap supports the outside of the bend and keeps the ends of the board compressed. This greatly reduces the tendency of the wood to burst.

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) for three to five days. 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

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.

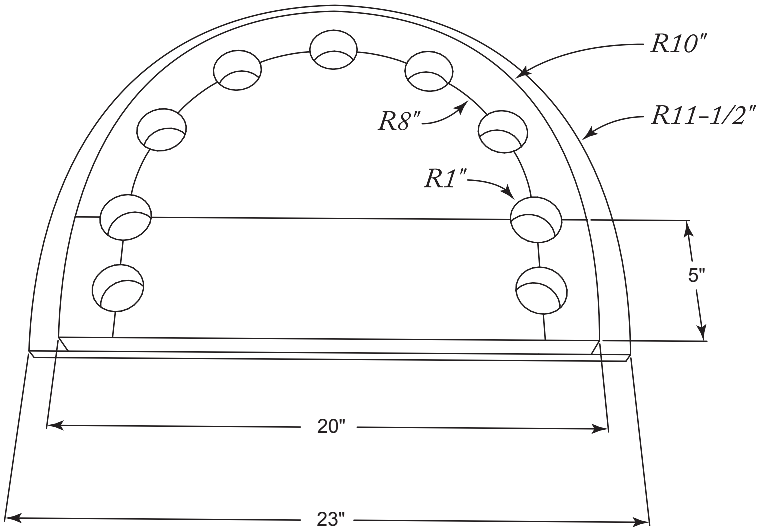
bend might tighten up or expand a bit as it dries. I refuse to get worked up about this. All my chairs are different, and this is one way they express themselves. Embrace it.

6. Steambending is risky. I've seen a fair number of old chairs with steambent components that have come apart – usually because of some short-grain problems. Steaming the wood can also introduce cracks and checks that appear later on. These defects might be ugly, or they might threaten the structure of the chair.

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 the safe way to make steam. You can buy a steambending kit that includes a wallpaper steamer with a hose and



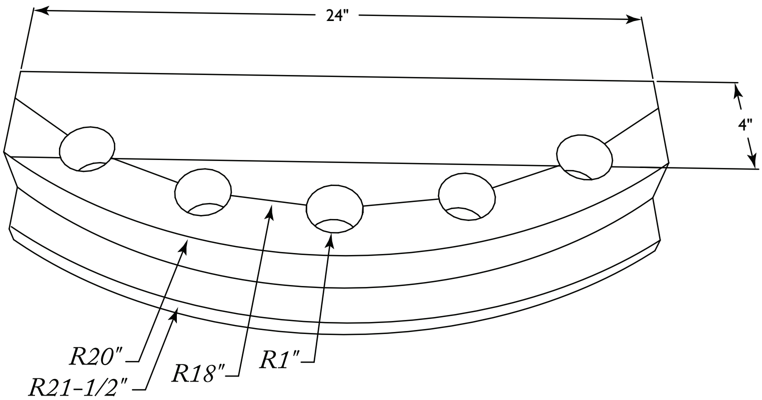
BENDING FORM FOR ARMS

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.

a fitting for the steambox. It works great and shuts itself off if you run out of water. 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 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.

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. A couple years ago I bought an adjustable Veritas Strap Clamp,



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.

which allows me to have one adjustable strap (instead of a whole pile of them 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 clamp my work to the forms with typical F-style clamps found in most shops.

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 men-

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.

tioned earlier, do everything possible to get the grain running straight 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.

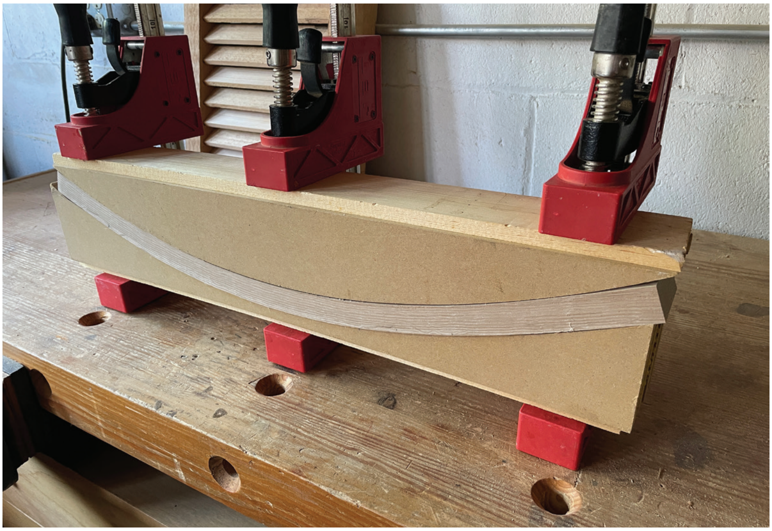
Set up the steambox and crank up the steamer. Check the box with a meat thermometer near the opening of the box and let the temperature rise to the boiling point before putting anything in.

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 let the other end hit the floor. Push the middle of the blank with your

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.

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. Clamp the pair to the center of the form. Pull one side around the form, clamping as you go. Then pull the other side around and do the same pull-and-clamp 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 clamp (or screw) a stick between the two ends of the blank to hold them at a consistent distance while drying. Dry the blank for three to five days 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 very technical about all this. Or you can just do it. For the last 18 years I have resisted becoming a steam engineer.

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 clamp it to the center of the form. Pull the stick around the form, clamping as you go.

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 tapered, so you'll need to cut the mortises in two steps. First drill a 5/8" pilot hole at the resultant angle. Then ream each mortise to its finished shape. Check your work with a dummy leg and a sliding bevel set to the resultant angle.

MAKE & TENON THE LEGS

The legs are tapered octagons with a tapered 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.

To make the tenon, drill a shallow 5/8"-diameter hole in the top of the leg. Then taper the top 4" of the leg down to the diameter of the shallow hole. Finish off the tenon with a tapered tenon cutter.

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 x 1"-deep mortises in each leg. Use two skinny sticks pinched together to measure from the bottom of one mortise to the bottom of its mate.

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.

POSITION THE ARM

Note the combination square (left). It tells me that the arm is in the correct position: tangent to the back edge of the seat. A spotter is helpful when you make a design that is new to you (right). After a few go-'rounds, you'll feel comfortable without a spotter (or not).

Now lay out the location of the two medial stretchers. These stretchers are 4-1/2" apart and centered on the side stretchers from front to back. Drill 5/8"-diameter x 3/4"-deep mortises in the side stretchers. Measure between the mortises to determine the lengths of the two medial stretchers. Make the stretchers, tenon their ends and install them 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 into the seat. The mortises in the seat should be about 1-1/4" to 1-1/2" deep.

SPEED STICK

The Veritas Dowel Maker can make all the sticks for 10 chairs in the time it takes me to make the sticks for one chair by hand. But it is expensive and requires maintenance and an engineer's mindset. But once it is tuned up, it's great.

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 troughs, which are beside the pommel. Then use the scorp to scoop out the wood in the "swoops" 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

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.

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 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 5/8" cylinders made with the Veritas Dowel Maker. Prepare the wood with care and ensure the grain is arrow straight. Then use a drill to drive the 3/4" x 3/4" blanks through the dowel maker. Cut the sticks to length, then tape off the tenons to protect them from getting shaved down. Scrape the rest of the sticks to remove any spiral toolmarks from the dowel maker.

Kerf the tops of the short sticks for wedges. Scrape the long sticks until they slide easily into their holes in the armbow. Remove all the tape and 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.

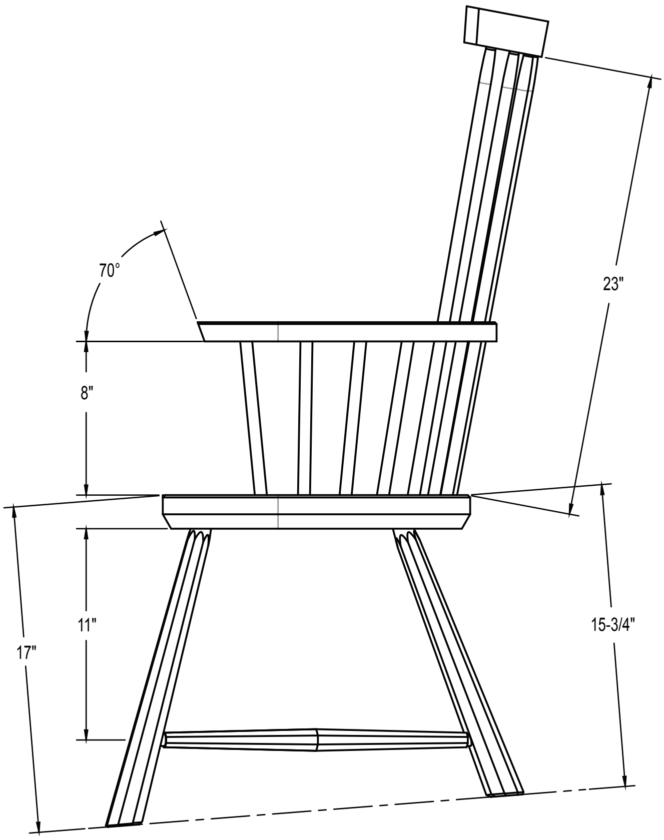
Sometimes I drill 1/2" mortises in the comb and shave the long sticks down to fit. Other times I drill 5/8" mortises into the comb and fit the sticks in the mortises without shaving. The first approach is more work; the second has a little risk if your drill bit wanders. Either way, the mortises are 1-1/4" deep.

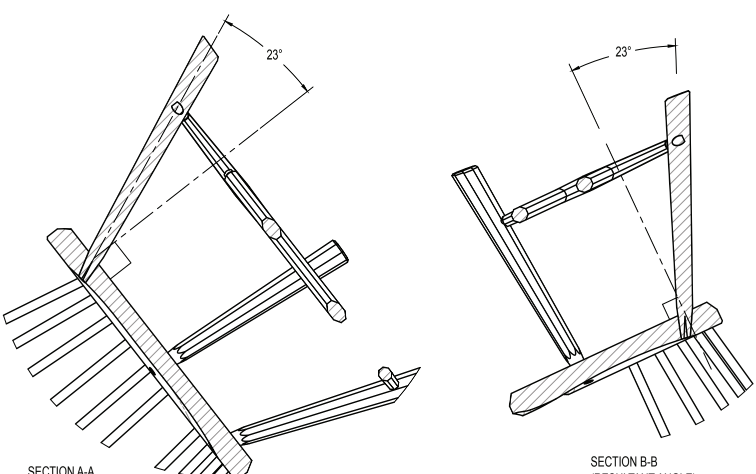
Clean up any ugly tool marks on the comb and cut a bevel on the ends. Glue the comb onto the long sticks and pin all the tenons with barbecue skewers. Saw the skewers flush.

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. When I paint these chairs, I prefer General Finishes Milk Paint. For a clear finish, I use a mixture of beeswax and linseed oil.

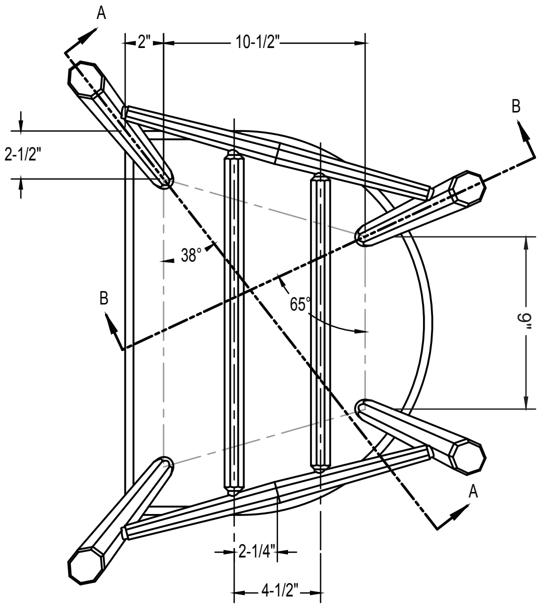


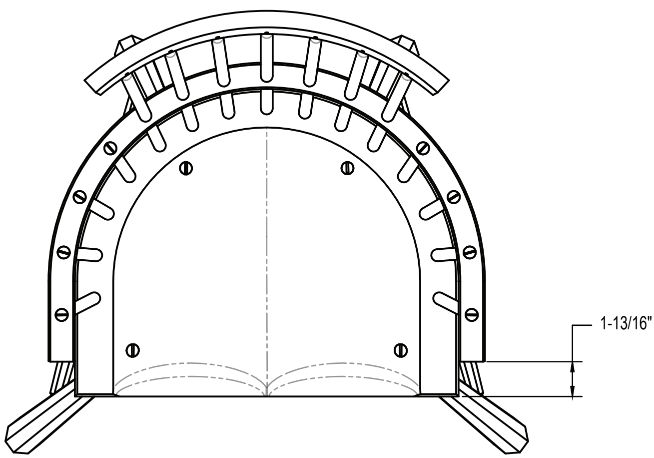


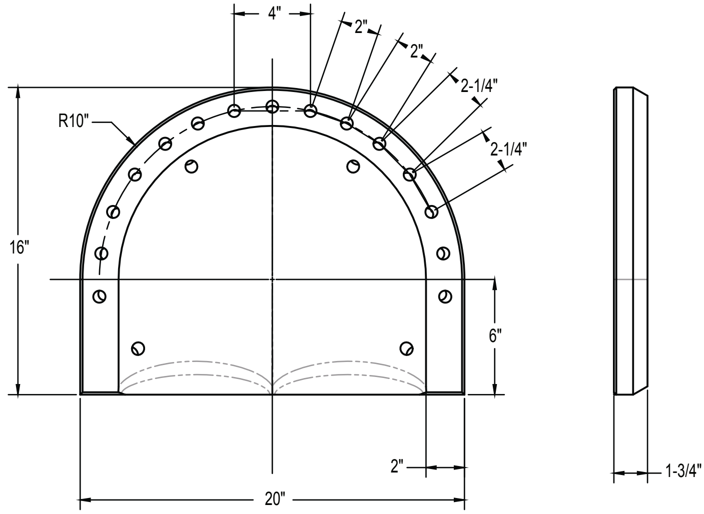
SECTION A-A
(RESULTANT ANGLE)

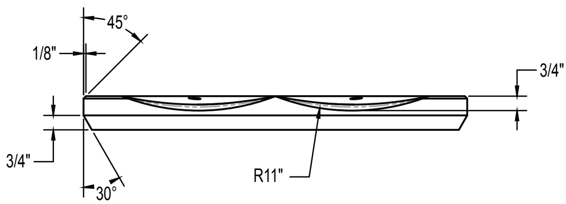
SECTION B-B
(RESULTANT ANGLE)

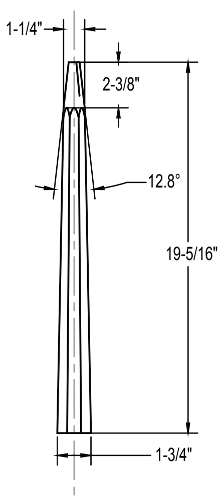
COMB-BACK WITH BENT ARMBOW



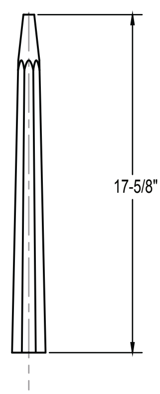






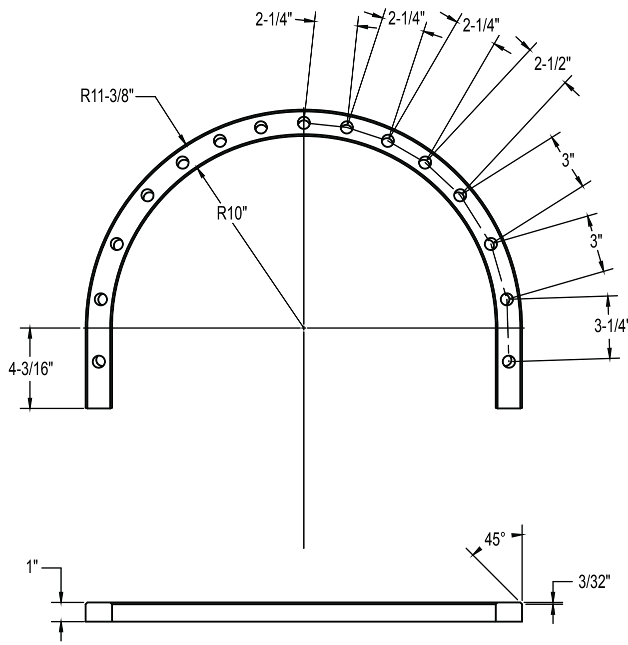


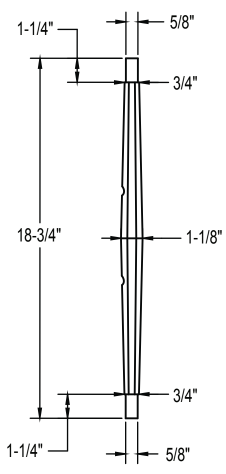
FRONT LEG
(PRE-TRIM)



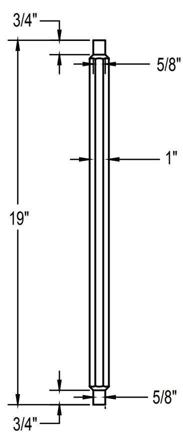
REAR LEG
(PRE-TRIM)

COMB-BACK WITH BENT ARMBOW

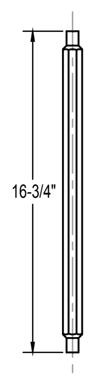




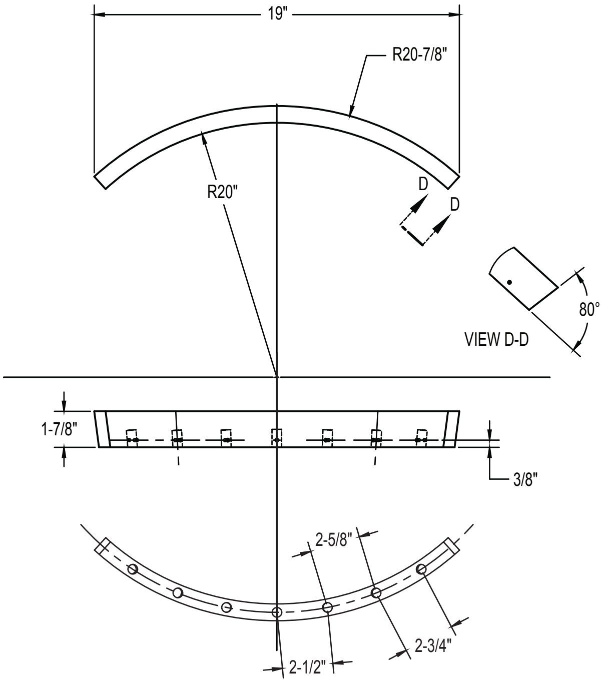
SIDE STRETCHER

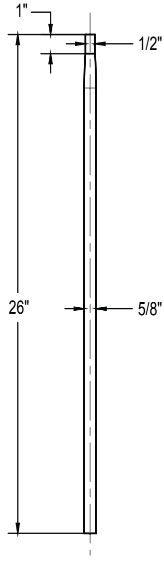


MEDIAL
STRETCHER A

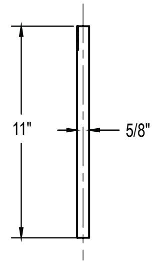


MEDIAL
STRETCHER B



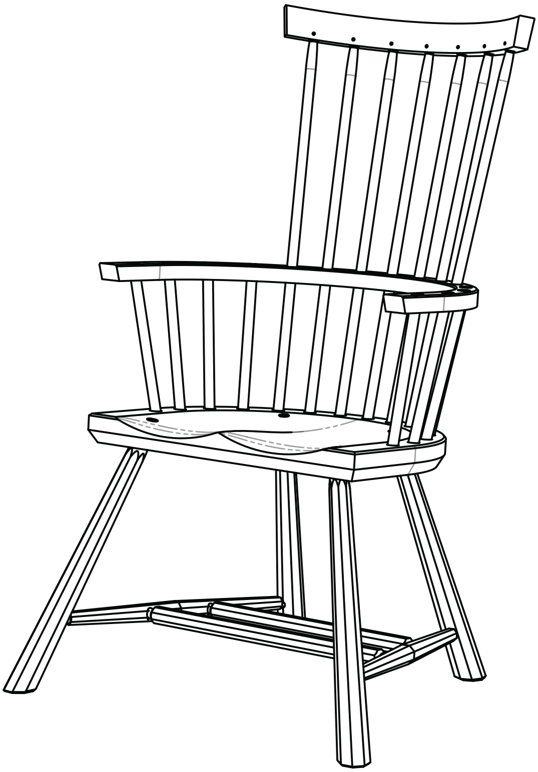


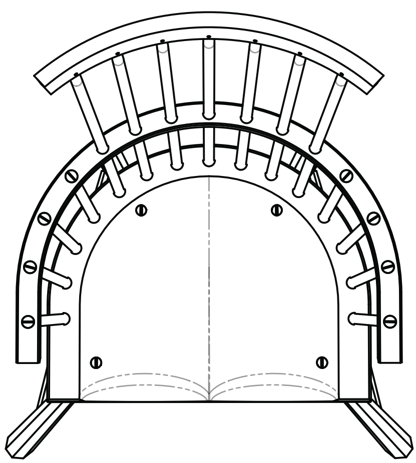
TALL STICK
(PRE-TRIM)



SHORT STICK
(PRE-TRIM)

COMB-BACK WITH BENT ARMBOW





MIXED MESSAGES

This chair was made with scraps of oak, ash, maple, cherry and poplar. I 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 weird 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 most 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.

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 somehow, 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. (And a new, 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.

You know, do the job properly.

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 joinery. 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? Please. 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 for 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 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 also 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, or I was working late at the shop to meet a deadline, or I had left this world – and also left the chair to look after her.

Some chairs, no matter how wide their armspans, 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.

2 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 equipment.

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 my 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 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 won't look right. It's best for bare wood.

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 Chair Finish
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.

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.

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 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.

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.

You can buy a 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 and cheap, and because I am in control of the entire 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 need to refine it to get the insect parts out.

The second ingredient is raw linseed oil – not the commercial boiled linseed oil (BLO) at hardware stores. BLO has toxic metallic driers and is not what you want for this recipe. Raw linseed oil is also available from most hardware stores, but sometimes you have to ask them

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.

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. As I mentioned earlier in the book: thanks to restorer Jeff Stafford for his advice on proportions.

Linseed Oil & Wax Finish Recipe
2 cups (16 ounces by volume) of raw linseed oil (or tung oil)
3/4 cup beeswax
2 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 for your next batch).

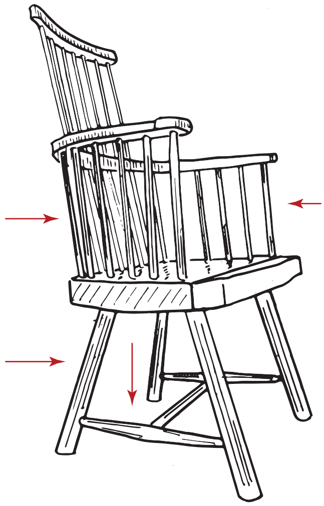
APPLY LINSEED OIL & WAX FINISH

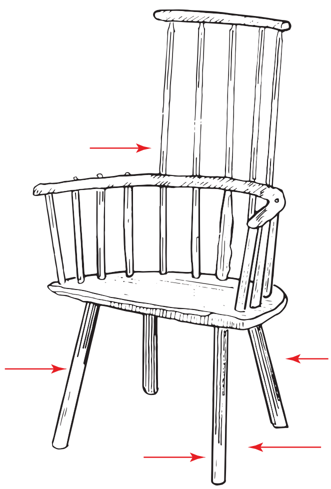
Apply the finish with a gray 3M abrasive pad. The pad will knock down any nibs or raised grain as you apply the finish. Apply it generously and spread it out to a thin coat. After 15 minutes, use a huck towel to remove all the excess.

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.





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 "Wood for Stick Chairs" chapter 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

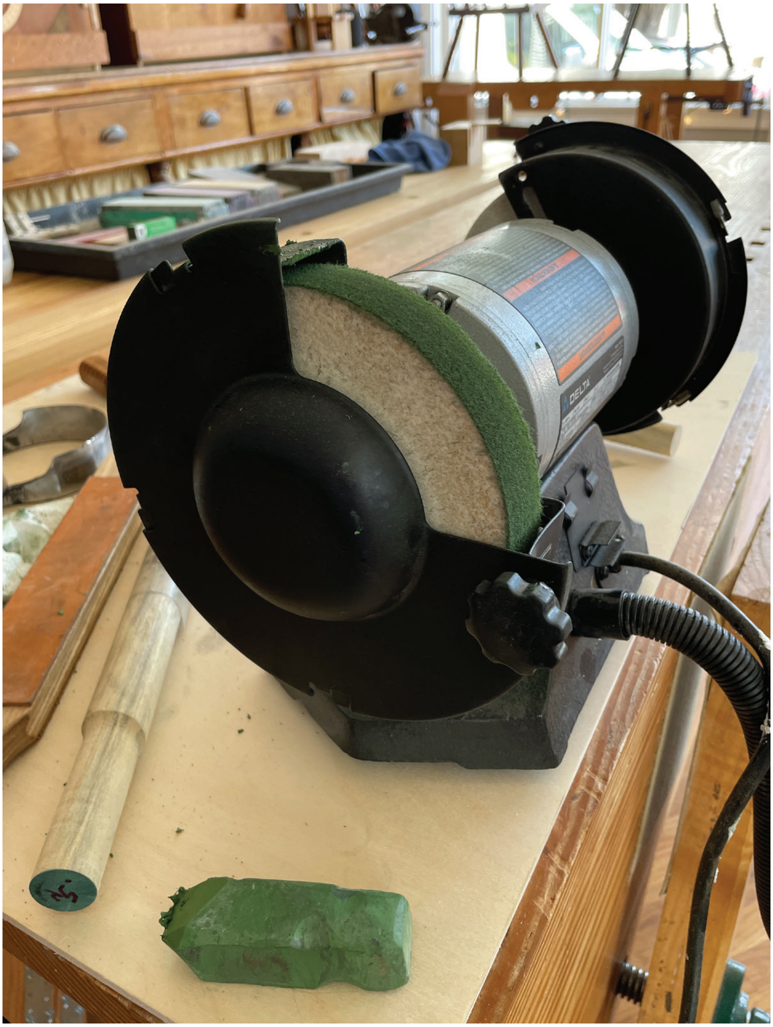
Pound-force per square inch to break stick = E x F^2/G

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 match, 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 a felt or cardboard wheel on a basic grinder.

SHARPEN CHAIRMAKING TOOLS

Sharpening chairmaking tools intimidates many beginners. Every time I teach a class in chairmaking, students request that I show them how to sharpen a scorp, a travisher and a curved card scraper. When I show them how I do it, this is what they say:

"Wait, that's all there is to it?"

Sharpening tools with curved edges isn't much different than sharpening straight-edged tools. A cutting edge is the intersection of two planes – aka, the bevel. 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 will make an exception here and 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 wheels for my grinder and some diamond lapping film.

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 WITH A MINIMAL KIT

For years, I sharpened my scorps and travishers using my existing sharpening stones (waterstones of #1,000, #5,000 and #8,000 grit) plus a #5,000-grit slipstone that I used to touch up my moulding planes.

POLISH THE BACK, THEN THE BEVEL

I polish the back of the travisher blade on my stones first – it's easy to keep the back on the stones. Then I polish the bevel using a dowel covered in abrasive paper.

POLISH THE INSIDE

Hold the scorp with one hand and the dowel with the other. By stroking upward only, it's almost impossible to injure yourself.

About five years ago I upgraded my kit and added three 1-1/4"-diameter dowels that were wrapped with three grits of diamond lapping film (15-, 3- and 0.5-micron films). The total cost of that upgrade was about $35. 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 and focus your efforts first on the flat surface of the blade. Rub the flat surface on your #5,000-grit stone. Then work your way up to #8,000.

Then polish the bevel with a #5,000-grit slipstone or a dowel wrapped with 3-micron lapping film.

If, after many sharpenings, the above process fails to give you a keen edge, switch tactics for a bit. 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.

POLISH THE OUTSIDE

A strop charged with honing compound is ideal for polishing the outside of the scorp. Watch the angle of the strop so you don't round over the bevel.

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 17 years and have never had to grind it.

SHARPENING WITH A FELT WHEEL

Back in the 1990s I attended my first woodworking show and met a guy who sharpened all his tools on felt wheels (he was selling felt wheels – surprise!). It seemed a bit risky to me – like it would be easy to

AVOID GRINDING

I keep my chairmaking tools polished so I don't have to grind them much, if at all. The felt wheel is turning away from me, and the wheel is charged with honing compound.

round over the tool's bevel. But one day I decided that I was probably just being an idiot and bought a 3/4"-wide hard-felt wheel (price $39) for a basic 6" high-speed grinder.

It turns out that I was indeed being an idiot.

If you have a grinder (and every woodworker should), here's how to add a felt wheel to the machine so you can safely sharpen scorps, inshaves and travishers in a short minute.

When you grind your tools with an abrasive wheel, the wheel turns toward you. When you use a felt wheel, the wheel must turn away from you. This is an important safety rule, so don't ignore it. Most grinders don't have a "reverse" switch, so you need to reconfigure the grinder's housing so you can turn the grinder around and work on the backside of the machine.

Remove the grinder's housing with a screwdriver. There are (usually) three screws that attach the housing to the motor. These screws are

BUFF THE OUTSIDE

You can build a jig to keep the angle of the scorp consistent, or you can simply pay attention and practice a bit.

positioned 120° apart. That means you can reattach the housing to the motor so the opening is on the backside of the grinder. Genius! (I am not the one who figured this out.)

Reattach the housing to the motor with the opening on the backside of the grinder. Then install the felt wheel on the grinder's shaft and reattach the rest of the safety covers etc.

Before you can add stropping/honing compound to the wheel, you need to add a little oil to the wheel. Any oil will do. Mineral oil, linseed oil, household oil. Moisten the wheel just a little with oil. Then turn on the grinder and press the honing compound against the wheel for about 5 seconds. The honing compound will heat up, mix with the oil and soak into the felt. Turn the grinder off. Then repeat a couple times.

After that first "charging" you shouldn't have to add oil again. You will be able to recharge the felt wheel with the honing compound only.

Once the felt is charged you can sharpen stuff. For the travisher, hold the blade with both hands and press the flat face of the blade against the felt wheel for a few seconds. Repeat this a few times. Then stroke the bevel of the blade with a dowel wrapped with 3-micron paper.

To sharpen the scorp or inshave, use the felt wheel to buff the outside of the blade. I stroke the blade against the spinning felt wheel about three times. Then I stroke the inside of the tool's blade with the 3-micron paper wrapped around a dowel.

If you do need to regrind your blades, I recommend you watch videos made by the people who manufacture these tools. Also, if you can't find a felt wheel, other manufacturers make cardboard wheels that do much the same thing.

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.

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

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.

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. 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

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.

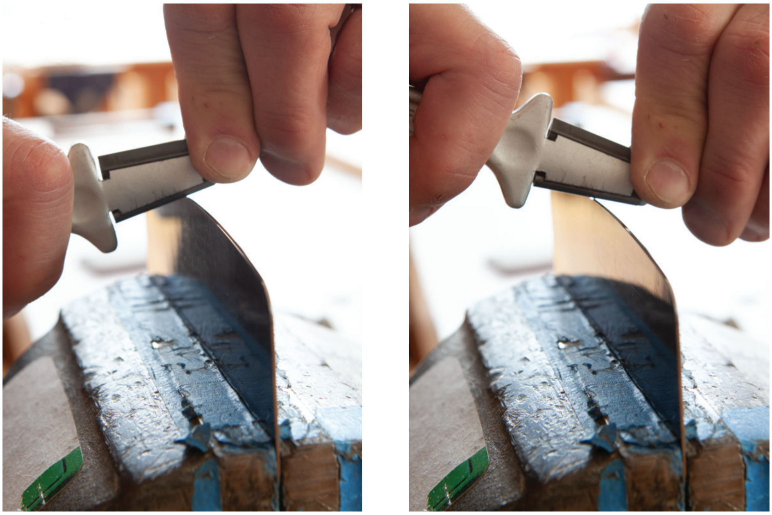
used to remove the burr. Remember: Use hard downward pressure (yet the burnisher should still glide across the face of the tool).

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 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.



TURN THE HOOK

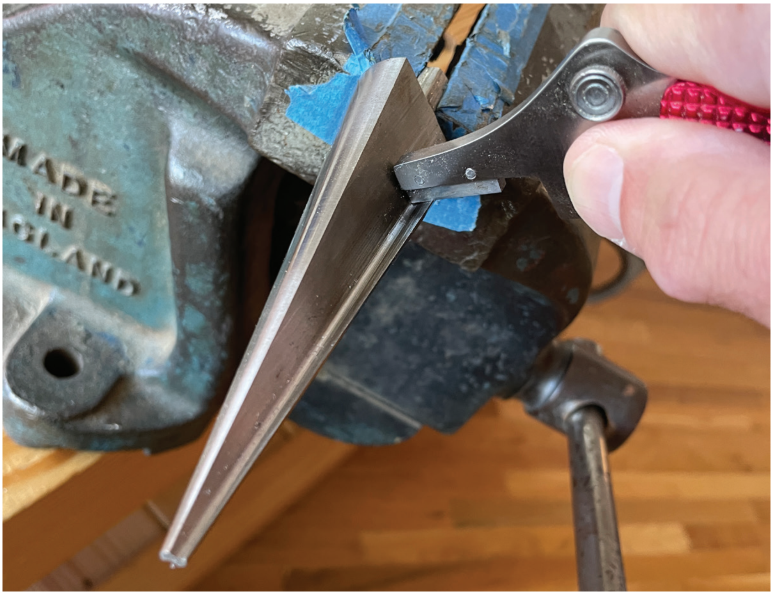
Tilt the burnisher about 5° (or a little more). Slide the burnisher along the corner of the scraper while simultaneously drifting the burnisher away from the corner. This compound motion helps to turn a hook.

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.

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.



EASIER WAY

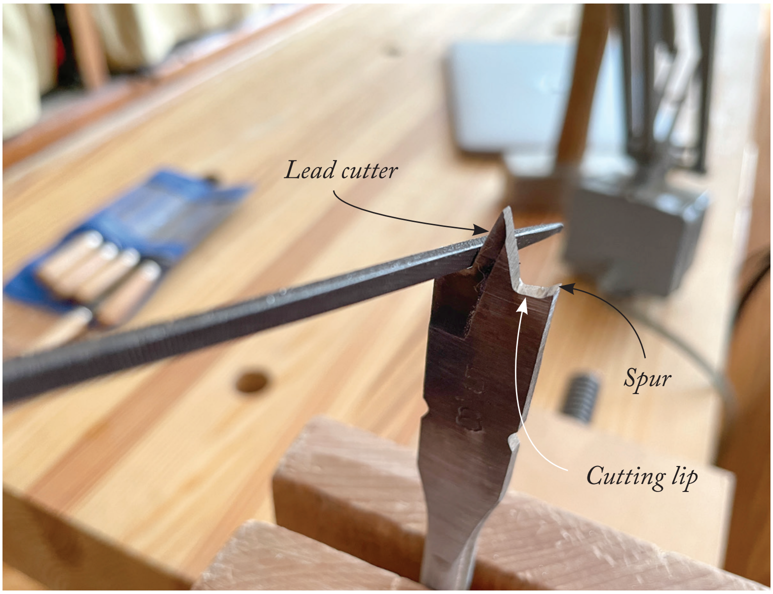
A carbide sharpener – usually used for touching up axes or garden tools – is ideal for sharpening a tapered reamer. Stroke the inside a couple times and it will give you a new edge.

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 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.



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 interior surfaces on the bit's spurs, lead cutter and cutting lips.

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. 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. 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.

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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 young, 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 and 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. 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 provided 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 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.