30° 60° 90°
Geometrical SET SQUARE

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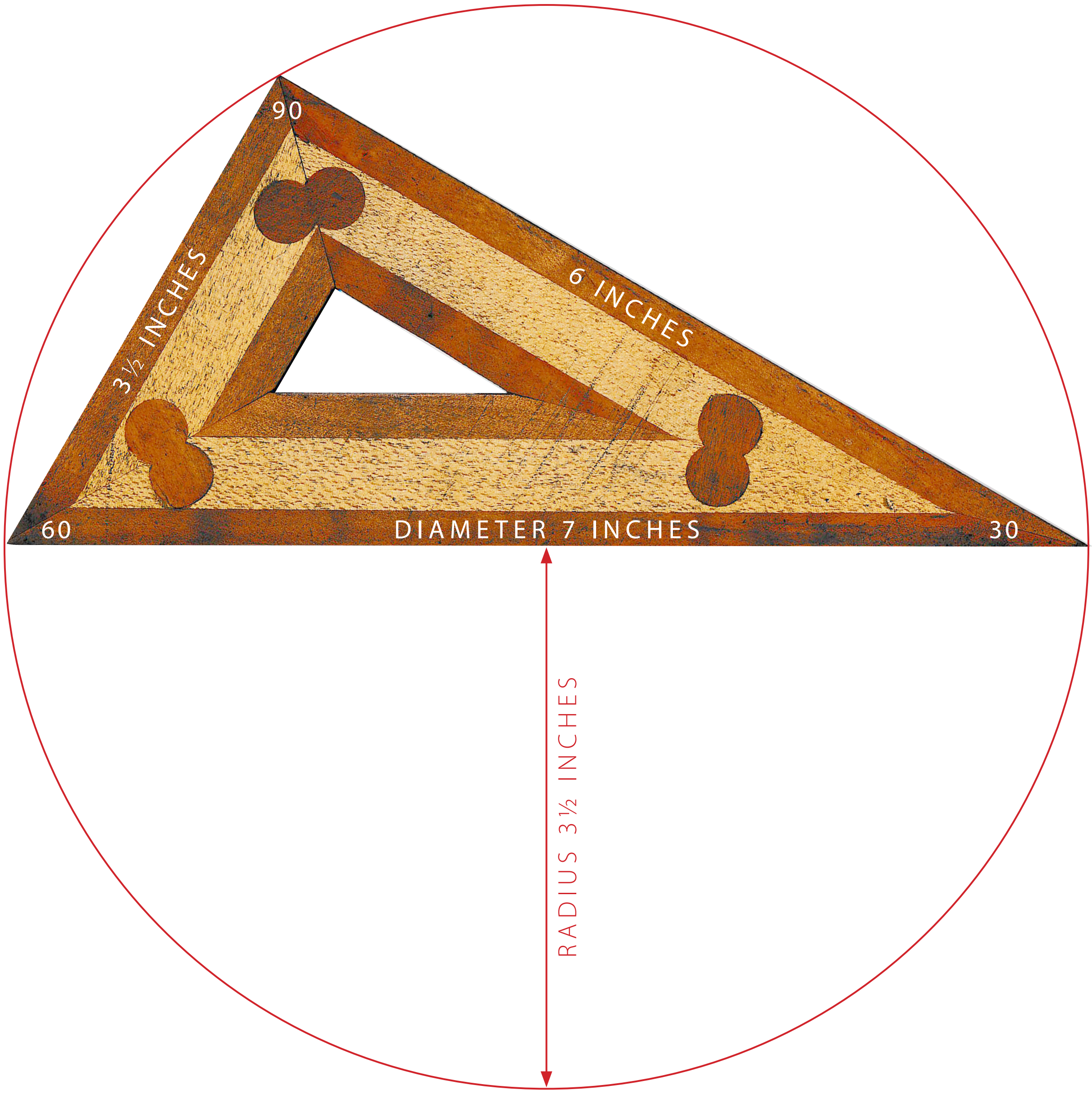
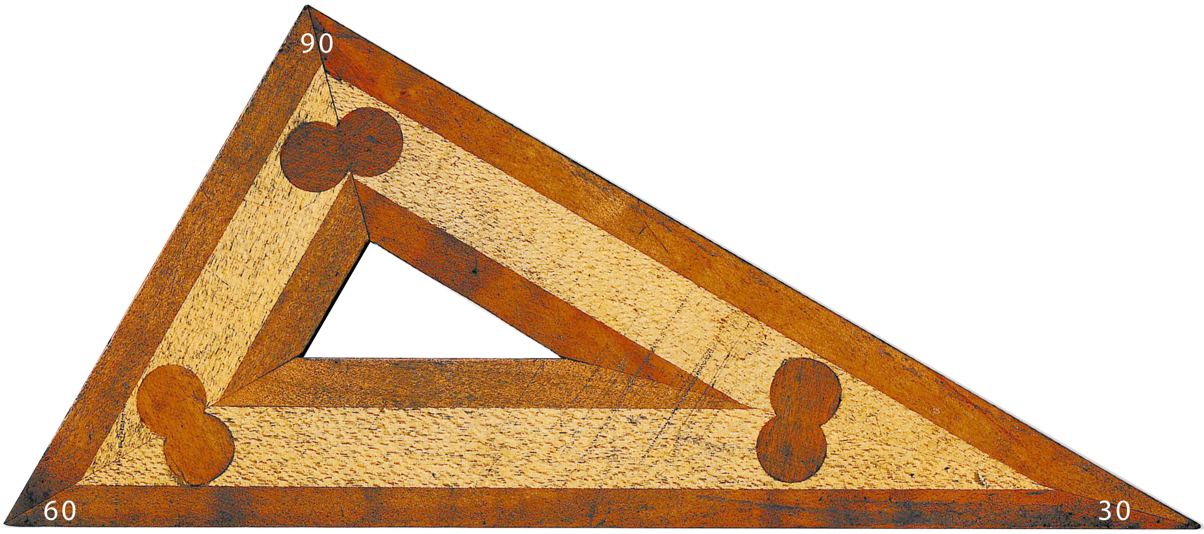
Laurie Smith is an independent early-building design researcher, specialising in geometrical design systems. Because geometry was part of the medieval educational curriculum he uses geometrical analysis to excavate and recover the design methodologies of the past, a process he thinks of as design archaeology. He lectures, writes and runs practical workshops on geometrical design and publishes his work through his website HISTORIC BUILDING GEOMETRY.

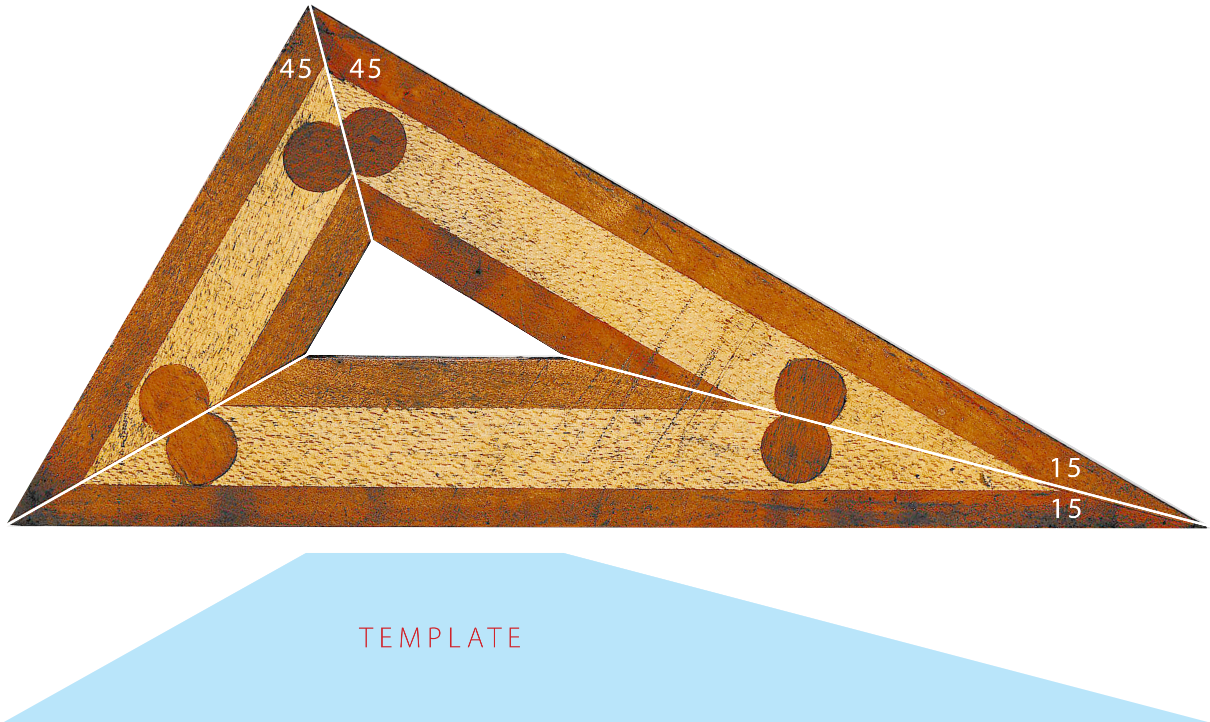


A Small Inlaid Set Square in Boxwood and Lacewood, English c 1850

I bought the set square from a Fine Art dealer in Bideford in Devon and have it in front of me as I write. It is quite small, it's three sides being 7 inches by 6 inches by 3½ inches with 30°, 60° and 90° angles, as indicated above. It proves Pythagoras' assertion that, if a triangle's base is drawn on the diameter of a circle so that it's other two sides meet on the circle's circumference, the result is automatically a right angled triangle. This is true wherever the triangle meets the circle's circumference. For example, a triangle drawn from the diameter to the circle's north pole would be an equilateral with a 45° angle at either end.

There are geometrical reasons for the precise form of the square and for it's inlaid linear and circular patterning and these properties are explained in the following pages. The Imperial dimensions of the square include a vertical side of 6 inches if the square is stood on its shortest 3½ inch side. As 6 inches is half the Imperial foot of 12 inches the square is scaled to a major Imperial dimension and is clearly a drawing board tool where an inch to a foot or 1:12 scale could be drawn with ease.

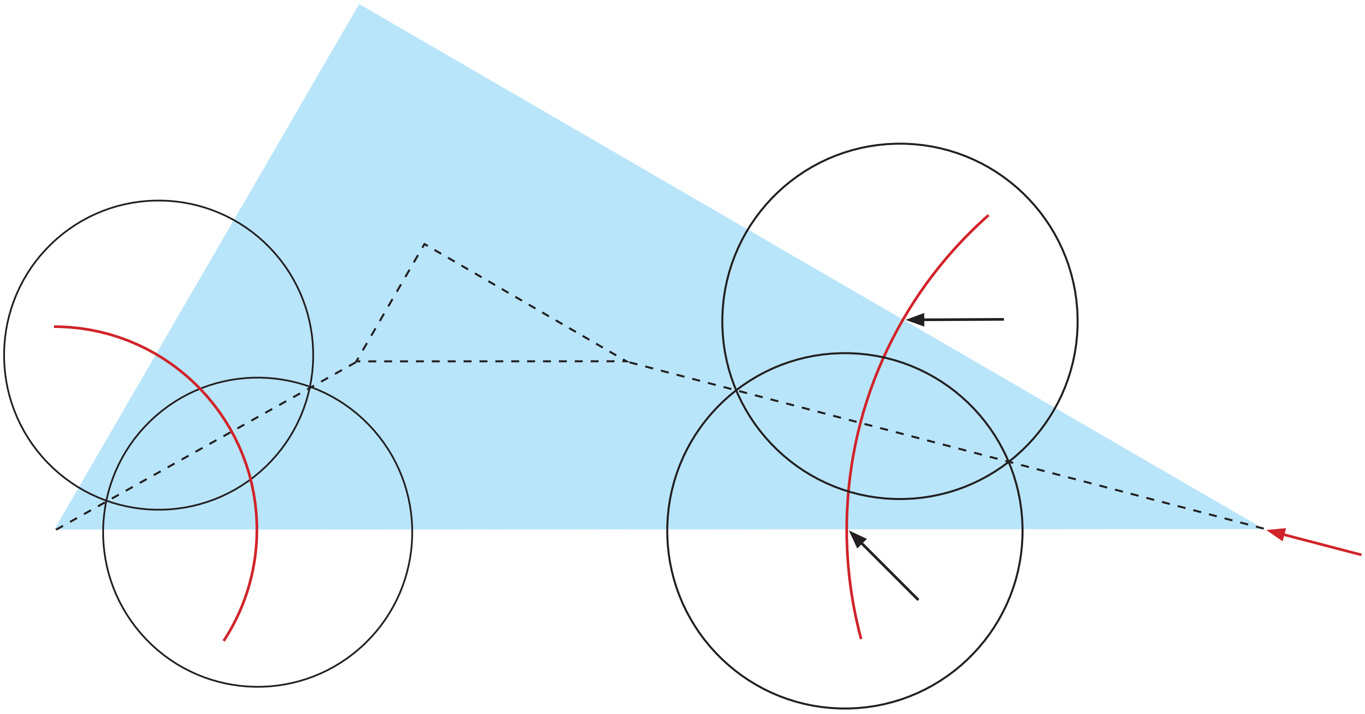


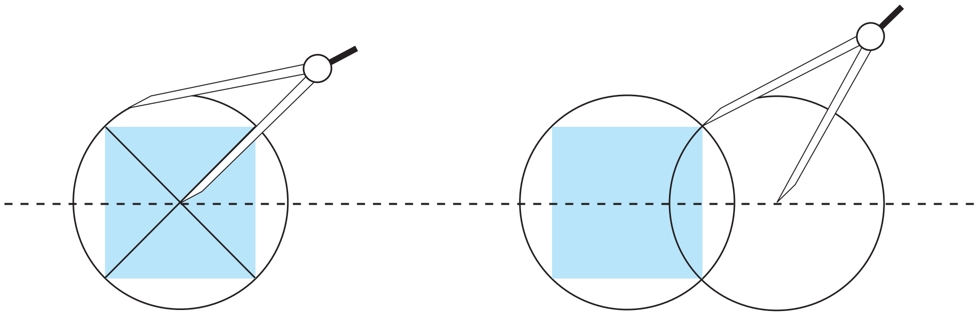


Mitred Angles

The set square's three external angles are mitred, which halves them so that additional angles of 15°, and 45° are easily obtained between the outer and inner angles. 30° is already there so there is no need to halve 60°.

Obviously, the mitres are not marked out on the square itself but on a template from which the three sectors of the square can be scribed and cut prior to being joined. It is clear that the first stage of assembly is the construction of a linear band composed of the inner and outer bands of dark wood and the central band of pale wood. Once this is available it can be cut to fit the templates for each of the square's sectors. The template for the lower section is shown in blue tone.



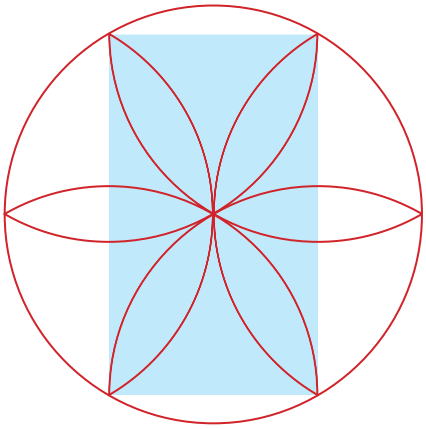


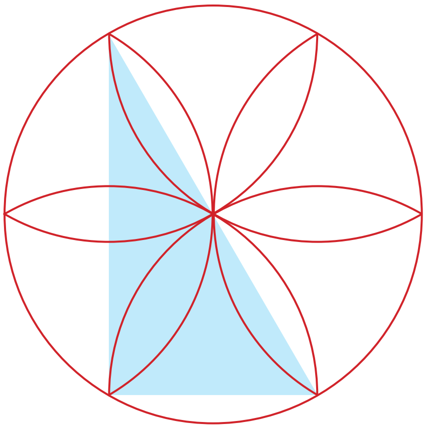
Mitred Angles and Inlaid Vesica Piscis

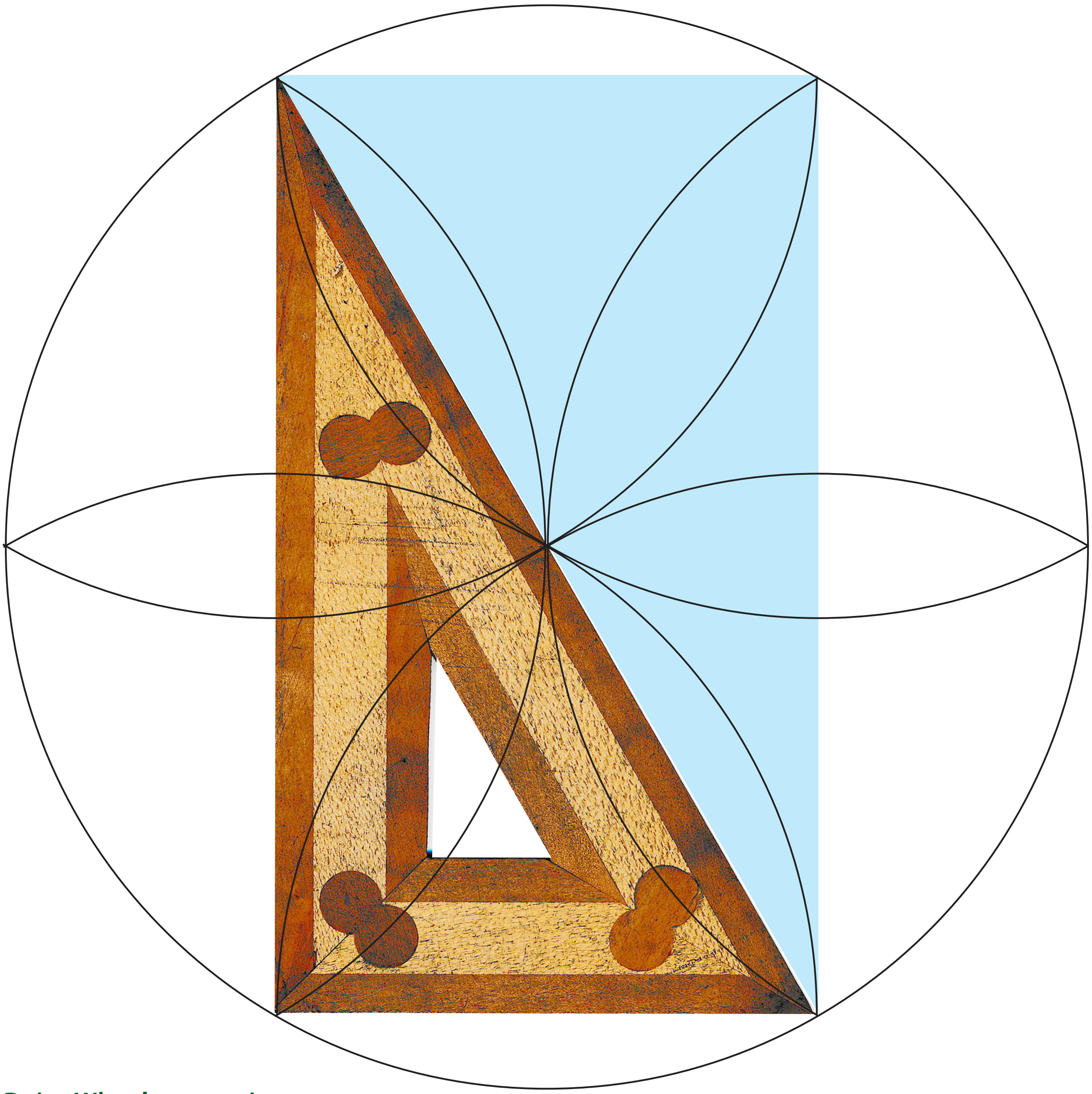
The drawing shows the marking out for mitreing the 60° angle, lower left, into two 30° angles and the 30° angle, lower right, into two 15° angles. Describing the lower right mitre, a compass or dividers are set to the tip of the angle (at the red arrow) and an arc drawn across the tool (the red arc). Where the arc cuts the edges of the square (at the black arrows) two equal circles are drawn (in black line) so that they intersect at two points to form a vesica piscis (the almond-shaped area where the circles overlap). The mitre is drawn exactly through the vesica's intersections (in dashed black line). The same technique is applied to the remaining two angles but, for clarity, the top mitre angle is not shown.

The two circles that form the vesica piscis must be identical but apart from that the radii of the circles is not important so long as the vesica intersections are a reasonable distance apart. The further apart, the more accurate the mitre. Similarly, the red arcs at each of the square's three angles can be drawn to different radii.

It can be seen, in the lower drawing, that the two circles drawn to determine the vesica piscis mitre are also the visual genesis for the inlaid double overlapped circles at each of the square's angles. The specific geometry for the overlap is determined by the relationship between a circle and its internal square (the diagonals of the square intersect at the axis of the circle). The second circle is drawn from a pin on the centre line and pen at the top corner of the square.

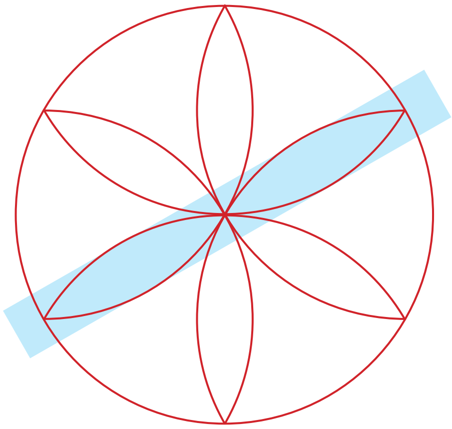


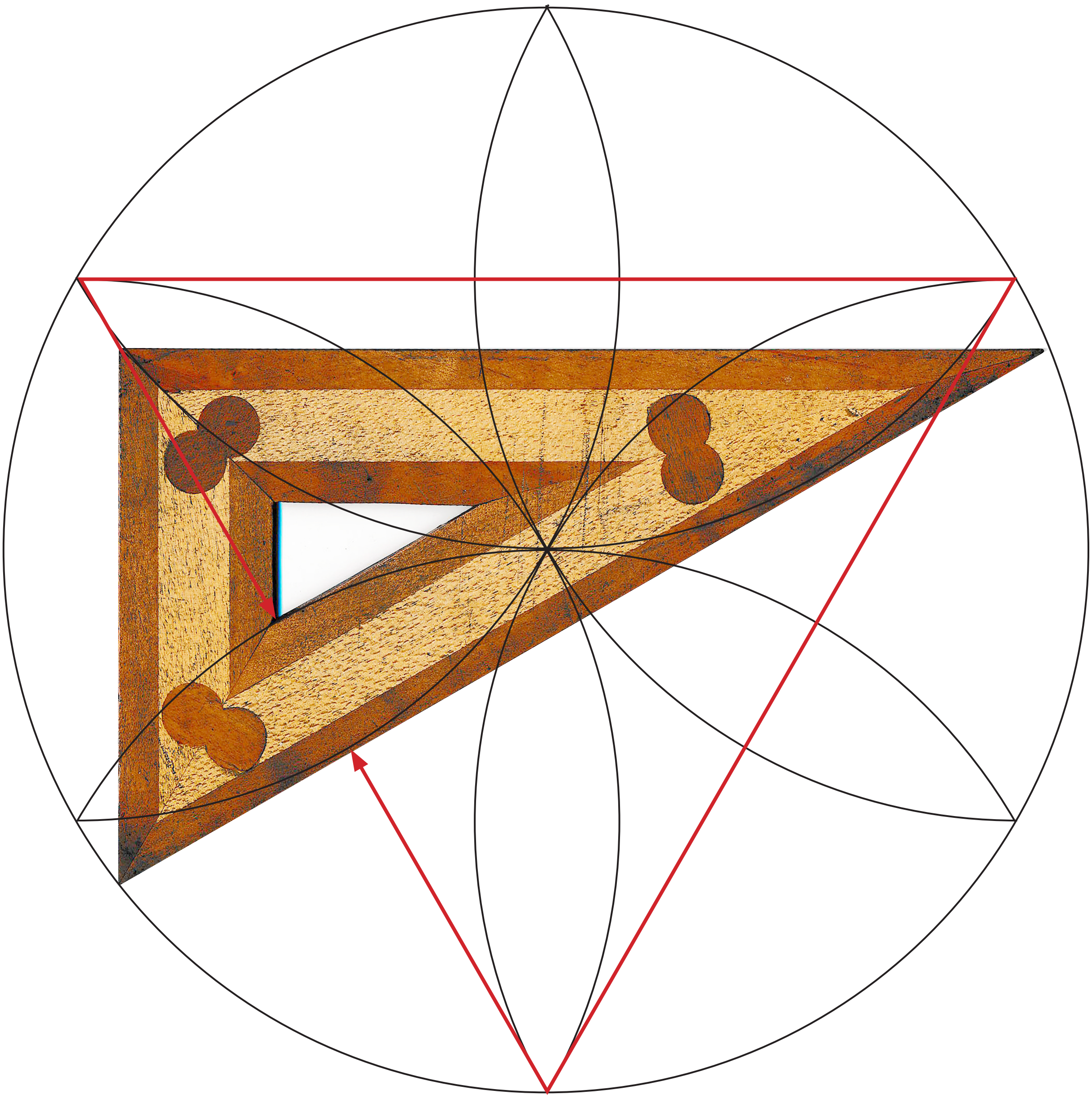




Daisy Wheel proportions

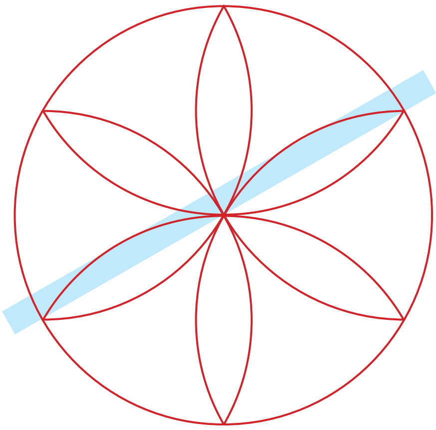
The set square's 30°, 60°, 90° can be laid out in a number of ways but the simplest and swiftest is by daisy wheel geometry where the primary circle's radius (3½ inches) is the only dimension required. Linking three of the wheel's petal tips automatically generates the set square. The upper drawings show the proportional essence of the square.

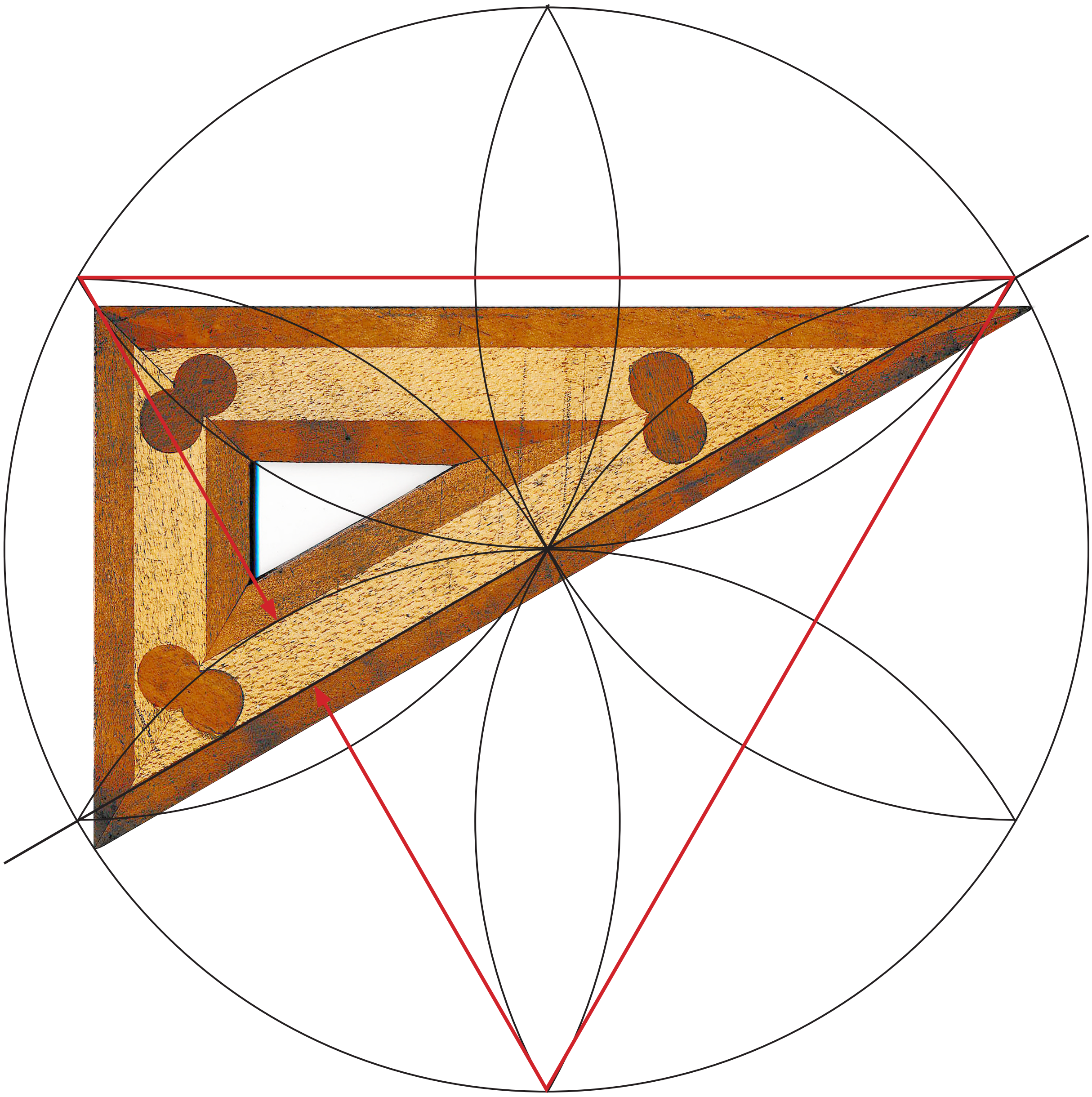




Daisy Wheel proportions

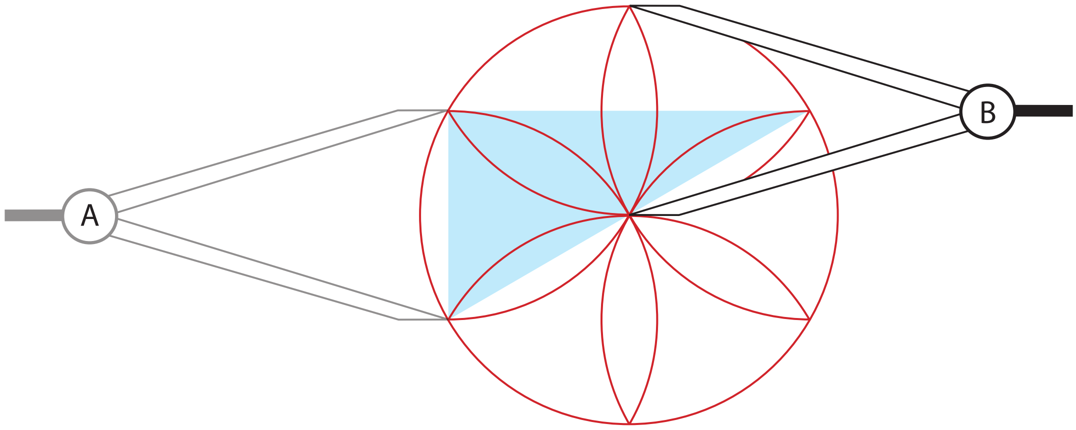
The set square's wide arms are also the product of daisy wheel geometry, exactly the maximum width of the wheel's petals. In this overlay the square's long arm is positioned to fit parallel to and within the petal boundaries and is best seen at the red arrows and in the upper drawing.





Daisy Wheel proportions

The set square's inlaid band of pale wood is exactly half the width of the full arm. This is attained by bisecting the daisy wheel's petals across the wheel's diameter. The upper drawing shows the principle.



Daisy Wheel properties

The beauty of working with a 30°, 60°, 90° set square designed by daisy wheel is that the wheel's radius and the square's short side (side A in the drawing above) are equal. If dividers are set to the length of the square's short side, the setting can be used to draw the circle (radius B in the drawing above). From the circle the rest of the daisy wheel can be developed and, from the full wheel, the set square can be set out. The set square is therefore much more than a tool defining three major angles but is part of a wider geometry where compass and angular geometries share a harmonic resonance. This comes about because the daisy wheel is drawn entirely to a single radius and that this, in turn, divides the primary circle's circumference into six equal divisions of radius length between the wheel's petal tips (the distance between petal tips along the circle's circumference is obviously greater). Choosing the maximum and bisected width of the wheel's petals to define the full width and inlaid band of the square's arms guarantees their harmonic visual balance within the square's overall boundary.

An appreciation

This small inlaid cabinet maker's set square is a perfect example of geometrical design thought. Geometry was the design methodology of the time when it was made, circa 1850, and was taught in schools and in the training of craftsmen. The advantage was that the whole work force including carpenters, masons (including brick workers) and furniture designers and makers spoke a common design language that informed every element of their work. This high level of aesthetic focus was applied in every aspect of a craftsman's work so the person sitting at the drawing desk also not only thought geometrically but used tools, like the square, that were geometrically designed. The precision geometry of the set square, expressed as an example of fine workmanship, was a source of pride in the workplace.

The set square is pleasing to the eye, it always demands a second look and, being sturdy but light, feels good in the hand. It has been exciting to analyse it and to discover the thought pattern of its maker, a process that carries the mind back into the mid 19th century, a time when aesthetics mattered. It is a mark of its functionality and visual character that, though small, it has survived in good working condition for around 150 years.

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