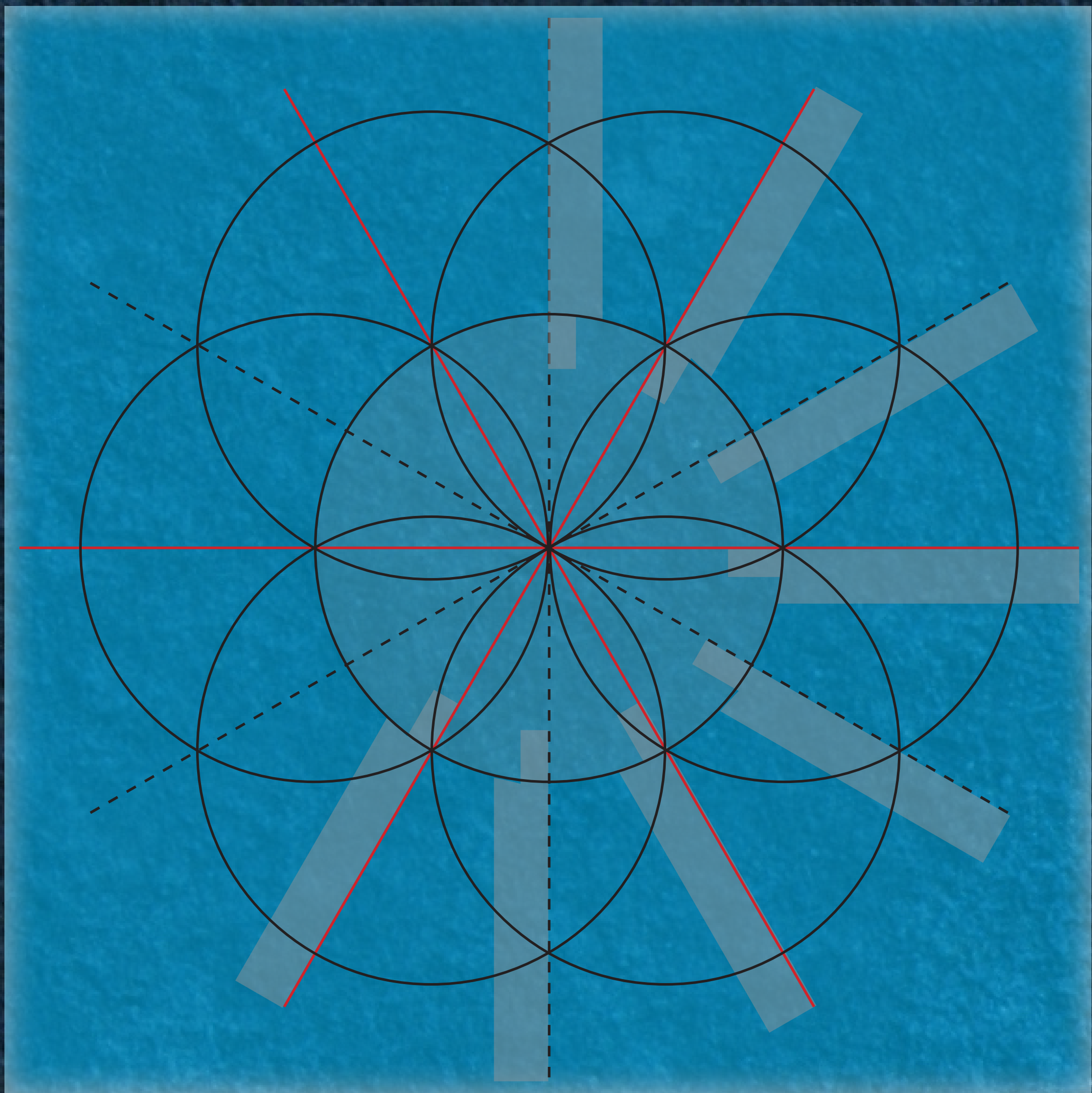
Ebbsfleet Sea Water Mill
An Anglo-Saxon Geometrical Design



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HISTORICBUILDINGGEOMETRY

The fragile daisy wheel, divider-scribed into a chute board at Ebbsfleet sea water mill, was brought to my notice by the archaeologist Damian Goodburn, a specialist in historic marine and dockside carpentry. He wanted to know whether the daisy wheel had any significance in the design of the mill and, if so, could I supply an explanatory text and drawings for his report. He could spare a page and a half and needed it fast! My original response was a short text describing several black and white drawings. The version presented here remains brief but with the drawings resurrected in colour and everything given more space on the page.

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Ebbsfleet Sea Water Mill compass geometry

The compass geometry finely scribed by dividers into a chute board at Ebbsfleet Mill, figure 1, is an extraordinary survival because, dating from the 8th century in Anglo-Saxon times, it reveals a hitherto missing link in the evolution of compass geometry in England. Although fragile and incomplete, the construction is clear enough to be reconstructed with certainty. The geometry is simple, a central circle with six further circles drawn to identical radius around its circumference. The arcs of the six peripheral circles intersect each other at twelve points, six outside the central circle and six exactly on the central circle's circumference, where they generate the familiar daisy wheel pattern, figure 2.

Further circles, of the same radius, drawn from the intersections of the outer circles, generate vesica arcs inside the circumference of the central circle. One is drawn and two are shown as blue tone in the daisy wheel.

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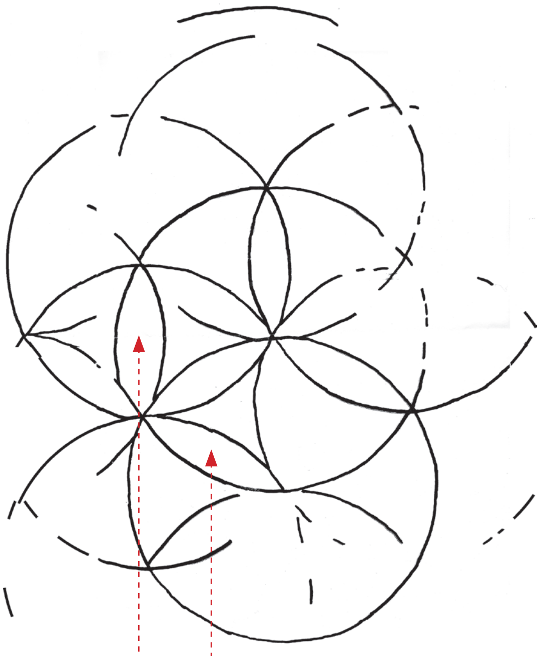

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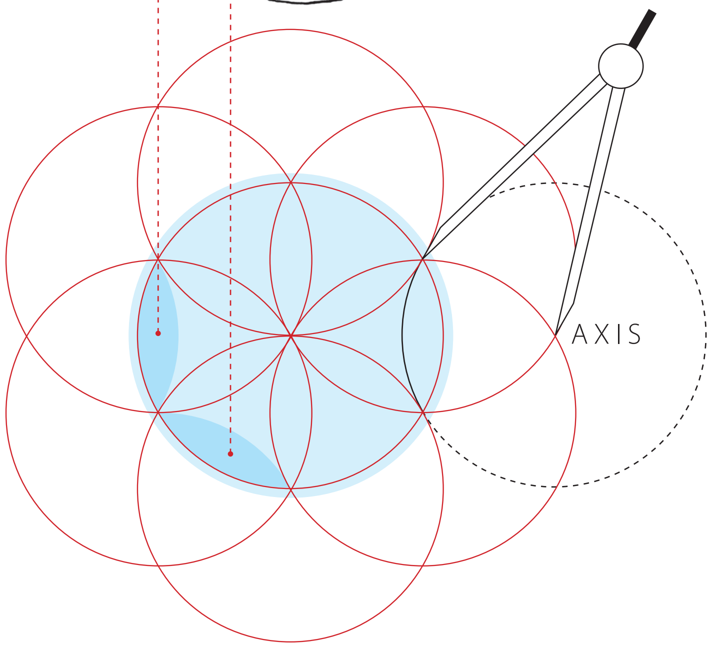

A source of angles

Significantly, the construction is the source of the radial angles from 0° to 360° shown in figure 3. A harmonic rectangle, formed by connecting four of the daisy wheel's petal tips, is shown in blue tone in figure 4. Halving the rectangle along its diagonal generates a triangle with 30° 60° and 90° angles. So the Ebbsfleet geometry can be used to construct a protractor and a set square, both essential tools for precision carpentry layout. The rectangle, which is known in modern parlance as the root 3 rectangle, a term unknown to the carpenter who scribed the Ebbsfleet daisy wheel, has the harmonic ratio 1: 2 between its short side and diagonal.

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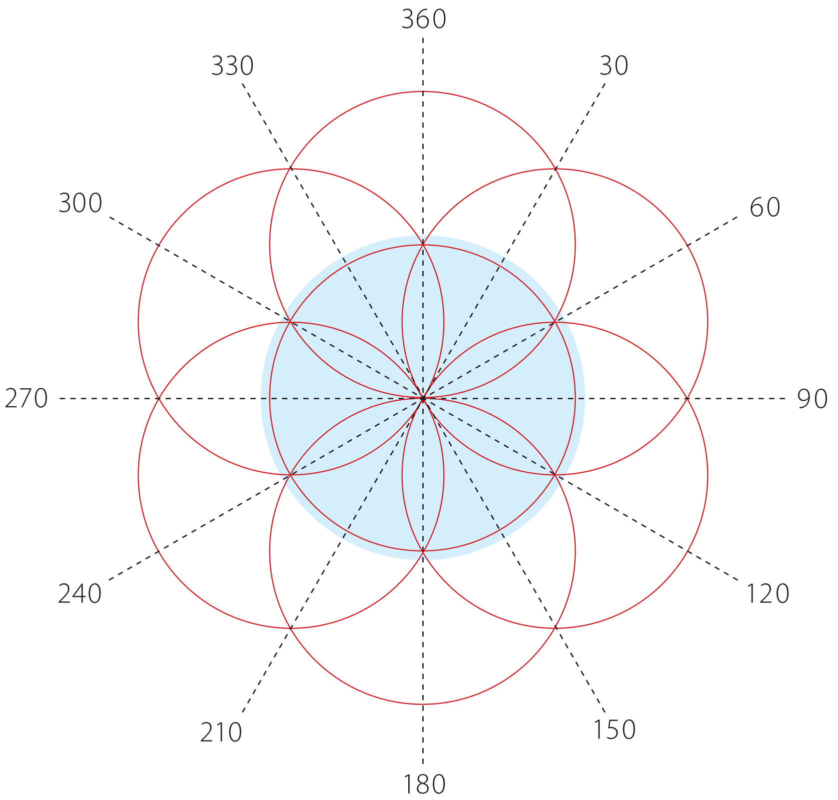

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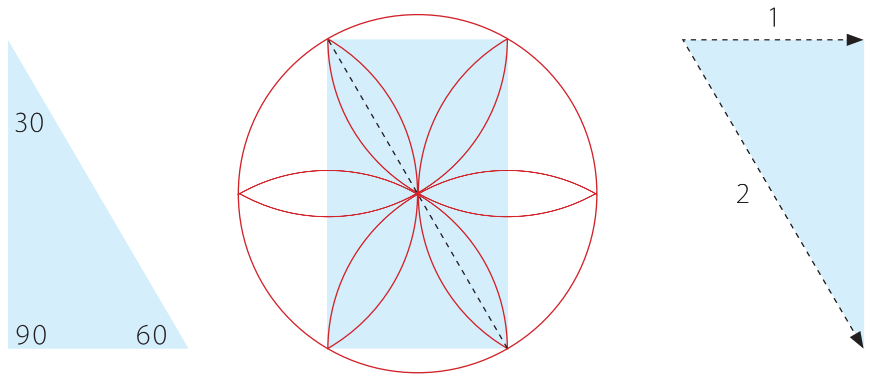

Setting out and cutting the mill hub

The setting out and cutting of the mill hub, so that the rotating blades that take the force of water from the chute fit accurately and securely, requires precise measurement. The daisy wheel is first scribed into the surface of a parallel sided timber suitable for the hub and then the radial angles can be extended to the perimeter by scribing along a straight edge with an awl. With the hub timber placed on a horizontal surface the set square can then be aligned against each radial in turn in order to scribe the line down the hub's vertical surface, figure 5. Figure 6 shows the geometry, hub and rotor paddles in plan.

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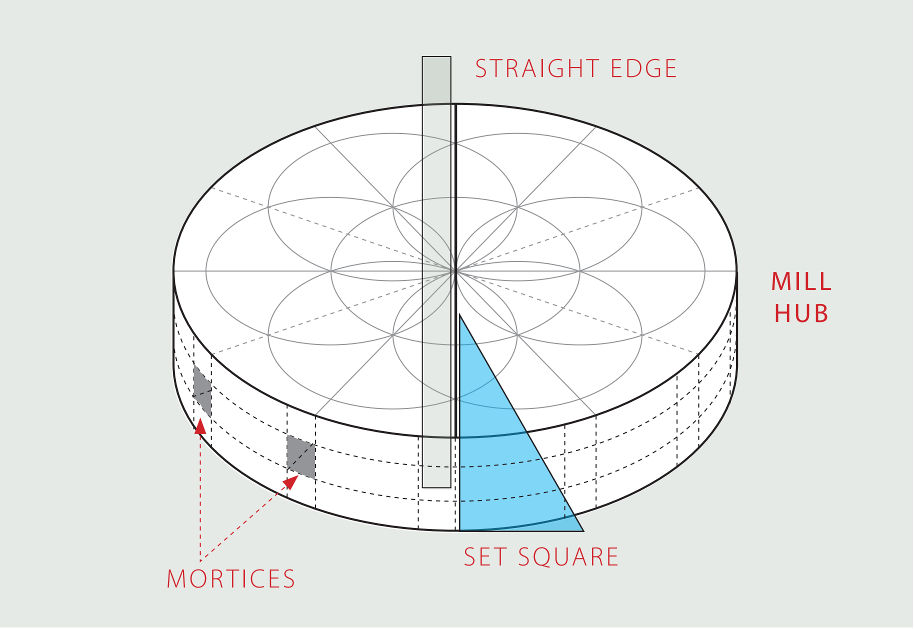

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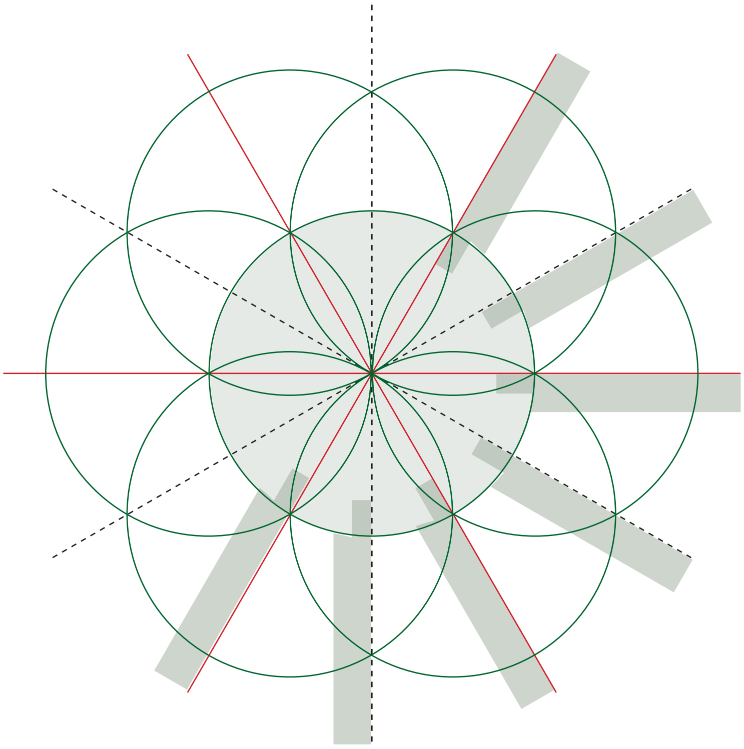

The mill chutes

The Ebbsfleet sea water mill directed water collected by a dam at high tide through two chutes directly onto the blades of a horizontal wheel. The wheel drove a vertical axle shaft that, in turn, drove the upper grindstone of the mill. The chutes were constructed of wood in the form of long, tapered boxes, wide at the top where the dam sluice permitted the inflow of water when the tide was out and narrow at the bottom where they were focussed on the mill paddles. Apart from the millstones the whole structure was of timber and was clearly designed using daisy wheel geometry, scribed, cut and assembled by carpenters. Daisy wheel geometry is beyond doubt because the carpenter scribed the wheel into the top plank of one of the chutes.

The function of the wheel anticipates much later developments in the control of water as a source of energy. The tapered chute boxes compress the flow of water to cause acceleration onto the wheel paddles in a similar way to Giovanni Venturi's invention of the eponymous Venturi[1], which generates an effect similar to placing a finger half over a running tap. The rotational aspect of the wheel can be found in the modern Pelton wheel, named after Lester Pelton[2], which also directed a pressured water flow onto a rotating wheel. Figure 7, which is neither in scale nor true perspective, shows the principle elements of the wheel in diagrammatic form.

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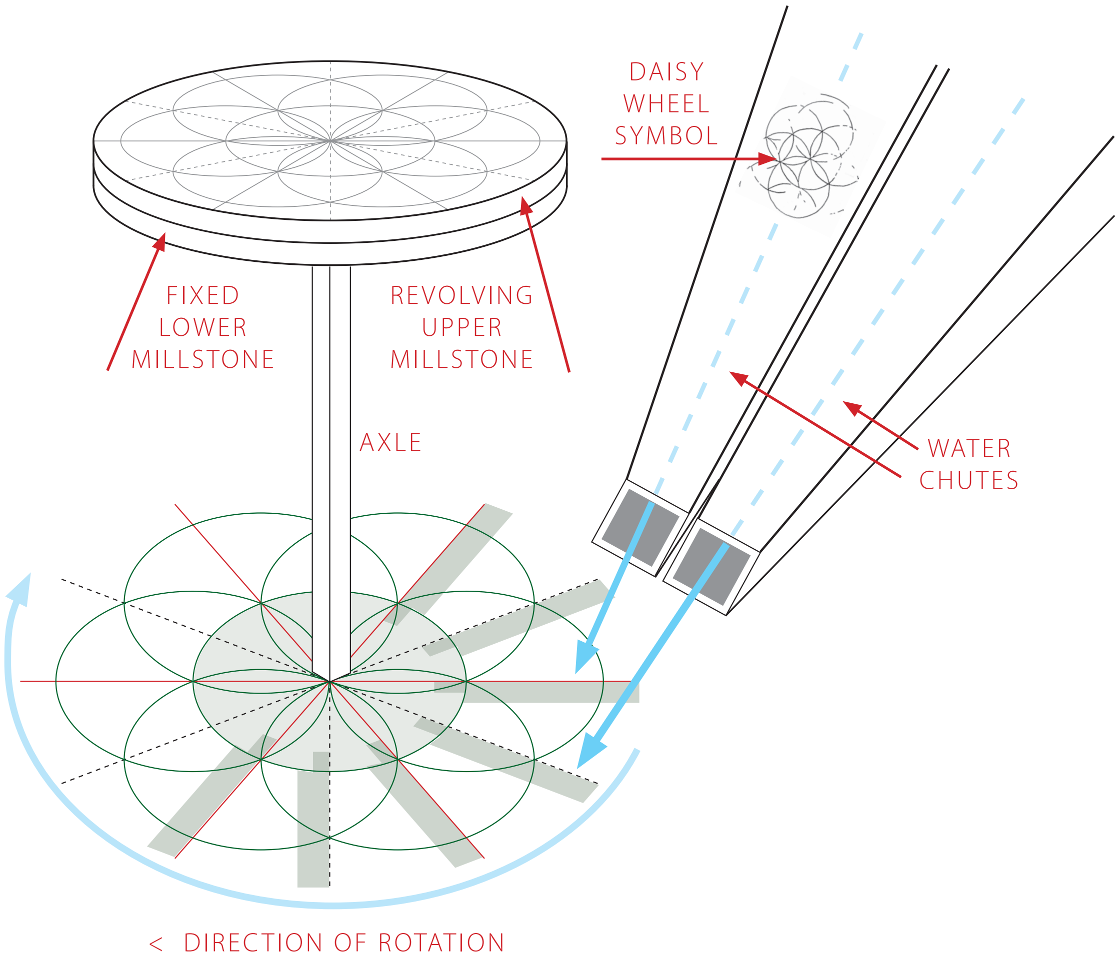
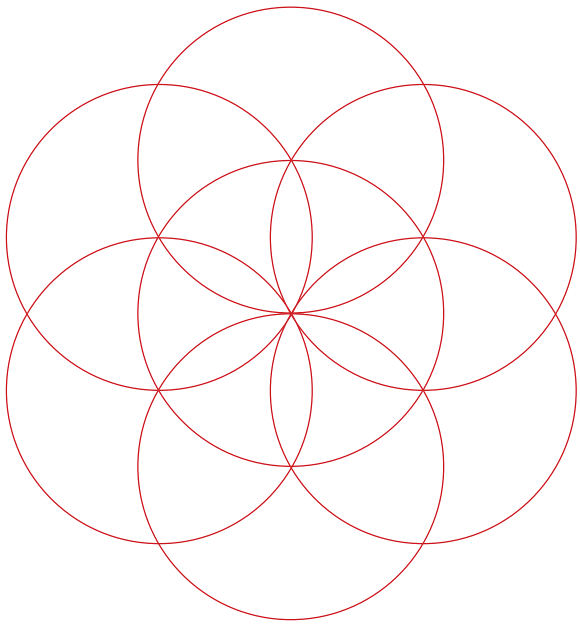


About the Daisy Wheel

The daisy wheel is a sophisticated geometrical calculator yet is incredibly easy to draw with dividers and can be drawn with minimal tuition by a child. It requires just one dimension for the radius of the central circle and everything else is drawn to the same divider setting. Once the initial radius is determined the process eliminates the need for complicated arithmetical calculation and measurement because geometry is a spatial rather than dimensional language. Using dividers, straight edge and scribe ensures that the geometry is drawn to the finest line possible which guarantees that the cardinal points of intersection are all absolutely precise locations, a necessity for the precision carpentry layout of what is clearly the skilled engineering of a wooden machine.

It is interesting to contemplate, when we look back through history, that, though we have had a stone age, bronze age and iron age, we have never specifically identified a timber or wood age. If we had, the Ebbsfleet mill would, without a doubt, be in that category.



FOOTNOTES

[1] Giovanni Battista Venturi 1746 - 1822

[2] Lester Allan Pelton 1829 - 1908

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