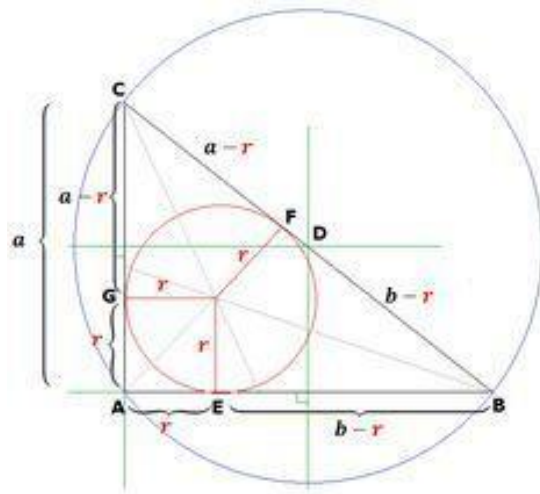
Arithmetic Can Be Your Friend

February, 2020 Bevel Cut by Andrew Davis

Seems to me that geometry and woodworking intersect in three different galaxies. The first is more physical, more problem solving, perhaps more practical – and certainly less intimidating to those who consider themselves math-phobic or allergic to the value of π. Examples include how to make a jig to route an oval with major axis Y and minor axis X without needing to understand any more about geometry than that, or how to find the center of a board with only a straight edge, a straw, and a piece of string.

The second galaxy involves pencil and paper tricks to draw smooth curves connecting different circles, circles inside squares, parabolic curves, spirals, joining two lines with an arc, etc. You might find a collection of French curves very useful. Why French? I have no idea since Germans are so much more accurate.

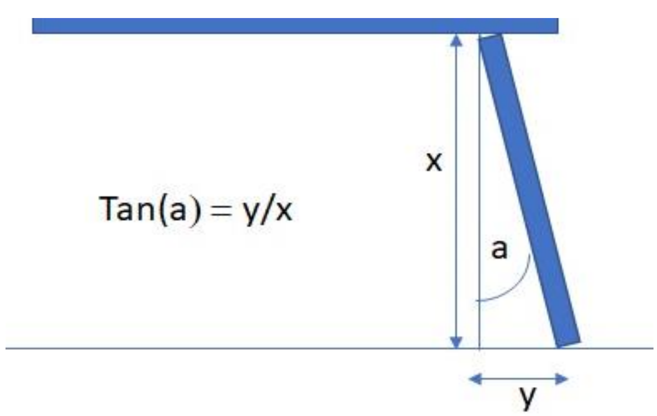


The third is pure math, usually algebra, but math at any rate that does not generally require four semesters of college calculus. Examples include calculating the volume of a cylinder, the spacing of slats, the circumference of an oval, the hypotenuse of a 30-60-90 joint, and dozens more. Exploring this realm can take you to formula heaven.

Here are three examples from my recent experiences in the shop.

Find the Offset

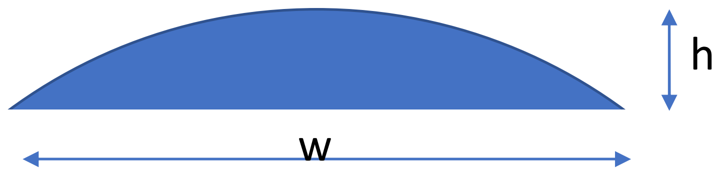
I keep a table of trigonometry functions taped to the wall in my workshop. It lists sine, cosign, and tangent values for angles expressed in degrees – much more convenient than using a calculator (or slide rule) that requires angle values in radians, a measure I don't relate to. I cannot remember exactly when this started, but I used the table more recently when building a coffee table with canted legs. The table was intended to be 16" high, and I didn't want the legs to stick out beyond the table top. At the same time, I didn't want the distance between legs to be too small and have the table be unsteady. I did not need my engineering degree to figure out the geometry; I just needed some woodworking skills to make the parts and joinery. The same method is used when calculating how long a cross member support needs to be when located at the midpoint of the legs.



With angle a = 5°, Tan(5°) = .0875 (by looking it up in the tangent table). If height x = 16 inches, then y = 16 /.0875 = 1.4 inches; in the end I settled on 3° angle as a design choice.

When the Radius is a Mystery

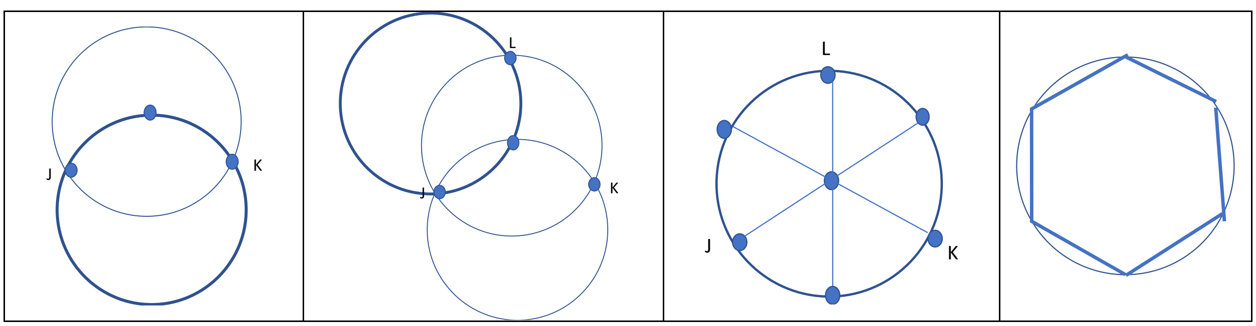
Have you ever started with a piece of furniture with a curve, a part of a circle, say a table-top segment, arched door, or long curved stringer and you need to match the arc for some reason in a new piece of wood? Turns out there are several ways to find the radius of the curve. Some approaches are physical using three tape measures or a combination of rulers, dividers, spatulas, and some long sticks and a friendly assistant. I found what I think is a better way, using just 8th grade algebra: You simply need to measure two dimensions on the available chord – any size chord (the straight line connecting two points of an arc) will do, but the bigger the chord the more accurate your results in the shop are likely to be. Of course, once you calculate that the radius of the needed cut is 11 feet, you have a different problem unless your wood shop and your compass are impressively large. They say size matters.



Radius R = $(h/2) + (w^2/8h)$

The No-Math Hexagon

Turns out there are 613 tricks online on how to make a hexagon inscribed inside or outside a circle. I used this one with decent results. Draw a circle with radius R. Then draw a second circle with the same radius that intersects the center of the first circle. The edge intersections define points J and K. Then using one of those two points, draw a third circle of the same radius so that it passes through the center of the original circle to define point L. Using these three points, draw straight lines through the center of the original circle until it reaches the opposite point of the original circle creating three more points; then connect the six points into a regular hexagon.



This "trick" reminded me a bit of ancient history, going back at least to the fifteenth century when many people much smarter than I tried to figure out how to draw a square with the same area as a given circle (or vice versa). Da Vinci himself worked on this problem (dubbed squaring the circle) for much of his life with results less impressive than the Mona Lisa. Today of course we know that a square with side x has an area of X^2 while a circle of radius R has an area of πR^2. In short – you can't get there from here – the magic of pi.