

Adventures in Chair Making and Design



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<http://valleycreations.org.uk/chairs/>

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Introduction

Over the last few years I have been making and designing Windsor style chairs and benches. The designs have all been reasonably successful and people have praised the look and comfort of the end results. Each time I have done one I have experimented with the materials and the geometry and have learnt a lot about what makes a good looking, comfortable and well constructed chair. Like most chair makers, I have become a chair bore. I am not an expert but I thought that my experimental approach and experiences might be useful for others. There are stacks of really good books out there, by people who make their living from this, so this short piece is not comprehensive but covers some design tips that might be helpful if you want to design your own chair. I'll just do a very short bit of introduction and name mentioning by way of thanks, then we'll get straight into the design side. Here goes.

It started with a friend asking me if I fancied doing a weekend course to make a stool in the woods. Three of us went down to Prinknash Abbey (Graham Saunders <http://www.cotswoldwoodlandcrafts.co.uk/>) and did a bit of cycling and noodling. Two of us made stools, while the third carried on cycling the steep hills round there. Using bodger's benches, pole lathes and other tools we did the usual and turned logs into furniture. Actually we only really made the legs and drilled holes in the seats for them, but it was enough to get a taste of it.

When I got home I decided to make a bodgers bench out of stuff lying around, such as a pallet and bits of old stage set, to use in working some of the wood from our long thin hillside garden. A walking stick, garden poles, hurdles and decking fences have their place in the home and garden scheme now.



When I was pollarding a maple, I thought some of my chisels could do with new handles, so made a pole lathe the same way. The lathe originally had oak poles at each end providing the spring and with cord between. The oak poles eventually went, so I used bungy cord instead, but may go back to the poles at some point. Without following plans, it was interesting to work out the geometry of the lathe and bench. They have evolved with use and maybe aren't the best, but they are still working.



After a while I asked the same friend if he fancied going on a chair making course, but he felt his skills weren't up to it. He was wrong and he knows that now, but I decided to go it alone. I booked on a course with Paul Hayden at <http://www.greenwoodcourses.com/> . Unfortunately using the pole lathe highlighted the fact that I needed a hip replacement. At home I had worked out a way of using the lathe sitting down, but down at Westonbirt I decided to make the whole thing using the bodgers bench / shave horse. First lesson about Windsor chairs: they don't have to use a pole lathe. Look up Welsh Stick chairs if you haven't come across them.

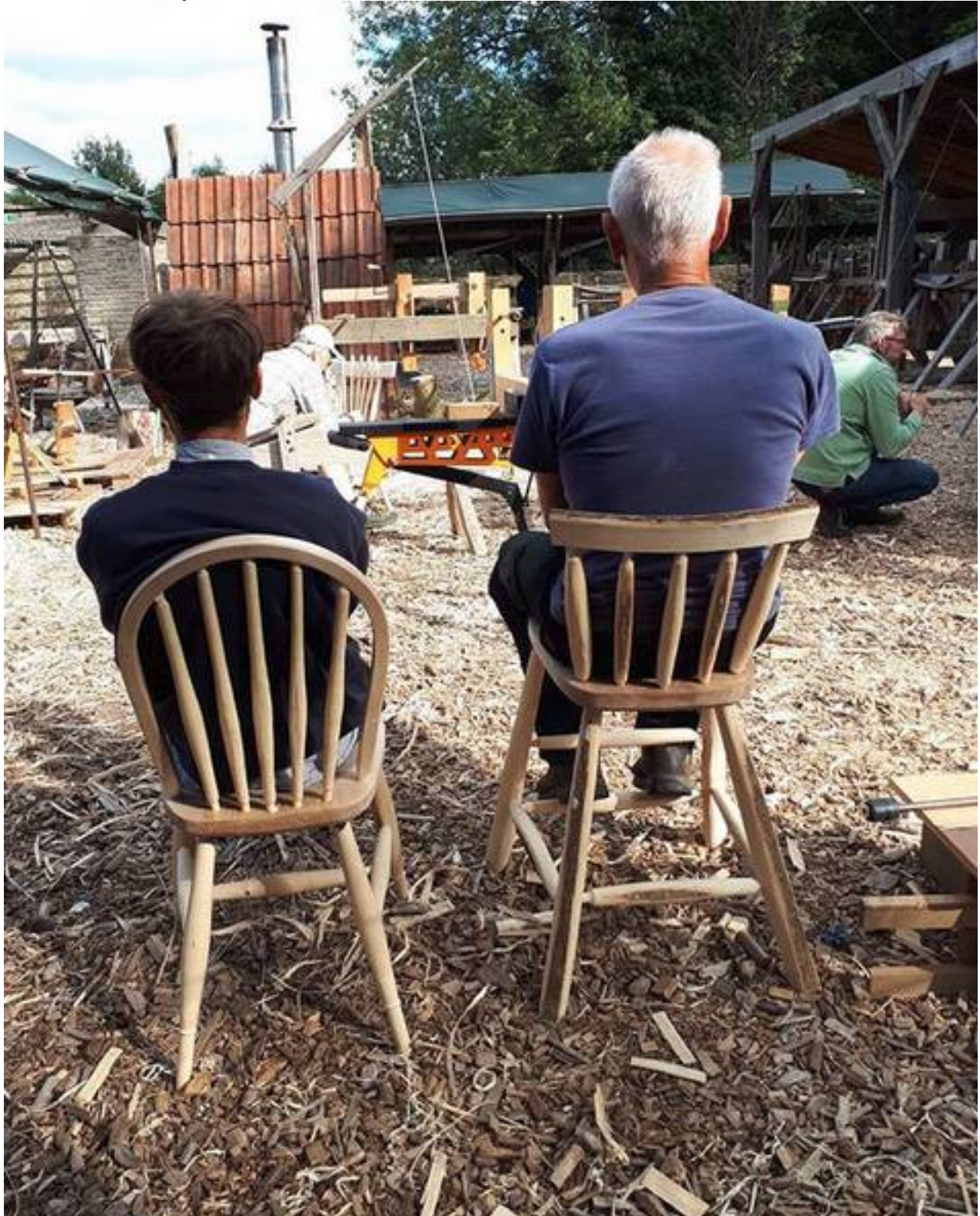
While I am at it I have to mention Peter Murray (<https://www.theartfulbodger.co.uk/>) who was helping Paul at the time and gave me the Welsh Stick inspiration, as well a lots of tips. Because I can and because the original friend decided he would try it at last and got hooked, I have now done several of these courses and am still not bored. Each time I have tried something slightly different and, though my skill levels are pretty good, the people there always help to inspire me.

While I was doing my first course Jason Mosseri (<http://hopespringschairs.com/>) was making a chair there. We chatted and I watched what he was doing and learned his interesting approach.

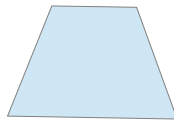
My stepdaughter lives in New Zealand so in 2019 I made a chair over there with Richard Hare (<http://www.rbhchairs.com/>). This was a completely different approach and taught me more again , not least about how privileged the UK is to have the wood species it does.

You can find all these people on Facebook and sometimes Instagram as well. They are all really skilful people and good teachers. Thanks also to Chrissie, Josh and Ralph for their patient assistance and good humour down at Westonbirt. Finally thanks to all those around me who put up with my chair obsession, especially Ruth and Stephen, who have encouraged it and Jo, who ordered a chair for herself then set me on the child's chair path. Stephen can be seen working away in background left in the picture on the next page. I hope you find my notes a helpful addition to what you can learn from other sources.

The Basic Geometry of Chairs

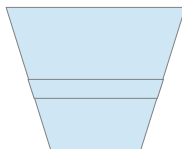


If you follow ready made chair patterns and use common leg and back angles, you may not have to think too much about the structure. If you want to check what you are doing or design your own chairs, then it is very helpful to have some understanding of the principles and forces involved. Let's keep it simple and ignore some of the variety of chair design options available. Whatever name they use for it (the base, the undercarriage, the legs) most Windsor chair makers tend to view the chair as a stool with a back on. The leg structure is tenoned into the seat to make the stool and the back structure is tenoned into the seat, usually after the stool is made. Excusing the geometry jargon, both the stool and the back use either triangles or trapezoids to give strength. If you look at the trapezoid below you can see the common shape of pairs of legs, whether front to back or side to side. This shape is more stable than a square, as collapsing one part of it requires lift in another part and thus gives resistance to the collapsing force.



In most Windsor chair stools the full trapezoid is created by the stretchers between the legs. If you look at the chair on the title page you will see that the side stretchers create a direct trapezoid with the legs and the seat. The trapezoid for the front and back pairs of legs is created indirectly via the side stretchers by the cross stretchers.

If you now look at the chair at the front again with that structural eye you will see that there is some excess structure there. The rockers actually create the trapezoid, so the side stretchers are redundant, if you put the cross stretchers directly between the front and back leg pairs. Actually good tenons into the seat and the right woods can make such a stable structure that the stretchers can be viewed as excessive. The trapezoid is created by the friction of the legs on the floor. That stability depends on the angles the legs enter the seat, the floor surface, the quality of the woodwork and woods and the weight and stability of the person sitting on the chair. Most people choose to build some contingency strength in. The decisions you make are all weighing up your own level of skill, the materials, your control over the possible uses the chair might be put to and then aesthetics and weight. The chair at the front is designed to sit on a semi protected shed porch, as close to the shed side as possible and to serve both as a rocker and as a dining chair, so it is a set of compromises. For instance if it had a stretcher across the front, then it would not be possible to tuck your legs under when you sit forward to eat.



Let's look at our trapezoid again but the other way up. Imagine this shape for the legs and seat. It is still a trapezoid with its built in stability advantage. Here though, the pressures downwards from someone sitting on the seat actually work to pull apart the tenon joints with the stretchers. Is that all that is wrong with it? Apart from anything else it just looks wrong, but it also means the the chair is more likely to fall over if rocked. When legs point out, any rocking force has to raise the seat at both sides to get it to the point where it can fall over and this works against the downwards forces created by the person sitting on the seat, indeed by the weight of the seat itself. We could splay the legs out wider and this effect would be increased, but it would also increase the effect of the downward forces from just sitting on the chair. All the decisions you make are compromises of some sort or another.

Below is the completed bar stool design I am sitting on in the earlier picture.



Here again you can clearly see the trapezoid shape of the legs, but you can also see that the trapeze is taller and thus the spread at the bottom is greater, despite there being a standard dining seat pattern at the top. Because of the wider spread and the longer legs increasing the leverage factors, it is possible to reduce the angles at which the legs enter the seat and still have the same overall stability and strength. This also stops the legs taking up too much room at floor level.

The intended function of the chair also has an effect on the decisions that are made about the angles of the sides of the trapezoid. Dining chair legs traditionally have more upright legs. One reason for this is that you tend to be trying to fit as many round a table as possible and not have people trip over the legs as they squeeze in, so a wide leg base is a nuisance. Another reason is structural. Because the seat tends to be slightly higher than a relaxing chair, this make the legs longer and thus the leverage forces are increased and a more upright leg reduces this. A rocking chair is the opposite of this. The rockers complete the trapezoid shape at the bottom of the legs, making it strong. If you have the traditional side and cross stretcher arrangement, you can splay the back legs out further because there is more working against the forces trying to make the seat collapse downwards. In addition the rocking of the chair moves the centre of gravity back and forth and the leg angles effectively alter accordingly. It is also worth remembering with a rocker that the other end of the rocker effectively pushes up as you push down so the forces are spread through the whole structure in a positive way. I will go into this in more detail later.

How about the shapes in the back of the chair? Below is my New Zealand chair in production on which I have highlighted another trapezoid for you.



This one is the other way up to the normal leg pattern, but has a similar functional purpose. In addition

the pressures created from leaning on the back are increased by its length and these are countered by the downward pressure on the arms but also by the greater angle of the front sticks. If you put one of these together without glue, you will find that backward pressure on the back creates an upward pressure on the front of the arms and that in turn will lift the stick out. The greater angle counters that pressure and in other uses the forces downward on the trapezoid from you arms are slight compared to the pressures the stool receives. In addition you can move the hole in the arm for the forward support stick very slightly forward and this creates a small tension that holds the structure together mechanically. The more upright of the two arm sticks can then act in compression to counter the downward forces on the more highly angled front arm stick.

If you look at a trapezoid, it is actually a square with two triangles attached and the triangle is another structurally strong shape. In a traditional bow or comb back (see below), the stiles or bow ends are placed forward of the centre stick. This creates a triangle often envisaged like the picture on the left below, but actually transferring forces more like the picture on the right.



On some chairs you will see an additional stick behind the back coming from the top down to an extension backwards of the seat, which is another triangle designed to spread forces and thus support loads.

Before we leave triangles it is worth mentioning another, that chair makers think about when making a rocking chair, the one made by the rockers and the top of the back of the chair, especially if children are likely to stand on the seat and start rocking. From the picture of a child's rocking chair below you can see the triangle.



The chair is placed on the rockers so that backward rocking does not take the top of the back far enough backwards to make the triangle unstable. Rocking forward at the front of the chair does not have the same leverage and more of the weight is distributed towards the back, reducing the rocking force. That is why the chair is placed well forward on the rockers. Incidentally on this chair design you can see that weight has been reduced by keeping stick numbers to a minimum and that the angle of the front arm sticks has been increased to compensate.

The final shape that is worth thinking about is the one made by the points where the legs stand on the floor. This is often roughly square like the one in the picture below.



In a chair with a fairly common seat shape, that is slightly narrower at the back than at the front, achieving a square involves splaying the legs out further at the back. You can check the shape made by the legs by putting the seat upright and level in a vice then putting a pair of legs in the mortices and checking with a level. If you are making a tapered mortice, you can do this as you work the taper and adjust accordingly. You can adjust an ordinary mortice slightly in the same way. As the square shape made by the four leg bottoms is not that important structurally, designers often keep the same leg angles and then the pattern of the legs becomes a trapezoid, with the back legs slightly in from the line of the front legs. There is a general view that the back legs should not be wider than the front legs and that the whole should be symmetrical, but, as the picture above shows, all rules are there to be broken if they do not affect the structural integrity. On this curved two seater bench the shapes mean that the slightly wider back legs and asymmetrical middle back middle leg work well in a number of ways.



I find that keeping these shapes in mind allows me to picture the effects of design decisions on the forces involved. As highlighted in the case of the arm sticks, once you understand those forces, you can also make very slight adjustments to the positions and angles of mortices that add other gentle forces to help the chair stay together. If you are worried about your design or making skills or the strength of the wood then add more structural elements or change angles slightly so they add extra stability. As you get more confident and understand it all better, it is possible reduce the size and number of all the structural components and it can become a challenge to go as light as possible while maintaining practical strength. Going back to the bar stool above, it would be possible to reduce the leg significantly and still maintain structural integrity, resulting in a chair with a different visual appeal.

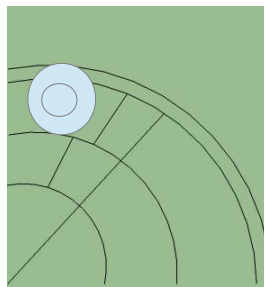
One final word on these shapes and the physical act of putting together (framing) the chair. The trapeze that makes up the legs means that the holes that are drilled into the seat are at an inward pointing angle. In practical terms this means that when you put the ends of the four legs in the holes and knock them in, the ends become closer together, squeezing the legs together and squashing the stretchers. On my first rocking chair this squeezing effect, together with the controlling effect of the rocker tenons, made the mechanical fit so strong that I have not bothered to put any glue in the joints and it is still happily rocking away several years later. I will come back to some specifics of this effect later.

Wood, Parts of Wood and Splitting

You may have noticed that some of the chairs used as illustrations so far have bits of bark left on them. I did this on the comb of my first chair and it has become a noticeable feature on most of the chairs since. Time will tell about the longevity of the bark feature, but it raises the issue of the woods and parts of wood to use in your chairs. Again it is not the intent of this pamphlet to compete with other advice. I just want to tell you what I have learned from experience. Ash, in particular, is such a wonderful, precious resource that some knowledge of wood can help you make the best of it, wasting as little as possible.

Working from the inside of the log, the sections of wood usually highlighted are the heartwood, then the sapwood, then the cambium layer, live bark or bast and dead bark. Wisdom varies and wood species are all slightly different but the part favoured for most chair parts is the sapwood. Indeed within a reasonable sized log you will often see two distinct layers of sapwood the inner of which is more compact as it slowly turns to heartwood. This inner sapwood layer is often still easily workable and seems to have good stability and strength. Received wisdom says that the nearer you get to the outside of the tree, the more susceptible it is to rot. In today's dry, heated houses, this is less of a problem.

The first wonder of Ash is its ability to split cleanly. As you exert a splitting pressure, it doesn't grab too strongly across the line of the grain, so you can end up with a split that almost looks as if it has been planed. The greener the wood and the straighter and tighter the grain, the more likely it seems to be that this clean splitting will happen, so that inner heartwood is good. The longer the log length, the more likely it is that the splitting forces will be diluted in comparison to the grab forces and then you tend to get 'run-offs' to one side and fibre fractures. You can use various techniques to try to control the split and that is one of the skills that you get from practice. Hopefully the sketch below illustrates that you can also split the wood from the inside to get more sticks from one segment of log. If you remove the inner, heartwood segment, then split roughly along the next arc outwards, you are left with two sections that can be split into three and two sticks. The outer section will often split better by laying it down and splitting from the middle of the bark side. Splitting it like this, from inside to outside, often helps control the split better too. If you get a piece of wood that has bent grain or a lot of grab, then you can often saw these smaller sections of log in two to get more controlled splitting for use as shorter sticks.



You can see that the three outer sticks marked for splitting in the above illustration will have bark on them, which you could try to preserve. There is actually the cambium, live bark (bast) and dead bark layers there and you can try to preserve any or all of those. You don't want the outer layer on your tenons though. If you use a lathe to shape your stick, saving that bark layer is going to be harder and I have marked it on the diagram, together with a smaller circle for the tenon at the end of the stick to show that. In essence you have to offset your centres on the lathe, so that the bark gets skipped each time the stick turns. Using the same technique, keeping just the cambium layer is a bit easier. If you just shape the sticks with a draw knife, spokeshave and similar tools, you can make the stick more oval, which again makes it easier. Anyone who has split bark will know how easily it comes off, so you have to work with care. Once it is dried it seems to be stuck to the stick more firmly and with something like Danish Oil on, it seems completely stable. I don't treat it with kid gloves once it has dried.

The next trick for getting the most out of the wood is to know when to give up for the moment or to move on to the next tool. The tools in sequence might be: splitting axe, side axe, draw knife, pole lathe, *Drying*, pole lathe, spokeshave, rounding tools. There is no fixed order or time to move from one to the other, but any problem the wood is giving you might be easier to solve with the next tool in the sequence. The first set of tools are all versions of splitting but a pole lathe shaves the wood in a different direction so will often help where the wood keeps trying to make your splitting tool dive in because of grain irregularities. Even then, it is worth remembering that we are using green wood because it splits and works more easily. That also means that the anomalies in the wood are harder to control. After it has dried, ash is so hard that I have made resilient jewellery out of thin slithers of it, cut from the ends of sticks. That means that finer adjustments are easier to make with good sharp tools after it has dried.

It is also worth remembering that grains run in a range of directions in any one piece of wood. As you look along your stick from the end, you may have a nice straight face, but the grain may have several different layers, as in the diagram below. You can detect this by the presence of lines running across the stick. If you pull your blade into the either of those stepped bits, it will try to lift the whole layer. Simply reversing your blade, so that you are sliding it from the end towards the step, will lessen the chances of lifting the layer. That means that you often have to swap direction from one part of the stick to another as the layers wave up and down.



Drying changes the nature of the wood. As it dries by evaporating moisture, the liquid parts, especially lignin, dehydrate and shrink. These liquids and the round structure have been keeping the harder parts under tension in various ways and that tension is released. The result is a number of distortions. If you have made a round stick it will probably become slightly oval. If you split a board from your log it will try to bend from side to side. If the ends are allowed to dry too fast, the board will start splitting at the ends. Controlling these tendencies, and even using them, is part of the craft. For instance, you can put a dry tenon into a slightly wetter mortice and the joint will tighten as the mortice dries, but if the difference is too great the wood round the mortice may split. If the tenon is slightly wetter, it may come loose as it shrinks further. If in doubt get a device to test the moisture levels so that different parts are in the equilibrium that you want. I think I can feel when wood is still too moist and hear the different sound dry wood makes when you bang two sticks together, but that is just hokum really.

If you get a log and only use part of it, you can still use it later because it will take a while to dry out. You might be wise to do some splitting to release some of the tensions, reducing uncontrolled splitting, but exposing too much wood surface can speed up drying. The old trick of burying it in shavings helps. If it has dried a lot you can give it a soak in a rain barrel or trough and this will make it slightly easier to work again. Soaking is a last resort though, as the water does not properly rehydrate the wood structure, just sits in the gaps, loosens it up and makes it easier to work. It also introduces potential contaminants, so may change the colour of the wood a bit. One temptation, if you like the Welsh Stick chair look, is to use whole sticks without splitting. This takes a some care and you would be wise to make the sticks over long, so that any split ends can be cut off. You can also control drying a bit by sealing the ends of the wood, reducing evaporation from there and reducing the tendency to split. I have controlled bend in a split plank in this way too, by shaping it and putting Danish Oil on the side that will become concave and the ends, so that moisture goes first from the side that will become convex. You can see that in the footstool below made out of split ash, which still has a slight convex bend where the grain has tried to straighten out (cupping).



Green woodwork is often associated with a more peaceful, rural way of life and this picture is associated with a wood fire burning in the chair making campsite. If you have a wood fire, then you might as well have a home made kiln sitting over it to dry your sticks out. Sadly, though pleasant, this is an inefficient use of wood and not encouraged in smokeless zones. I dry my wood in an under stairs cupboard that has a domestic battery with a fan, running off the solar panels. Mostly that has been successful but, on a couple of the earlier chairs, legs shrank afterwards and had to be re-glued. For that reason and certainly for bigger pieces of wood I exercise patience. For seats, I would recommend buying boards dried by experts. If you don't have a band saw try to get them cut to shape as well, as a jigsaw tends to bend in to the curve and ruin the shape. You can be left with a lot of finishing work to get an acceptable seat blank.

I recently made the bench seat on page seven out of oak. It that had been properly milled and stacked, but not for that long. It was nice and straight and carving the seat was like going through butter. I had to leave off finishing the seat till it had dried a bit though, as it tended to rag. Having removed wood in the carving and shaping, it started to dry and then split. We drilled a decent sized hole from the back, clamped the split together with some glue in and put a long screw in through the hole from the back to hold it together, then plugged the hole. After the seat was made it dried a bit more and started to develop more splits, so in with more glue, re-clamp and then put in some fencing staples from the underneath. Glue and sawdust mixed is very useful. It seems stable now, but I have left the underneath unfinished, so it dries out from there and will keep an eye on it. If it splits more, I will find ways of holding it together and perhaps make more of a feature of the splits. The bench looks beautiful and full of character but it would have been easier if the board had been dried longer.

There are whole books on bending and steaming and some amazing videos on the internet, so I will just tell you my experience and personal theory. Ash is revered for its quality in bending too, so I would choose that as a starting point. You can bend it when it is green just by slowly putting it under strain in a vice with blocks at each end on one side and in the middle on the other side. This way you will bend it, but it takes up a vice for all the time it takes to dry thoroughly. Even then it seems to tend to straighten up again gradually. The alternative is to steam it. As far as I can tell the best wood for steaming is tight grained board that has been carefully dried and kept straight, usually by someone else. The moisture has been removed and the the lignin has dehydrated and other chemical changes have taken place. Before you steam the wood you soak it to take advantage of wood's tendency to equalise moisture content. I don't think this re-hydrates the lignin completely, just puts water into the structure that acts as a good heat transfer medium when you put it in the steamer, which softens the lignin and fibres so that the fibres will slide alongside each other and it can all be bent. After you have taken it out of the steamer and bent it, the water leaves the wood faster than it would when it is green and so the bend seems to be more stable quicker. I have seen and had mixed results. Some pieces have just cracked despite my best efforts. Some have a greater tendency to fight you by trying to twist as they bend. Finally the stainless steel used to make compression straps seems hard to get in small quantities, so I used 25mmx.20mmx 3 meter CS95 High Carbon Steel strip and covered it in masking tape. This worked after a fashion but the steel is not really strong enough, so a thicker strip would be better. When

you make a compression strap it is important to have a back on the strap beyond where the strap joins the handle/tension block that holds in the piece to be bent. If you don't, the strap tends to pop off, which is stressful when trying to work fast and calm. I built a steamer out of sewage pipe covered in some insulation and blockboard I had lying around, put a small length of pipe in the end and fed a pipe from a wallpaper stripper into it. I also put some sticks across the bottom of the pipe by drilling holes in either side and feeding the sticks through. This keeps the bits being steamed off the bottom. I just stand the steamer on saw benches, which makes it a smaller thing to hide in the garden when not in use.

Most Green Wood courses in the UK are in parts of the country where the best wood is available. Elsewhere getting fresh, straight ash logs and other woods can be a problem. If you are near one, join in with a local Bodgers (APT&GW) group, who will know about sources. There isn't one very near me. As mentioned earlier, drying and storing wood effectively is quite an art.

Simplifying Angles

Angles are confusing and chair makers often add to the confusion, but you need to have some ability to deal with them to put a chair part into the seat correctly and more importantly to put the other parts in with the required level of symmetry. Although I will start out with a bit of more complex explanation, my aim here is to simplify things as much as possible and to highlight some tricks and easily made tools you can use to help.

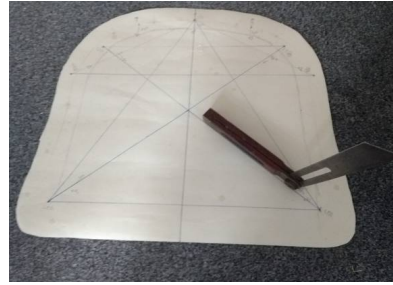
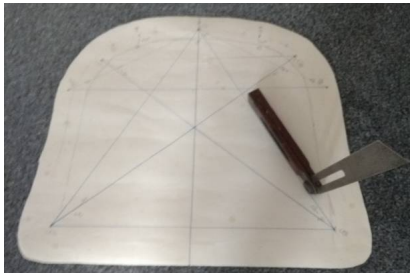
The earlier section on shapes pointed to triangles and trapezoids, so you already know that the angles involved are not usually right angles (90 degrees). What I didn't highlight in that section is that the legs, for instance, point out both to the side and to front or back. This makes the angles what are often referred to as compound angles. When you start on the seat it is usual to find a centre line from front to back to use as a basis for the symmetry of everything on the chair. If you now draw a line across the seat at right angles to that first line you have the basis for a compound angle. Each chair leg has an angle pointing out from its own centre along a line parallel to the front to back line you drew and another angle pointing out from its own centre along the line of the one you drew across the seat. That is the compound angle, but I am not even going to draw it or explain it further, because it is hard to deal with in both mental and practical terms.

Let me introduce the sliding bevel.



These can be purchased cheaply and set at any angle with the use of a protractor. You can add a block alongside the bottom to help with balancing the wooden base on your chair seat. It is worth saying at this point that all measuring, placing and drilling is easier if you do it before carving the seat and with a flat seat but there are other ways, such as placing a board across the seat. Let's call the angle shown on the bevel 101 degrees. Confusingly this angle can also be referred to as 89 degrees (the angle from the metal upright to the line of the base of the bevel in the other direction) and 11 degrees (the difference of the tilt from vertical). Get into a habit of using one of these and be prepared to translate from any books you read. If you were trying to set up the angles for a chair leg that points out to the side the same as it points out to the front, then you could take two of these and place one along the front to back line and one along the side to side line and drilling your hole in line with both blocks would give you the compound angle you need. How about making it simpler though? Take one of these and place it with side of the wooden base pointing to the dot where you want your leg centre to be and then spin the other end around till the base is pointing along a line halfway between the front to back and side to side lines (45 degrees). You now have one angle and the direction in which it is pointed. This combination seems to be easier to deal with in general. As long as you have room for your drill, you could align it with the part of the bevel pointing up and drill your hole. Don't do that though, because we have more options and better ways of balancing all the parts together.

What if you want the legs to point out more in one direction than another? Keep the end of the bevel nearest the leg centre pointing where it is but move the other end either towards the front or back of the chair seat (see pictures below). If you look you will have made the bevel stick out in one direction more and in the other direction less. You will have the same angle on the bevel, but by changing where it points to you will have changed the front to back and side to side angles.



The bevel on those pictures is actually sat on a seat template, on which you can see some lines drawn. These show placement and directions taken for all the legs and arm and back sticks. The front legs are set up to line up with a centre point at the back and the back legs are set up to line up with the opposite front leg. As you can see from the second picture, running your bevel along that leg to leg line gives more splay to the side, which counters the narrower back end of the seat. Using a wall lining paper template allows you to experiment without drawing lines all over your seat. Put your bevel on and move it around, looking at the effect. Once you are happy with the shape it makes as a leg, draw a line alongside the bevel, over the leg centre dot and until it crosses the front to back centre line. If you have marked your leg centre at the same point on the other side, you can then join it to the point where the line you have just drawn joins the centre line and you will have symmetry. When you are drilling the mortice hole, this combination of angle and direction is much easier to deal with. Put holes through the paper where the two leg centres are and where the lines from those two legs join and you can lay the template on your chair seat and push the holes through to reproduce them on the chair.

Let me introduce another simple device. The upside down legs are simply screwed to the sides of a block and are held to the angled board by friction. If you move the legs backwards or forwards the angle of the board changes. If you do this till the angle between vertical legs and tilted board matches your bevel from above then you are ready to drill holes. Place your seat on the board with the line you drew between leg centre and centre line aligned with the centre line on the board. Place your drill on the leg centre point and keep it vertical (the vertical legs above make that easier to spot). Drill your hole and it will have the angle and direction you have set out.



So, keep your angles simple and add a direction. Mark things on a template if you are not sure or want to do the same more than once. If possible find a way to tilt the work rather than the drill; it is easier on the eye and brain. I will cover some more complex problems relating to angles next.

Backs, Rockers and Arms

After making a three legged stool I ended up diving right in at the deep end in making a rocking chair with arms. I am still amazed that it didn't all end in tears. That it didn't is because of three things. First is that I am lucky enough to be able to see shapes and angles in my head. The second is that I am not a person who wants everything neat and perfect. Third is that I am pretty good at making it better when I mess up.

The three elements of this chapter title all add a significant level of complexity and can often work against each other as you try to frame the chair. If you put a straight forward comb with stiles or a bow back on, your sticks only need to fit the mortice hole size you have chosen at each end of the stick and you only need to get the mortice holes at the right angle and it will probably be acceptable. Paul Hayden has a neat way of adding arms to a ready made chair that is both strong and can be retro-fitted, but even this requires some extra thought and care in drilling the hole angles. Similarly you can make a chair and then add rockers, but attaching the rockers and getting the height and movement right requires a bit more understanding. This section outlines what I have learned.



This picture is a prototype for a dining chair that I made to test out the design before making some for my friend. It is about as minimal as you can get for a dining chair with arms. I am sat on it now, because it works well at my computer too. You could add more sticks and put the arm bow horizontally and it would still work reasonably well. I'll go into the design principles in the next section, but this is the easiest way to add a back and arms. You need one bow and however many short sticks you require, with tenons at the end. With a horizontal arm bow, assuming you put the back sticks in at 101 degrees, then you just need holes at the same angle in the bow, though care is needed if the bow is not very wide or is over deep as the drill can emerge from the side rather than top or bottom. You can do through tenons or hidden tenons. I tend to use a mix as one works better when you push down on the arm and the other tends to work better when you pull up. If you taper the stick in towards the tenon, so that the arm sits on the point the taper starts, you get the supportive effect of a hidden tenon on a through tenon. That is harder to do though, especially over a whole series of sticks, with slight variations in tenon and mortice lengths. If you are drilling the arm from underneath for a hidden tenon, you have to remember that you are drilling from the inside of the curve towards the outside, which is the opposite of the seat or drilling from above, as you would with a through tenon. Though it might be tempting to try drilling through the arm bow on into the seat to ensure the same angle, I would recommend drilling the bow separately to the chair seat as it is hard to work out correctly and doesn't allow for any flaring of the sticks. Drilling through also requires a very long drill, as it is best done when the arm is at the required distance from the seat.

One reason for having a central stick at the back is that it can make setting everything else up easier. You drill your centre stick mortices place the arm on that stick and support it somehow at the front, then you can line up the other sticks and play around with placement and angles to work it all out. The sticks can attached to the arm bow with by putting an elastic band round the stick, pulling round over the bow and then looping it back over the stick. This which helps visualise it all, but you have to

remember that it will all change a bit as the tenons sink in to the mortices in the seat and when you drill your holes in the centre of the arm bow, rather than the side, where you have attached the sticks with the elastic bands.

The arm sticks are bit more complicated than the back sticks. It is rare that an arm bow has exactly the same flare as the seat. Usually the sticks are going to have to flare outwards from the seat like the back sticks. The back sticks have also moved the arm bow slightly backwards, so that makes measurement more difficult. Even if you make your arm sticks vertical this is complicated. With angles like the chair above it is even more so. At this point I would say that, if you want to make a complicated chair, then go on Paul Hayden's course, make a simple one first and then try a more complex one next time. Paul has T-shaped supports for the arms that you use after drilling the central back support to help work out the rest of the back and arm supports. If you want to work it out for yourself, I would recommend doing the front arm sticks first, so that you have a reasonably stable triangle with the central back stick, that you can use to plan and check the rest against. To give a rough measure you could put a square up from the seat where the centre stick is and measure the distance from the upright of the square to the front edge of the centre stick hole. This is how far back the bow has moved. On my first chair this distance was 4.5cm with the top of the arm bow 23.5cm above the seat. Assuming an upright stick, if you now decide where you want the front stick to enter the seat and measure the distance from that to the central back stick, you can first mark the equivalent spot on the other side of the seat, for symmetry again. You can then add the 4.5cm above to that distance and mark this new length in the same way, from the centre stick, on the bow. If the sticks are to be angled forward you need to add the extra distance that will create too. When you bend your arm bow it will often be longer than you need and probably slightly asymmetrical, so the fronts of the sticks are often unreliable as points to measure from.

The description above does not make designing and making a chair with an arm easy, but it does give some indication how hard it is. However you measure and drill your holes, you are likely to get a difference from one arm to the other. If you are an engineer and have the time, you can draw it all up and do the calculations. If you have a CAD system you could draw it all up and let the machine do the calculations for you. Most of the time you just have to devise a means of supporting the arms while you lay the stick pattern out, mark up positions and angles as well as you can, set your bevel to help you and then concentrate as you drill. As with the chair legs, it also helps to work out an angle and a direction. Set your bevel to match the desired stick angle and note where it is pointing. Then you have the two things you can keep in mind while drilling the hole. The sloping drill platform shown earlier also helps, as you can put the seat on it pointing in the right angle direction and then match that with the bow.

The prototype I made above has two small plugs in the seat where I got the holes for the front arm sticks a bit wrong. The downward sloping arm makes working everything out even more complicated as the mortice in the arm is at a different angle to the one in the seat. Since the first chair I have also always tried to make the holes in the arms for that front stick slightly forward of where they should be, so that everything is under tension to resist the backward force created from leaning on the back. If the chair can be made so that it is reasonably robust just by mechanical force, then it will be even more so when glued. In this chair the effect of putting the holes slightly forward was to pull the back slightly forward too. Because the back of a dining chair usually needs to be slightly more upright in the first place this is more noticeable. I say noticeable but it is only me that has noticed and the final chairs didn't have the same problem.

If you are making a chair with an arm bow and a comb back as well, or a double bow chair, then you have the added complexity that the back sticks have to be made so that they can go through the arm bow and up into the top of the back. The extra length also increases the backward forces a bit, which in turn puts a greater upward force on the arm ends. Despite these extra things to think about, the fitting of

the arm bow is the key to stability and comfort, so I would recommend that you work this out first. If you want some outward flare on the back sticks, you can usually achieve this from the arm upwards, as the thinner sticks will have some ability to bend. This means that you can drill all the mortices in the seat and arm bow at the same angle, pointing directly forward and the same distance from each other and from the seat back or line of the bow.

I have already explained that rockers help in stabilising the legs and that when you press downwards on one pair of legs to rock the chair, the rockers exert an upward force on the other pair of legs. This means that the join between leg and rocker is under less strain than you might imagine. The joint still needs to be strong though and you have to take into account the angles involved. You really want to have the rockers sitting flat on the floor, so the legs need to hit the top of the rocker as if they too were sitting flat on the floor. This means that the mortices in the rockers have to be angled from the inside of the rocker towards the outside and toward the front or back at the same compound angle as the leg. The curve of the rocker makes this harder still to calculate or envisage. You can't have over-long tenons or they risk coming out of the side of the rocker. If you are daft enough to make a leg like the one on the front of this pamphlet, then you have to hide the tenon inside the perimeter of the leg and cut the bottom of the leg to match an angled, curved profile. After carving the tenons out of the leg on my first chair, I decided not to do that again, so I now drill matching holes in leg and rocker and fit a dowel tenon to join them.

Because the mortices in the rockers point outwards, it means that when you put the legs in, the effect is to pull the legs outwards, which is the opposite of the effect when the legs are inserted into the seat. For this reason care is needed placing the mortices. My dowel method means that the holes in legs and rockers naturally start in the same place. If you are not using that method, you need to ensure that the holes in the rockers are the same width apart as the top of the tenons on the leg. When you are assembling the chair you need to put the legs onto the rockers before you put them into the seat so that you widen them then close them up again.

Sitting the legs on rockers raises them, so you have to shorten the legs to accommodate this. When you sit on the chair it is nice if it rocks back slightly into a new equilibrium with your weight on it. This raises the front of the seat slightly and, at this new height, your legs need to be at a comfortable enough height and angle to enable you to rock easily. The slight lay back as you sit also makes the seat angle more relaxed, so it doesn't need to be too laid back in the first place. You need to be able to rock both forward and backward and placement of the legs near the front of the rocker and slight lay back on sitting make this happen nicely. As explained earlier the extra length of rocker at the back is to stop the chair tipping backwards with excessive rocking, mainly for when a small child stands on the seat, leans on the back and starts rocking a lot.

As well as being a little tricky to fit, traditional rockers are also quite hard to shape. You can cut them out of a larger piece of wood already curved or steam bend them. You can also fit rockers by making them much narrower and cutting a groove in the end of the leg to sit over the rocker, drilling a hole all the way through and filling it with a dowel. You can see this in the New Zealand chair detailed later. This works and has the advantages that the rockers are easier to cut and finish and that they have less floor area on hard floors. On soft floors they will tend to make a deeper groove.

Finally on rockers is the line of them on the floor. If you want the rockers to be parallel, you have to make the four leg ends describe a square pattern. If the legs are coming out at different angles front and back, this is not always straightforward. If you shorten the legs it will change the shape they make slightly. It is better to even out the chair on a flat surface before you start fitting to the rockers. It is

generally fine if the rockers point in slightly towards the back, but any lack of symmetry will cause your chair to travel sideways as you rock.

Chair Form and Function

Everyone's tastes are different, so it is not my intention here to tout a particular style. You will see clearly from these pages the sort of chairs I have been developing. I have mainly stayed with that style because I like it and, more importantly, other people genuinely praise it. That doesn't mean that these are the only style of chair that I like. A well designed chair is a mixture of form and function and its appeal is not dependent on a particular style. The dining chair I designed was intended to be completely different, but still seems to work.

When I made my first full chair, which was a rocking chair with arms, I just worked out the geometry based on sitting on the seat, being reasonably cautious about structural strength and what I thought looked good. I also aimed at something lighter than many chairs, which are often heavy on the stick numbers. When I put the chair together before gluing, people sat on it to test it out. One of the women on that course sat on it and we both knew straight away that it was a bit tight across the seat for her. When I thought about it I realised that I had measured what I was making against myself (tall and thin), not against a body average or variation on that. I have since heard other women complain that Windsor chairs are often made by men for men. I have one daughter who has long legs and a short body and one who is the opposite, so that started me thinking about the form of the chairs in a new light beyond the width of hips. For comfort chairs, I now try to make the chair fit the person, with heights and widths adjusted subtly to optimise, but also allowing for other people using it. Your challenge if you design chairs is to make them work first and then to make them look good as well. A good carved seat is just wonderful to sit on, even if you lay it on a log, so it is a shame to lose that joy by either bad practical design or ugly looks.

Because I didn't know much about chair making or its history when I made my first chair I was able to let it develop in the way I thought looked good. The result is still pleasing to look at and because my wife has relatively narrow hips, she likes to sit on it too. Because she has shorter legs, she uses the footstool shown earlier. The second chair I made, I knew too much. I added more sticks, because a lot of other people did, I made big efforts to make it as wide as possible because the first had been slim. I noticed that people often carved curves under the seat front that matched the ones on the top, so did that. The chair is fine but it is a bit of an experimental mix that isn't as coherent as the first. Each chair since has had some element of experiment and compromise, but I think I have got better at making the whole work well. The decisions you make should reflect the purpose for the chair, the design features you have decided to incorporate and an element of taste in styles.

Before I look at particular chair types, here are some observations from my experiments. I have a chronic bad back that is also relatively long, so I have experimented with a range of back styles and lengths. I have found that good Windsor chairs, with a carved seat that holds you firmly, negate the need for a longer back. While I was visiting Richard Hare he showed me his first rocking chair that had a really high comb back with very thin and long sticks, that had followed him round for many years and was still functioning on his outside porch. You can make a back as high as you want mechanically, but this prototype dining chair of mine that I am sat on is perfectly comfortable, so you should do the back at a height that you think looks OK. I mentioned the seat above. I think many people don't carve the seat deep enough. It should stop you sliding about without feeling restrictive. If you are worried about going too deep, measure how deep your seat is and keep checking by putting a straight edge over the seat and measuring downwards. I think you will be surprised how much wood you still have left. Because I was carving one seat with a gouge, I decided to do so in a pattern. Peter Murray mentioned that some people leave the pattern, so I did. It is amazing how comfortable a set of raised ridges are, as long as you round them off. This highlights that people often spend too much time worrying about finish. Form and function are much more important.

Perspective works well on a chair. As mentioned earlier the back legs can be in from the line of the front ones, exaggerating the perspective. Side stretchers can be larger at the front than the back, giving a similar effect. Stretchers do not need to be at the same height. On the bar stool I am sat on at the front, the side stretchers are higher than the lower front one and the back one higher again. You can slope stretchers slightly from front to back as well. It is often good for backs to be able to tuck your legs back under the seat, so bear that in mind when designing stretchers. When you are looking at features like bark left on or turnings that have been planed either side to make a flatter version, remember that the chair will be looked at from all angles, so walk round it like a sculpture.

A dining chair has some particular features that are dictated by purpose. It should normally be light because it will be moved around a lot and for the same reason it is better if it is reasonably easy to pick up. It will usually be narrow because most of us don't have huge dining rooms with space for large chairs. It needs to be high enough and upright enough to eat at table comfortably, but not so upright that you can't enjoy relaxing at the table after the meal. Even with narrow chairs you often have to be able to slide sideways into the chair in a reasonable tight space, so arms that come right to the front of the seat are usually better avoided. The chair normally needs to be able to push under the table partially to allow easy passage behind. If it has arms, they should not interfere with elbows while eating. My chair design aims to achieve all of those while giving every chair occupant arms to rest, rather than just those at the heads of table, as is often the case.

How should a relaxing chair differ from a dining chair? The answer is probably less than you think. Because it doesn't have the need to move around as much or to be light, it can be a bit more generous in width. Any arms can be at the most comfortable height without worrying about interfering with elbows and tables. Perhaps it should have slightly more slope from front to back and a lower seat, but actually these are probably not really necessary. I have already written about rocking chairs and these are probably the most comfortable chairs for long term sitting. I suspect most people are not going to give up their comfy settees, but you will probably find it easier to get up again, without an involuntary groan, if you use a good Windsor chair.

Beyond those simple tips I will leave it up to you decide what you like. I prefer simpler forms and think that a lot of more ornate patterns were a product of a battle between bodgers and manufacturers to make chairs lighter, or at least look lighter and to add more twiddly bits, as a way of showing off. Artists and chair makers alike will talk to you of a golden ratio. If you think of a ratio of 3 to 2 it will give you some idea. There is no real point in getting too fussy about what it really is, but if you place your stretchers roughly three units up from the base of the legs and two from the seat, or put three fiddly bits on you legs at the top and two lower down, or make your back length three units down to the arm bow and the arm bow two units from the seat, then you will be following in a tradition of asymmetry that people often find pleasing. I would advise that you just do what you think looks good, as long as it is comfortable and robust.

Tools, Making and Framing.

I have made furniture all my adult life and have also inherited my carpenter dad's tools but, when you come to make chairs, you realise there is a whole different word of tools for that purpose. That can make it expensive when setting up, but you can get away with surprisingly little: an axe for splitting, a draw knife for shaping, a spokeshave for more detailed shaping, an external bevel gouge for seat carving, a mallet, a good saw, a flat chisel for wedges. A bodgers bench is enormously useful, but you can just about manage with a clamp on vice put on the edge of a bench, where you can move your tool round the wood easily. You will need the ability to drill mortice holes. If they are hidden mortices, as in many chair legs, the drill bits can't have too long a lead point or it will poke out the other side. Once you have your basic tools, you can make special ones as you go. I have a couple of mallets for splitting, made out of logs. Use your drill bits to make a series of holes in a nice piece of wood, so that you can check your tenon to mortice fit. If you make the same set of holes along a long straight piece of wood then cut it in half along its length, you will have a series of half holes that can be dropped onto a piece of wood in a lathe to check its size. I made some rounding planes for the tenons and just swapped a Veritas blade from one to the next in use, but I have found that leaving the tenons slightly oversized and then careful work with a concave spokeshave when it is dry, makes for a better fit overall. Get a good roll of lining paper to work out patterns for seats, rockers and bows.



I mentioned the bevel before and you will also need a square and protractor too. If you make a comb backed dining chair from a bought seat blank, then that should see you through. Add a few pieces of different, fine grade emery paper to sharpen edges (picked up from Robin Wood <http://www.robin-wood.co.uk/>) and you are away. Using a simple tool set allows you to play with the actual chair making without getting distracted too much by the less essential bits. After that you need lathes, more sophisticated cutting tools, steamers, planes, tenoners, rounding planes.....

If we go through the actual making process, we can combine some hints and tips with the tools and tricks that I have found useful. Let's start with the wood splitting. There are all sorts of tools available for this task alone but this raises one of the problems you will have – confusing terminology. When you start searching for wood or log splitting, you will mostly come across devices aimed at making firewood. This is opposite to your aim. In good wood, that is not too long, any axe will probably do the job. One that has straight, rather than concave, sides and is slightly wider at the thick end, will probably do the job a bit better. Although axes are made out of strong steel and have a thick side for hitting, they will last longer if you don't hit them with a club hammer or other metal tool. That is where the log mallets come in. The books tell me that a froe is useful to control splitting, but, like many others, I have never mastered the technique. Mine is rarely used and even more rarely used satisfactorily. The use of the splitting axe at different points in the wood, as outlined earlier seems to work fine. It is worth mentioning again at this point, that you will want to give yourself some margin in the length of your pieces, especially if they are drying and showing a tendency to split at the ends. You can cut to length later.

After you have done the initial split the next rough shaping often uses a side axe. This is an axe that is not symmetrical, both in shape and in bevel, so that you can chop down the length of the wood without the axe skating off dangerously or digging too deep. Because it is asymmetrical it needs to be either left or right handed, unless you are usefully ambidextrous. Some people use a carving axe, which is lighter and more controllable to achieve the same end. As I have made more chairs, I have used this part of the process less. Instead I try to split more accurately and more finely with the splitting axe and then use the draw knife to refine. I have a robust draw knife and find that letting it dig slightly deeper, then rocking it gently works like a froe to give a better controlled split. If it is digging too deep, turn the workpiece over and work from the other end. Using this method I tend to get a long, smooth, straight piece, without over-enthusiastic axe cuts in it and done quickly and efficiently. When I work alongside other people making chairs, I often find myself picking up pieces of wood that they have discarded, because they are nearer the desired end size without chipping away at them with hard to control tools.

Having mentioned the draw knife, it is worthwhile spending a little time looking at these tools. Essentially it is a very wide chisel, with handles at either end of the blade. By default it comes with one bevel, again like a chisel. If you use the flat side down it can either tend to skate over the wood or dig in deep. If you use a chisel bevel side down it will normally tend to turn out of the wood because your hand is behind the blade, so forward and downward pressure lifts the front up. This is not so true on a draw knife, because your hands are in front of the blade edge and you are pulling. For that reason many people use the draw knife with the flat side down. A subtle addition is a very slight, curved bevel on the flat side, which gives a nice level of control. Although the tool is designed to be pulled towards you, there is no reason not to turn it over and use it in the opposite direction for short adjustment, where the grain changes direction. You have less control, so be careful. If I am wanting to remove larger amounts of material quickly, I use it bevel side down, which then helps with a rocking motion to split the wood as you go. Every single piece of wood is different and indeed every bit of every piece of wood. I have very skilful friends, who work with metal who dislike wood because it is so unpredictable. If you peek behind the chair on the cover photo you will see a metal sculpture of mine, so I know the joys and problems of both materials. With wood you have to know when to stop and move on to another tool or stage. Be prepared to stop using the draw knife while the going is good, no matter how hypnotic and relaxing it is.



Before I leave the draw knife it is worth saying a bit more about the bodgers bench. As you can see from the picture in the introduction, mine is very rough and ready. It has had a few minor rebuilds too, as I have developed a more subtle understanding of what works and as a result of a lot of wear and tear. You need somewhere to sit and the structure needs to be reasonably stable on whatever ground you put it. You will often be sat on the seat with your legs up on the swinging arm, so you will not be surprised by now that there are triangles involved, one widening down from the sitting point and one from the front to the back. Having just three points of contact with the ground makes it easier to get it stable on uneven ground. If you are adventurous, you might like to make your seat a carved one. When you are sat on the seat you need to be able to extend your legs to the end of the swing arm movement with ease.

If very different sized people are using it, you may need to make the seat moveable, otherwise it needs to be a reasonable compromise size. The gap between the table, where the workpiece sits, and the clamping jaw really needs to be variable by more than is given by the swing arm movement. Allowing the table to tilt, mine is hinged at the far end, by putting a piece of wood under, is an easy way of doing this. If you look again at mine you will see that the swinging arm is attached by a wooden pin and that there are multiple holes in it, allowing a wide range of adjustment. This is useful, for making a log mallet for instance. The other design tip is to make the table narrow towards the front end. This allows you to angle the draw knife downwards more easily, to round the piece and to do this with the piece at various angles across the table. That flexibility of the angle of the stick in the clamp is also useful for sticks with varying thicknesses, as in the picture at the head of this paragraph. For this reason I also now prefer that the clamping piece of wood does not have a groove in the middle, as some designs do.



Next in subtlety for shaving sticks is the spokeshave. The blade is much smaller than a draw knife and, in most modern versions, it is clamped in a metal double handled holder. The one in the picture, next to the clamp-on vice and the hole tenon size checker, is a concave bladed version. The spokeshave can be pulled or pushed. They are wonderful devices, especially if sharpened well. Like a plane, the shaving being created has to rise away from the blade and go through a slot to clear the work and thus has a tendency to jam. The finer you can set your blade, the better it will be. You may still need to change direction to go with the wood layer directions and there may come a point where it is better to stop, let the sticks dry out and then fine tune.

In writing this I nearly ignored the pole-lathe all together, but that would be unfair. My friend Stephen and I have developed an understanding and he quietly goes away and uses mine, if he wants turned sticks or legs. Making chairs in New Zealand or Westonbirt Woodworks, I have used the pole-lathe occasionally and my competence sometimes takes people by surprise. I just like the simplicity and challenge of doing the job without one. The first important thing about the pole-lathe is the preparation work before you step up to it. You need to keep checking the stick you are preparing by looking down it to make it straight. Place it on a flat surface and roll it round to double check. Take it down to only slightly thicker than you want the widest piece of your stick to be, so that you are not stuck on one leg pumping away for too long. Make sure that your centres are where you want them to be, especially if you are practising deviant behaviour, like leaving some of the bark on. When you have it in the lathe, run something, such as a piece of shaving, along the tool rest to check all this before you start waving sharp tools at the piece. On the commonest, bungy cord type of lathe, try to make the cord that wraps round the stick as vertical as possible and as central as possible to the lathe and this tend to ensure that you are not constantly having to untangle it or move it out of your way. As it turns, you can move the cord back or forth along the piece by lightly tapping the cord away from the coil round the the stick, so tapping above the stick takes it one way and below the stick the other. I am strongly left-handed but I have found that the pole-lathe is one of the tools where it is of little importance, so I often use one set up for a right-hander. If you are making your own treadle, then a long reach on it gives more turn per kick, which it important if you are doing pieces with wider diameters. Richard Hare ties the moving part of the treadle to the board you stand on and that seems to work very well and saves a lot of messing around with strained hinges.

Once you have made all the legs, stretchers and other sticks, you need to dry them out. I mentioned earlier that you don't need to build a kiln with a fire underneath for this. I have just checked the cupboard under the stairs, mentioned earlier, and the cupboard with the heating boiler both seem to have humidity levels of around 50%, which is lower than our Yorkshire, unheated property at the moment in late Spring. That seems to be enough to dry the wood reasonably quickly. If you want to speed it up you could build a box with a rack over a bulb that gives off some heat. There is a picture of Richard Hare's box below.



There is nothing for it now that you have put your sticks in to dry, you are going to have to start work on the seat. Before you go any further think about drilling the holes for the sticks. If you are starting with a nice flat seat blank it is much easier to experiment with angles and positioning before you remove the flat surface. I'll write about the holes and angles later but pause before hacking away. To remove wood from the seat the tools I have used are long and short handled adzes, draw knife, gouge, scorp, travisher, spokeshaves, a pullshave, rasps, scrapers, small planes, sandpaper. As age has started to get to me, I have also tried a rotating sanding disc in a drill and an electric sander, but they are horrible, if useful. I have never really been happy with the adze and find I am just as quick with a gouge and mallet. All the rest seem to work better or worse on different bits of the same piece of wood and in different direction relative to the grain. Because I have problems with both my hands, I find the pullshave very effective. To use any of these you need to clamp the seat effectively. At home I have a bench with holes in and I use wooden plugs in the holes and a bench hold-down. To work on the edges I use a vice and I also have the luxury of being able to use the hold-down sideways to clamp both ends of the seat. Use whatever makes the seat stable and at the right height for you to work. If needs be stand on a box. If you want a neat edge on the seat bowl, then working round it carefully with a carving gouge, before removing more wood, is useful. Finally, a sharp rounded scraper is a wondrous thing.



The other thing you can work on, while your legs and other bits dry, is the steam bending of combs and bows. Here I will just add a bit about former jigs, to what I said earlier. There seem to be two main kinds. In the one above you have two pieces of wood shaped to form the inside and outside of the curve and you squeeze the wood between them. See the left hand picture above. You can squeeze it all

together using clamps, a vice or a bottle jack (thanks Paul Hayden). This method is especially useful for combs. I have had little problem with this method, apart from one large, particularly stubborn, comb in New Zealand which gave in to our will in the end. In the second type there is just an inner former and you use a strap to hold the outside of the wood as you bend it round the former. The wood is then held in place against the former using either pegs or clamps. This is the normal method for bows. Typical of me, my formers were made of whatever I had to hand, so the full curve of a bow former is made up of three separate pieces attached to a board. See the right hand picture above where there is the former for the double bend below. I will highlight for you some of the problems I have found with this method. If you use pegs in the board to hold the piece, then you can't really vary the depth of the piece, as the peg will either not go in the hole (which has to be fairly deep for stability) or will leave the piece able to move away from the former. If you use clamps you need to make sure you can put them where the ends are parallel. If there is any slope on the ends, the pressure of the piece trying to straighten will slide them till they come loose. A hole in the former, big enough to house the end of the clamp, is one way of reducing this risk. You need the former to be stable while you bend, so a piece of wood attached underneath that will clamp in a front vice is useful. Finally I would recommend that the curves you bend are reasonably gentle and continuous, as sharper bends seem to have more tendency to fail, and that you build your former to over bend a little to allow for some straightening. This is more important for arm bows that will not be held in place at the ends in the same way as back bows. Steam bending can be very stressful while you are doing it, but it is a wonderful feeling when it works. All I can say about the double bend below is that it gave me a headache trying to figure out the former and it failed first time, from a dwindling stock of half suitable wood, but it definitely merited a fist pump when it worked.



There is nothing for it now but to go back to angles, drilling holes and putting chairs together. As I outlined earlier, the angles are hard and this is made worse by the fact that each piece of wood you work on ends up not entirely true. On the plus side the wood is also fairly good at adapting to slight changes in position and shape, especially longer back sticks and bows. Unless you are incredibly meticulous, you will make mistakes though, so here are some tactics to help you through. Most chair makers tend to put that central stick at the back of the seat. That is not for looks and it is certainly not for comfort, as two separated central sticks is more comfortable for the spine. The central stick is to give you a point to measure everything else against. Once it is in place you can put a bow or two on it and move them around to see how well the whole thing works. To put in a central stick you need to decide where the centre is. Symmetry is not everything in chairs, but deviations from it need to be thought about and controlled, so a good centre line, top and bottom, helps a great deal. Before this gets any more complicated, it is worth reminding you of the seat patterns I mentioned earlier. I use both the paper and the fibreboard ones at different times. They are certainly useful if you want to be able to repeat a design, even with variations. Using the patterns, you can work out your angles without drawing all over your seat. If your seat ends up slightly different to the original pattern because of enthusiastic cutting or shaping, you can draw round it on a new piece of lining paper and check that all the angles still work. You can put the pattern flat on a bench and use the bevel to try things out visually.

When it comes down to it though, you are going to have to drill a hole at some time. The most likely thing that will happen is that you have the hole at slightly the wrong angle. You will put four legs in and one of them obviously doesn't look right. While it is still in the hole, carefully work out what you have done wrong and draw on the seat what the correct line or angle is. Remove the leg and plug the hole with some spare stick timber. I just fit and knock the plug in without glue. Re-drill correctly and

refit. If it works, then you will have a perfectly shaped curved wedge of plug in the hole. If you are sure you now have it right, you can glue that wedge in after removing the leg. The next most likely thing to happen is that you have drilled the hole in the wrong place. A plug is the correct solution again, but now you have more of an aesthetic decision about how much effort you want to put into disguising your mistake. I think honesty is the best policy. As I have heard said many times, it is all part of the story of the chair. On smaller parts, plugging is more likely to compromise strength and is thus less satisfactory.

Hopefully you now have all the bits to put your chair together. I advised leaving your tenons slightly oversized earlier and now is the time to start bringing them down to the fit. Don't rush this. Take the end of the tenon down to size on all the bits and put the chair, or a particular assembly (undercarriage, back, arms..) together to get first look at the shapes. As you bring the tenon down to size, it is possible to alter the angle and placement relative to the stick slightly. Even small adjustment can make the resulting chair alter shape slightly and become more solid in fit. Keep working at it and remember that adjusting one side of the chair can alter the other side. If you have more spare wood on one tenon, it may be the one to adjust, rather than the most obvious one. Once you have it ready or very close, I suggest adding a first coat of whatever you intend to finish the chair with to all the parts that will still show after fitting together. In this way any excess glue can be more easily wiped off without soaking into the hungry wood.

That is all I can think to say except to talk in a little more detail about some of the chairs I have made. I hope you have as much fun with the process as I have.

Some More Detail on Some of the Chairs



This is the chair made with the double bend bow shown earlier. It was made from bits of ash lying around from previous chair making during the corona virus period. The seat is actually made up of seven different pieces of wood. The rim of the seat bowl is three pieces and the base of the seat is two pieces. Underneath are two reinforcing pieces that the legs go through. All the pieces work to reinforce the strength of the joins and give depth for the sticks and legs. The legs, stretchers and sticks are shaped using the draw knife and spokeshave. I was considering making it without stretchers, though I had a couple of experiments with bending short pieces, to make the curved front piece, that I wasn't happy with. Then I found a broken piece of the failed first double bend hidden in the wood box and it worked fine. The seat is 48.25cm high, which is probably a bit high for many people but it feels at a nice height for the table and is really comfortable. The bow is really slim but feels strong with 1cm concealed tenons on all but the back two arm sticks, which are through wedged tenons. The central back stick is slimmer than the ones either side to ease pressure on the lumbar region.



I talked about the prototype for these chairs earlier. Compared with chair above, they are even lighter and thus easier to move in and out at the table. You don't have to pull them as far back to slide in and sit down. The back is at about the standard height of 23cm above the seat, which is comfortable for sitting back after the meal, as are the lower front arms, though they are low enough not to get in the way while eating. The seats are at a more traditional 26.75cm. After making the prototype I widened the seat pattern so these two are the same width as the chair above.



When I discussed the triangles in the chairs earlier, I pointed out the one made by the rockers and the top of a comb-backed version. After considering making a few more cute child's rocking chairs, I realised that they are of fairly short-lived use for something that takes up a lot of room. My own grandchildren had already got too big for them but I had a request for one. I decided that I would make the seat slightly wider, so that the chair could stay in use longer. With the same thinking I made the rockers shorter, after prototyping that on another chair, because the shorter rockers would make the chair less stable with a high back, left the chair without the comb that I had put on earlier chairs. These changes had the additional advantage of making the chair even lighter, which is also important for a child's chair. The seat height is 27cm, sitting on the rockers with legs 22cm long. The arm height above the seat is 15cm, making the arm sticks around 20cm. The back legs are at 16° drilled pointing half way down the side line between the legs and the front legs at 10° pointing at the same side back leg. These angles are a bit strange because of the tapered seat pattern I designed.



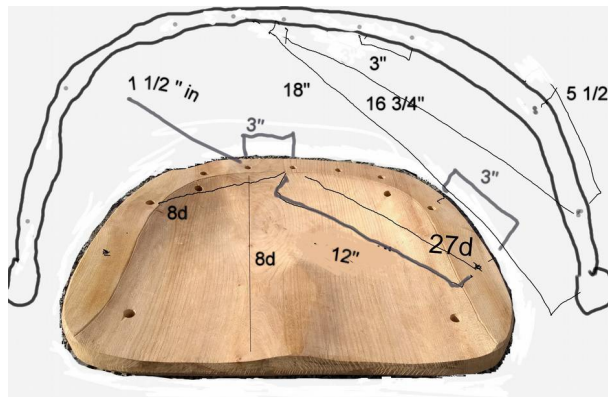
This is the chair that started the thinking on short rockers and their consequences. You can see that the chair is close to the shed and next to a table. The short rocker and relatively low comb allow you to rock without moving too far away from the shed wall. It is designed for relaxing cups of tea, but is also high enough to turn round and eat a meal at the table. It sits outside except during winter, when it retreats into the shed. Because it is outside, I left the sticks good and solid and put plenty of them in. You might notice that the seat is left with carved grooves in and that there are two holes at the back of the seat to allow drainage. On this one you can also see where I have cut off the ends of the arm bow and attached them to the side at the front. On this chair I left this addition fairly obvious and chunky in shape to match the style of the rest.



This the first child's rocking chair I made. Having made a chair for my sister-in-law Jo, she asked about a rocking chair for her granddaughter. When I looked round the shed and in the log pile, I realised I had enough log wood for the sticks and a piece of wood that I had been given to make a stool or side table that would serve for the seat. Because the seat wood was so rough, I decided to make the whole even more rustic than my normal style. The rockers, arm bow and comb are all made from pieces of the same log as the sticks, but carefully split and dried into planks. Thicker sticks, but less of them, make the chair lighter but still stable. On this one I made the rockers the same relative length as a normal adult rocker but with a flatter arc to restrict excessive rocking by enthusiastic toddlers. At Westonbirt I have been given the nickname BFG, so I carved a self portrait on the seat of the chair. The chair looks like something the BFG would make. The measurements are the same as the child's chair described above, but the back legs and thus the rockers are at a slightly different angle. This one has sharper angles on the bow, but I altered that for the other one, which was later.



This is the chair and footstool I made in New Zealand. It uses a range of different techniques and woods. The sticks are made of Sydney Blue Gum, which is harder to split and work than Ash, but a nice wood. The legs are let into the chair using through tapered tenons made with a pilot drill hole then a reamer. The comb and bow are imported American Ash, because none of the New Zealand woods are as useful for bending. The system of sitting the legs over the rockers seems effective, though making the split down the leg requires some care. There is no stain on this chair, so those colours are just the woods used. The two pictures below show how effective the technique of joining a piece on the side of the arm can be. The third picture is measures and directions (in inches and degrees) of the stick placements

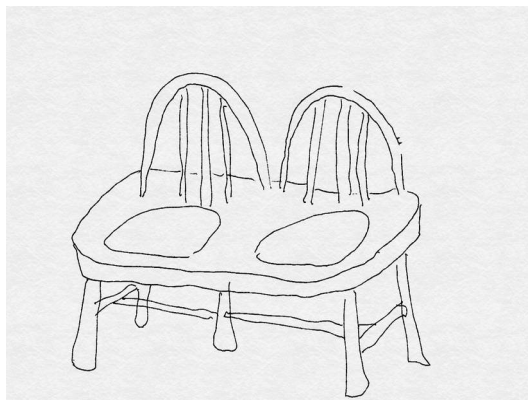




My friend was having a new kitchen fitted and wanted a couple of bar stools. So we had a look round the shed and woodstore and there was a reasonably fresh long Ash log, two combs I had cut out of an earlier log, dried and bent for kid's chairs and a couple of reasonably straight bits cut off from a failed attempt to dry wood for seats. The two potential seats weren't really big enough to carve and sit on properly but we thought we'd give them a try anyway. We carved the seat with a simple shallow bowl all the way across, sloping straight down towards the front. Right up until we put them together for the first time, I thought we would have to source some decent size seats and fit a stretcher across the front to put your feet on. I was amazed. You just perch your gluteus on the seat, feet on the floor, and you could sit there comfortably for a long time. The short back sits in just the right place to provide support for this semi-standing position. Perfect for doing the crossword while you eat your breakfast. So good, in fact, that the little one on the right is going in our house when it is finished. This one has drawknifed sticks and legs rather than turned.



This bench was featured earlier but I thought it was worth revisiting briefly. Below is the detailed plan I drew up.



You can see I stuck to it rigidly. When we went looking for the wood for the seat, we picked the nicest shape, which was slightly curved, and started adapting the design round it. We got two dining chair seat blanks and placed them on the piece we had chosen and a group discussion ensued about the best visual, practical and domestically political arrangement. It could be a love seat arrangement, but that would have meant looking in different directions and its intended placement would mean someone was looking at the view and someone at the shelter side. Because of the curve you could have each person looking slightly away from the other or towards each other, with a risk of banging knees. You could put the seat areas closer together, potentially leaving room for a drink at each end. We all played musical chairs without the music and decided facing in was the best option. On something like this your centre lines are wherever you decide they are, but the line of the back still needs to be right for the carved bowl. Ruth and I use it all the time and it comes indoors over winter.



These two rocking chairs were made around the same time. The one on the left was the one that Stephen and I made together after he had made a smaller chair down in Westonbirt. Down there, he had turned some back sticks and then planed them off to make that lovely flattened shape you see. The right hand chair was made for my sister-in-law Jo, so incorporates more of my own developing style. Both of them were made from wood bought by their owners by contributing to Westonbirt's chair making bursary fund. As an aside, these were the first made here in Ossett and we obviously got a bit excited and impatient waiting for the sticks to dry. As a result they both had to have a little bit of re-gluing when the sticks shrunk a little further.



These are the first two chairs I made. I still like them and they are both used regularly. You can see that the later chairs have become a bit lighter and developed more of that rustic touch that I enjoyed adding. The right hand one is the one that was made lower and wider in the seat. I also experimented with a higher comb back, but have since decided that it doesn't really add to the comfort of the chair, even when your neck is hurting from a day in the woodshed.