By Hand & Eye

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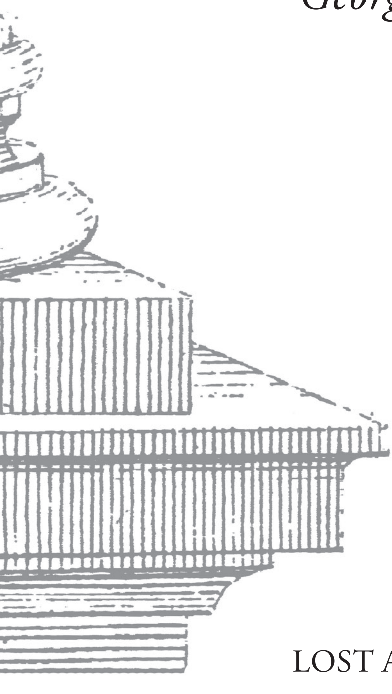
George R. Walker & Jim Tolpin



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Dedications

To the memory of Professor Joseph Hartshorne, who got me started writing, and to my uncle Irving Pregozen, who got me started woodworking.

— *Jim Tolpin*

To the memory of Rudy Holloway, who saw things often missed by others, and to my father-in-law, Glenn Rafeld, whose presence is still felt in my woodshop.

— *George R. Walker*

Foreword

The material herein is a revelation in every sense of the word, for it not only reveals mysteries to us that were, according to the authors, common knowledge to furniture designers and makers in centuries and civilizations past ("artisans," to use the authors' term), but it teaches us how to approach our own design efforts in a wholly new (or ancient, really) way.

George R. Walker and Jim Tolpin introduce us to the language of pre-industrial artisans, and they discuss how period work is based on how we relate to our own bodies and the world around us in terms of proportion, ratio and scale. And they show us how to use that craft tradition and translate the tools and lessons of that prior age into useful strategies for design in our workshops.

In his section of "By Hand & Eye," George likens awakening the innate "designer's eye" to learning music: To build a song, one must first know and practice the simple notes of a scale. But once a composer internalizes those bedrock lessons and learns how notes combine harmoniously, the possible combinations are endless. The same applies to furniture: Internalize the shapes, forms, proportions and ratios that underlie a design and soon harmonious combinations will be easily recognizable.

Jim then introduces us to and teaches us how to use the simple instruments of "artisan geometry," with practical lessons on ratios and scale, and on drawing geometric forms. Then, he takes us to his bench to show us how he translates these lessons into everyday work, with nine projects developed using this pre-industrial artisan approach.

Together, George and Jim offer a harmonious combination of theory, tools and practice to help you unlock your innate design ability. That is, they teach you how to unleash and embrace your inner artisan.

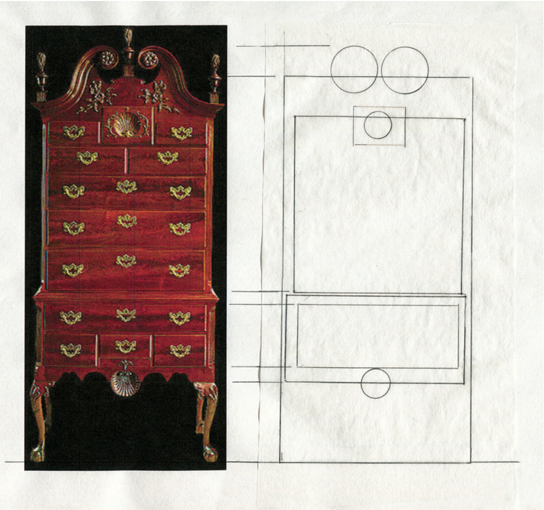
Megan Fitzpatrick, editor

Preface

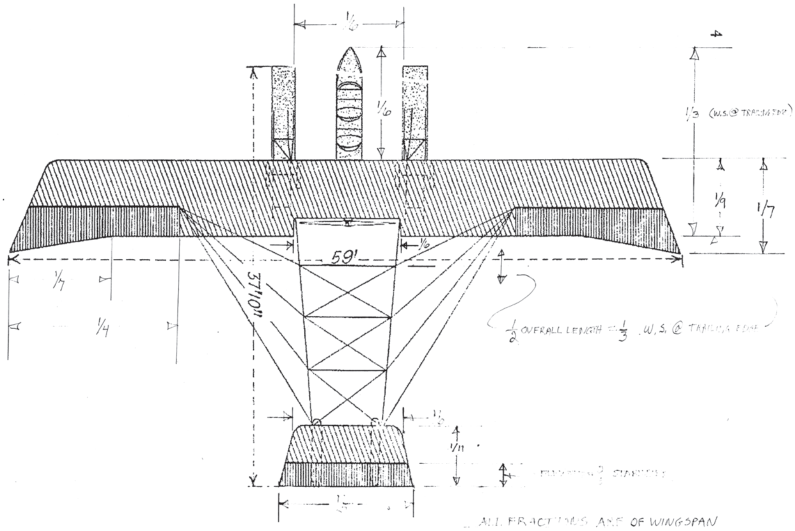
From Highboys to Flyboys

Hi, my name is Jim Tolpin, and I stink at design. Always have...and I thought I always would.

Which meant that most of my projects rarely strayed very far from measured drawings. I simply could not fathom how to come up with pleasing dimensions and proportions without endless trial and error. About four years ago, though, my attitude about design started to change as I began to notice a few things. Looking closely at some early American furniture pieces, I started to detect how the artisans might have organized the overall design. I was beginning to perceive some of the furniture's underlying geometry – the squares, rectangles and circles.



I didn't, however, fully realize the profound import of this unveiling until I attended George R. Walker's lecture at a Chicago furniture design conference. He confirmed that the underlying shapes were indeed geometric forms – and went on to fully open my eyes to the richness of the organization hiding right there in plain sight. He showed how pieces such as a Philadelphia highboy are composed of forms arranged in a harmonious symphony of symmetries, contrasts



and punctuations, all executed through plane geometry. From the smallest detail to the general outline of the form, all the parts of the piece are related – not by arithmetic measurements, but by simple whole-number ratios. George's analysis was a revelation to me: The design of this highboy, considered by many to represent the epitome of Colonial furniture design, was the pragmatic outcome of an artisan executing plane geometry with a pair of dividers creating ratios in whole numbers – in exactly the same way a musician (from Amadeus to ZZ Top) employs the codified notes of the scale to either cover a song or to create an original.

I finally understood how the artisans (versus industrial-age engineers) came up with the designs for their furniture pieces.

Well that was pretty cool, but I long ago ceased to have much interest in recreating period furniture. These days I want to design and build all sorts of other things, from a hanging cabinet for my latte cups, to a bathroom vanity to satisfy the honey-do list, to an endless variety of vintage scale-model airplanes.

While in that last pursuit, a second revelation came to me that really dropped my jaw: I found proof that this ancient art of design was employed by artisan woodworkers to create far more than Colonial bling. Several months after George's lecture, I was looking at one of my books on very early aircraft and, while studying a plan view of a circa 1914 German navy seaplane, I suddenly found myself seeing inter-related geometric forms (see the drawing above). The moment I started to explore the plan further with a pair of dividers, a flock of ratios flew off the page, all relating in whole numbers to the wingspan. I shouldn't have been surprised. Like highboys, these early aircraft were being designed and built in woodworking shops under the hands and eyes of traditionally trained artisans – in both cases probably the best in the trade.

In an unbroken lineage from these early 20th-century artisans, back through the Colonial and Renaissance eras and deep into antiquity, these design strategies have remained intact as a tool of the trade. (Though as far as George and I can tell, this design tradition had gone extinct in the production furniture trade of the 1800s – as it was to also disappear in aircraft design soon after World War I).

For me, these revelations came just in time. While I had recently rediscovered the joy of working with hand tools in lieu of table saws, routers and sanders, I still hadn't cracked my fear of creating designs from scratch. Now, I was delighted to see that design was simply another skill that could not only be learned, but could also be thoroughly enjoyed in its execution – not unlike learning to wield a handplane.

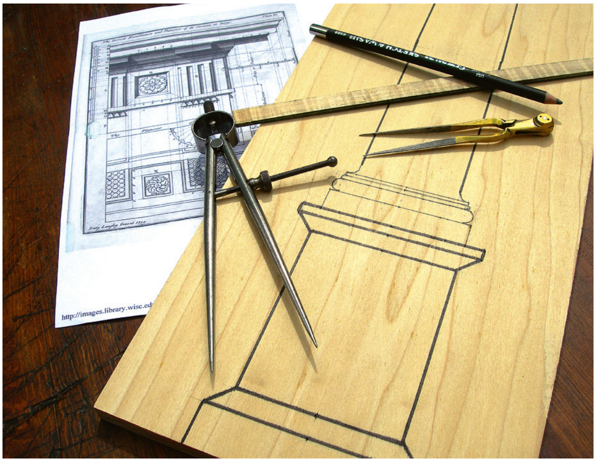
Best of all, while I may have stunk at design in the past, the future is looking pretty bright – not to mention well proportioned! I hope and trust that you too will experience your own "aha" moments while reading this book and will feel the same way about your future adventures in furniture design.

Jim Tolpin
Port Townsend, Washington
May 22, 2012

Preface
Lifting the Veil

My journey into design began at my dining room table after toying with some drawings of the classic orders in an artisan guidebook from the pre-industrial era. The classic orders seemed a quaint relic of the past, but oddly, all the old books insisted they were the key to understanding design, and the masters spoke with one voice about the need to explore them. It started innocently enough. I cleared off the table and laid out a clean strip of poplar as a canvas. Using only a straightedge, pencil and dividers, I set out to draw a Doric classic order from the plates in Batty Langley's "The City and Country Builder's and Workman's Treasury of Designs..." (circa 1756).

After a few missteps, it slowly began to dawn on my eye how each part was linked together with simple proportions. That first attempt wasn't polished, but it did yield a sense of accomplishment – not to mention a nice drawing that felt good to me, knowing it came from my hand. But it also elicited a deeper sense that I'd brushed up against something profound. During the ensuing weeks I repeated the drawing, try-



This exercise upended my normal thought processes and revealed rooms in my head that I'd never before visited.

ing to be the diligent apprentice (but also because each time it was as if layers of smudge were cleared from my inner eye). I'm not sure of the exact moment, but somewhere between the third and fourth renditions, some gears broke free in the back of my brain and I began to think and see proportionally. I still wasn't sure how to pronounce all the things I was drawing, but I could see each part and sense how they knit together with the larger design. This powerful revelation lured me deeper into the literature of the pre-industrial artisan and inspired me to acquire a working knowledge of the craft element of design.

This gets to the heart of how Jim Tolpin and I had our eyes opened to the possibilities of this approach. Neither of us are trained designers, but rather experienced builders with a healthy curiosity. We both began experimenting with the practices and suggestions laid out in the period design guides. We set aside tape measures and began using dividers. We opted to use geometry to trace layouts, even when precision tools were easier and more convenient. Our goals were to learn to see, and to discover if the tradition might reveal relevant information for today's builder.

As a builder it's unlikely you'll ever incorporate a classic order directly into a furniture design. Yet the lessons those orders contain, and their ability to help you cultivate a good eye, remain relevant and exciting. These ancient design standards and the many geometric layouts that Jim so expertly shares are not mere historical curiosities from another era, but powerful tools to help you readily imagine spatial objects. And just as when learning to sharpen a plane iron or saw to a line, printed words can only act as a guide. The lessons have to sprout from your hands. So don't shortchange yourself by merely looking at the drawing exercises. Pick up those dividers and allow them to begin taking you on your own journey. This book is written for woodworkers who love building and who desire to take that next step in the craft. Once that threshold of design is crossed, a whole world of new horizons spreads before you.

George R. Walker
Canton, Ohio
May 28, 2012

Statue of Artemis

Hands cannot touch you where you move,
Swathed in dreams of deer in stride,
Apollos to answer you – all to prove
The age that shaped you never died…
for now along your marble ways
ancient line of light must ring
and flow at the touch of our musing eyes.
In Attic hush, the bright limbs sing.

— Godfrey John
(Late Canadian poet and essayist)

CHAPTER

4

FIG. 3.4.1. This furniture piece beautifully blends arc forms with the shape of the hardware and the natural swirls of the drawer face graining.

Generating Curves & Tapers

So what's this "thing" we have about arcs? We seem to love them. Not surprisingly they are, as I'm sure you've noticed, one of the most common design elements applied to our built world – from the lofty entryways of cathedrals to the sweeping supporting structures of bridges to the raised "eyebrow" of a cabinet door. Once again, we have to go with conjecture for an explanation for this love affair, but I think most people agree that they make a structure look inherently strong – and in fact, the arc generally does make them stronger. Consider these natural examples: the supporting swelling under a tree branch or the arched opening of a cave. Both of these elements are essentially curb appeal in that they provide us with the visual cue that we will be safe taking shelter beneath or within them.

Arc from Station Points

We use this type of geometric construction (in which we are essentially generating a proportional expansion of a circle) to establish a number of station points to which you can bend a batten. You'll find this method useful for producing large

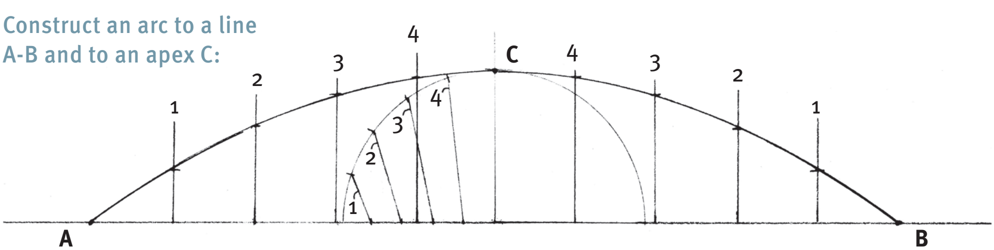


FIG. 3.4.2. Expansion from circle to arc.

arcs (again, like the edge of a conference table or in architectural work) where it would be unwieldy, if not impossible, to generate the arc with either joined sticks or a trammel point set to a focal point. Note that you aren't limited to the four station points shown in this example; the more you choose to use, the more accurately you can make the arc.

Arc Relative to Chord

In this construction we are drawing an arc to our choice of curvature between two fixed points. We don't care about the height of the apex, but rather the degree of curvature. (Gentle curves were traditionally referred to as "slow," while more dramatic bends were called "fast.") I came up with this construction to allow me to not only quickly change an arc's radius, but to do so at a certain proportion – that is, to a defined segment of a circle. My friend, Dr. Francis Natali, worked up a spreadsheet (see the "Rabbit Holes" page at georgewalkerdesign.com) that shows the amount of error between radius and segment produced by this construction. I was gratified to see that for segments between one-sixth and a one-twelfth (which are perfect), the error was less than 1 percent. When you go below a sixth, however, the accuracy is severely compromised with this method.

The drawing and animation show a ninth-segment generation. To change the segment to another value, simply set the focal point to another one-sixth of the chord division point along the bisector.

Why might this be important – or at least useful? My experience indicates that choosing a specific value segment gets you very quickly to an appropriate degree of curvature for the overall shape of the structure. I think you'll see this clearly in the way I arrived at curvatures in a number of my projects that we review later in the book.

Construct a ninth-segment arc to a line A-B:

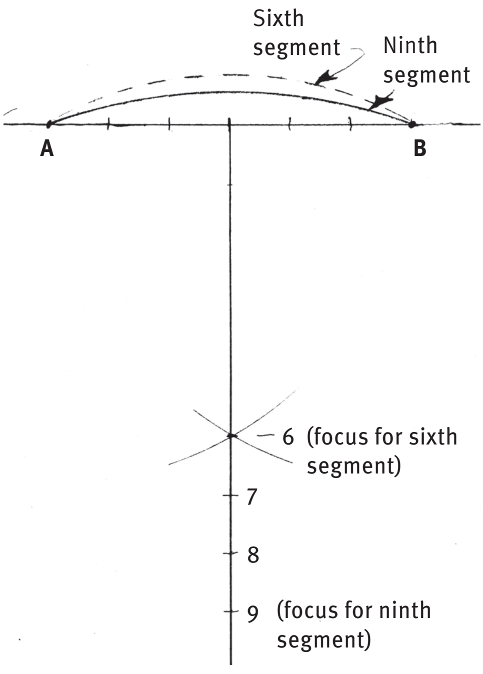


FIG. 3.4.3. Arc to chord construction.

Locating a Focal Point

Let's say you know the endpoints of the arc you want to draw, and you know how high (i.e. the apex) you want it to reach. You also want to draw it out with either a compass or a set of trammel points on a beam. What you need to know next, then, is where to put the focal point of the compass or trammel point – which is, of course, the focal point of the circle that will generate the arc segment you are looking for. This simple construction reveals that point.

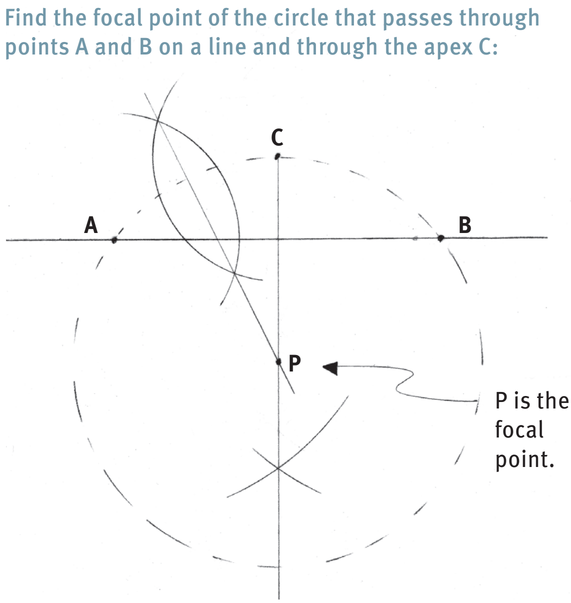


FIG. 3.4.4. Finding an arc's focal point.

Generating a 'Gothic' Arch

Are you into Goth? Or do you forgo the white face powder and black capes and just appreciate the brooding design? If so, then this construction is for you. It's simple, it's easy and it makes a very pretty double arc. I'm

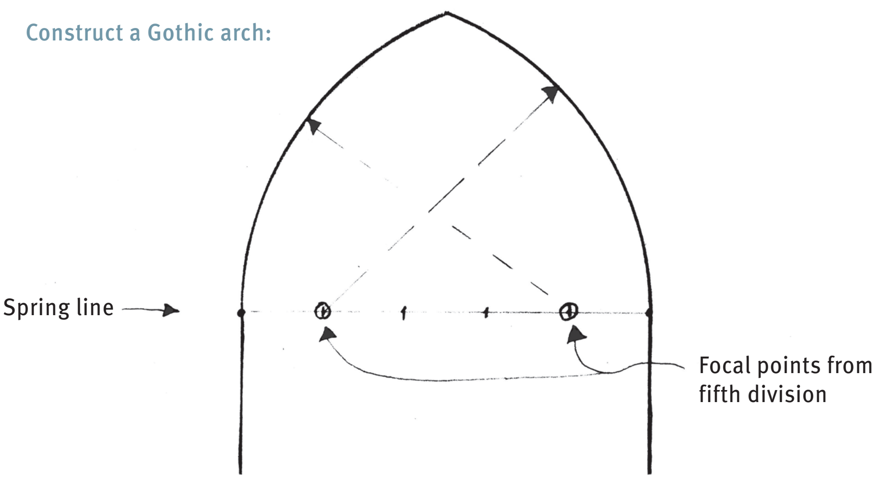


FIG. 3.4.5. Gothic arch construction.

FIG. 3.4.6. This magnificent secretary employs Gothic arches atop its divided-light doors.

showing the traditional version in which the height of the arc's intersection is made lower than the width of the opening – specifically, to a focal point set to one-fifth of the width at the "spring line."

Generating a 'Lancet' Arc

Or maybe you have a thing for Sir Lancelot…or perhaps you just like arcs with a bit more reach. In either case, you will be well-met to learn this construction, which is only slightly more difficult to execute than the already easy Gothic arc. The traditional Lancet arc is always higher than it is wide, which means the focal point of the arcs are set outside the opening. Traditionally, the focal point was set to plus ⅕ of the span at the spring line, which is why the Lancet arc was also called a "pointed fifth." The apex of the arc is, as a result, in a 4:5 ratio with the chord (span).

FIG. 3.4.7. This contemporary church furnishing is based on a Lancet arc.

Construct a Lancet arch:

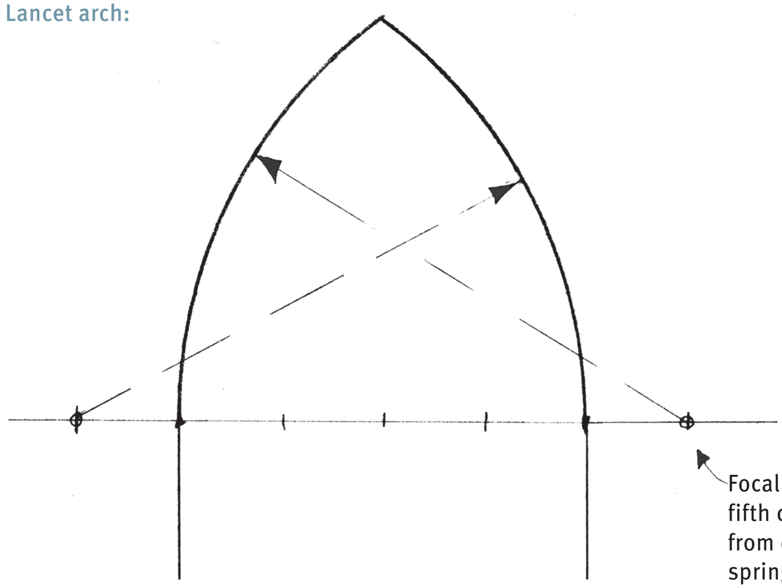


FIG. 3.4.8. Lancet arch construction.

Ellipse

If you like arcs, you probably really like the ellipse. It's a common furniture element found everywhere, from traditional moulding profiles to primary styling elements such as those seen in Thomas Moser's contemporary furniture line. They are also relatively easy to generate as I showed you earlier, using the pegged stick and square method. Here, though, you'll see how to execute various geometric constructions. The first is appropriate for creating large ellipses that would be too cumbersome for the stick and square. The next two are best for smaller-scale drawings and can be readily executed using only a compass and straightedge.

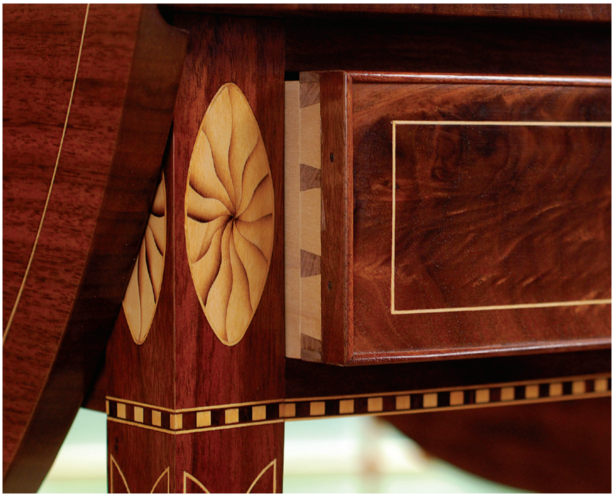


FIG. 3.4.9. The ellipse is often used as a decorative element.

An Elliptical Arch from Station Points

This construction produces a series of station points generated from intersections arising from lines drawn from equal divisions along the major and minor axis of the desired ellipse. The more divisions you step out along the axis, the more numerous – and potentially more accurate – the resultant stations points. If you are careful in using the dividers and straightedge, you can make a very large and accurate ellipse (or a portion thereof).

Construct an elliptical arch from points A-B on a line and to an apex point C:

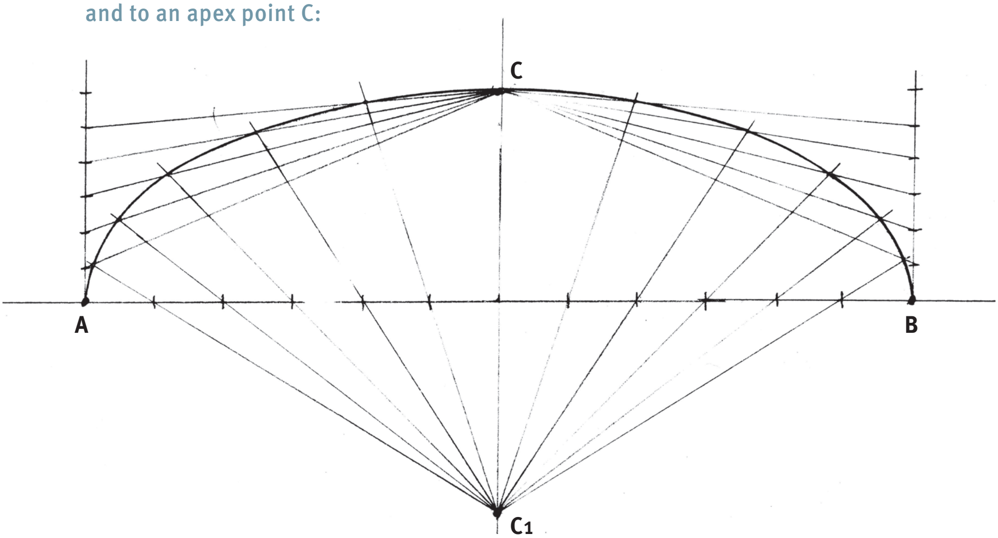


FIG. 3.4.10. Semi-ellipse station point generation.

An Oval from Melded Circles

In this construction you will find four focal points for a pair of different-sized circles. The melded intersections of the two large circles with the two smaller circles produce a visually acceptable ellipse – especially at the size of scaled drawings. (Technically, the form is an oval because a true ellipse has a constantly changing radius.)

This version assumes you want to form the ellipse to a set width and height (i.e. major and minor axis). The apex-to-major-axis ratio must range from between 1:3 to 2:5 for this construction to work.

An Oval to a Fixed Width

This version of the melded circle construction assumes you are only concerned with the width of the ellipse and can let the height (or the apex in the case of a

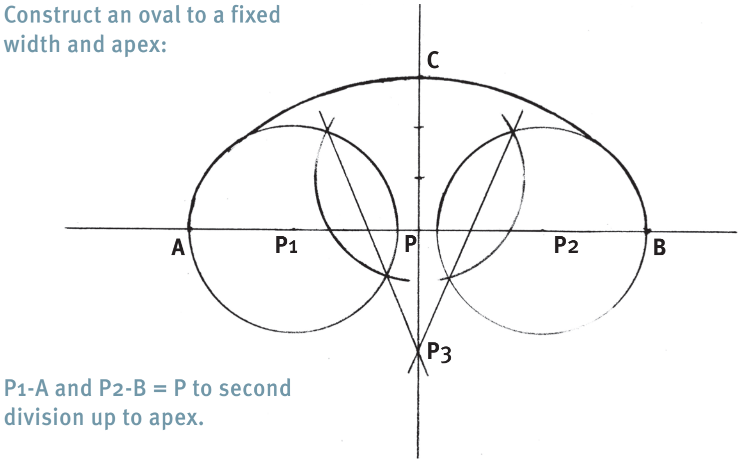


FIG. 3.4.11. Oval generation from melded circles – fixed width and height.

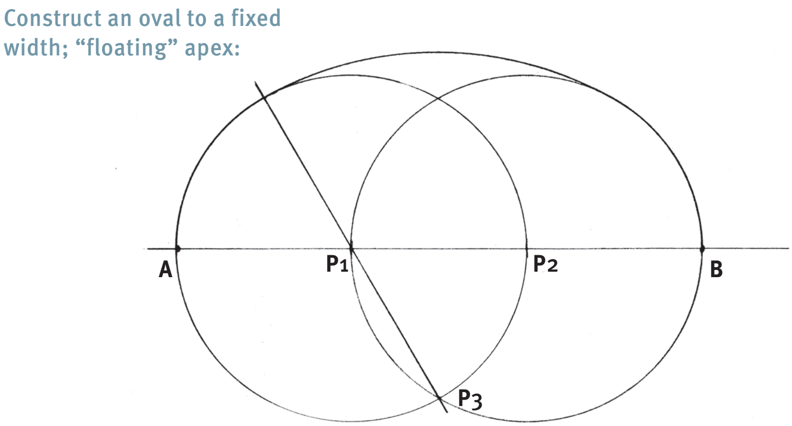


FIG. 3.4.12. Developing an oval from melded circles – fixed width only.

semi-ellipse) float. The apex-to-major-axis ratio automatically comes out to about a 1:3 ratio.

Volutes

It looks pretty complicated at first, but for creating large-sized spirals all it takes is four nails and a pencil tied to a piece of string to create a visually acceptable form. The starting radius is adjusted by the length of the string while the rate of change in radius as the string swings around and bears against a different focal point is determined by where you place the four nails in a grid. Basically, all you are doing is creating a sequence of quarter-circles of diminishing radii. For scale drawings

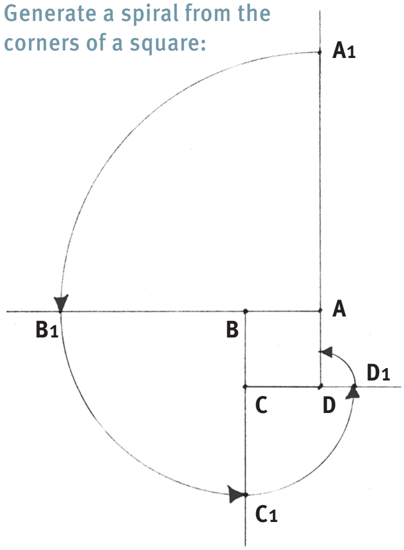


FIG. 3.4.13. Volute in furniture piece.

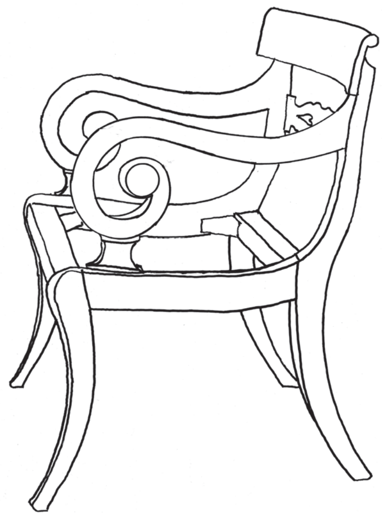


FIG. 3.4.14. Volute generated from a gridwork of focal points.

and smaller layouts you can, more practically, forgo the string and use a compass as illustrated in the animation (download at lostartpress.com/geometry).

After doing at least one drawing using a grid of focal points set at the corners of a square as shown above in Fig. 3.4.13, play around with the grid layout. Try a rectangle pattern and notice how it "quickens" the spiral in two of the quadrants (because the longer side of the rectangle increases the radius' rate of change). You can also experiment with other grid patterns such as a hexagon, or even an ellipse. You'll notice that the greater the number of focal points, the more tedious it becomes to use a compass – so in this case revert back to the string and pencil technique.

Tapers

Earlier, I introduced you to the sector and to a simple way of laying out tapered planks between two spans (see: "Task 2: Maintaining Proportional Divisions from One Station to Another" on page 108). This method works fine for straight lines, but what if you would like to make the taper curve slightly outward (for reasons I'll get into below)?

To do that, we'll reach back into antiquity for the simple geometric method that the ancients developed to create this convex taper (which the Greeks later named "entasis"). For millennia, artisans used this method to lay out everything from the pyramids in Egypt to the Parthenon's columns in Greece, to the radiator grilles of a Rolls Royce.

But why did they bother with this subtle – and obviously labor-intensive – curved tapering? The answer is aesthetics and therefore subjective. What happens is that long vertical objects with straight sides – and even straight tapered sides – tend to look concave to the eye because of parallax. For most people, this concavity tends to make the object – especially columns that are obviously supporting massive weight – look less sturdy. After all, when we see a person holding up a heavy object, we are used to seeing the muscles strain and bulge. Our entire musculature is, from one point of view, a study in entasis. There may be other reasons entasis is ubiquitous, but I'm going with this one.

As you can see in the drawing at right, developing entasis is, once again, a simple matter of choosing and laying out whole-number ratios. In this example, I decided to apply the entasis to the top two-thirds of the column shaft and to reduce the shaft's width by ⅙. Note that I chose to use just two station points which to spring the layout batten for drawing the curve. You can develop more points if you wish by simply increasing the number of divisions of the upper two-thirds of the column.

FIG. 3.4.15. Note the curved taper of the legs of this demilune table – an application of entasis.

Lay out a convex taper where one end is one-sixth narrower than opposite end. Start the taper at one-third of the overall length.

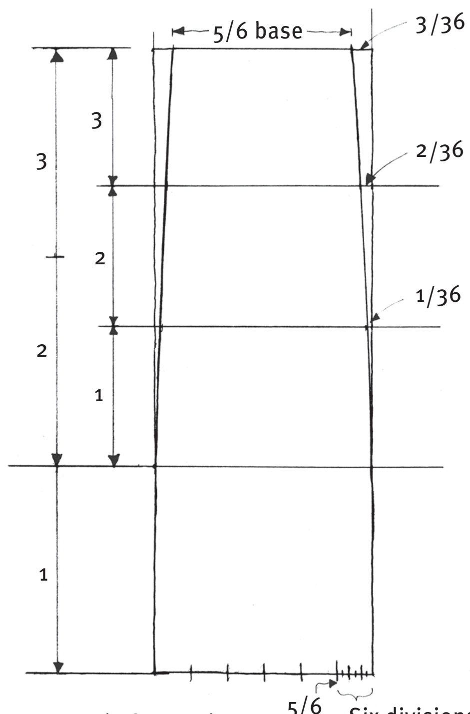


FIG. 3.4.16. Generating an entasis taper.