

Brays Hill Farmhouse

A Rare Geometrical Survival



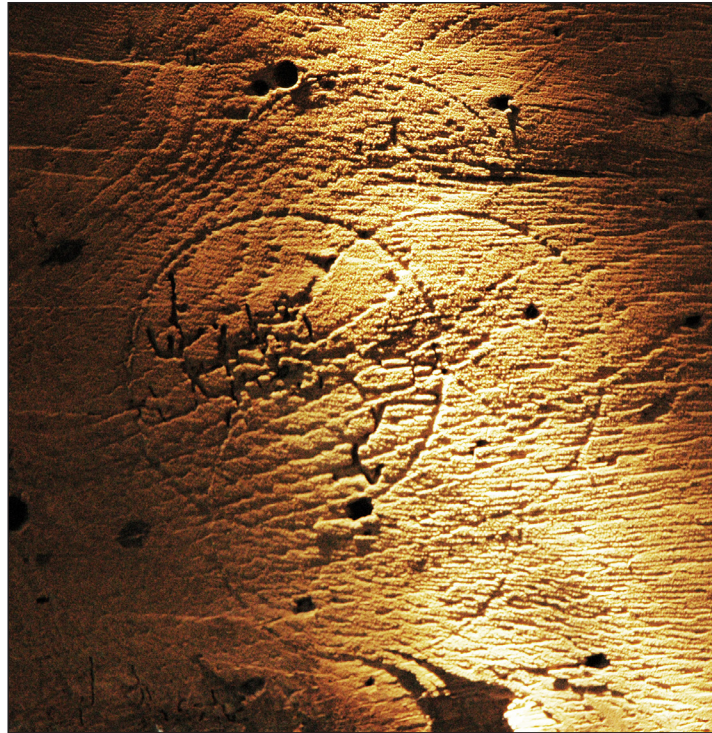
Laurie SMITH
HISTORIC **BUILDING** GEOMETRY

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FOREWORD

Brays Hill Farmhouse retains the three elements that allow its original design method to be found. First, it has a largely intact frame and, where timbers are missing, their locations can be safely inferred from surrounding timbers, second, it has had an archaeological survey that includes measured drawings of its plan and elevations and third, it has a geometrical symbol scribed into its hall chimney lintel. The scribed geometrical symbol is both the subject of this article and the key to unlocking the building's design.

A few words must be said about geometrical symbols. They are widely considered by historians to be apotropaic in nature, emblems for warding off evil spirits. Many are found on chimney lintels, facing into rooms, and this location casts severe doubt on an apotropaic function because, seen at ground level inside the hall, the spirits have already made their downward descent through the chimney, entered the room through the fire and turned back to face the lintel before coming face to face with the symbol. Surely, in order to ward spirits off effectively, it would be far more sensible if the symbol was on the chimney pot and therefore visible at their point of entry.

Perhaps the symbols have a different function. They are usually scribed with dividers, which are carpenters' tools used in the act of marking out joints for cutting. They are therefore likely to have been scribed by the carpenters themselves and the view here is that the geometrical symbols state the geometrical design methodology employed in the layout and construction of the building. At Brays Hill Farmhouse this can be proved beyond doubt: the rare survival of a medieval carpenter's design icon which, if his language is understood, tells us exactly how he designed the house.

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FRONT COVER *Brays Hill Farmhouse, East Sussex, photographed in February 2007*
TITLE PAGE *The geometrical symbol*



Figure 1

Introduction

Figure 1 shows Brays Hill Farmhouse as it is was when I visited in February 2007. The owner had read my notes on geometrical symbols and had contacted me to find out more about the one carved into the fireplace lintel of her ground floor's main room. She showed me a copy of an archaeological report on the house carried out by David Martin FSA IHBC MIFA and Barbara Martin AIFA of Archaeology South East that included measured drawings and placed the construction of the house in its historical context including the fact that the main chimney stack was constructed and new timber frame raised together when the farmhouse was rebuilt in c1560. The Martin's floor plans and sections are used throughout this article and demonstrate how important accurate measured drawings are for geometrical analysis.

At ground floor level the house had undergone some changes. Much of the external wall framing had been lost, presumably eroded by weather, and replaced by brick. The upper floor and attic were protected from decay by painted weatherboarding (or shiplapping as the estate agent's particulars stated) and a clay peg tile roof. Internally, the house was similar. Apart from the studs, the ground floor had lost its cross wall planking between the original hall (the modern main room with triple casement mullioned window at the centre of the house) and parlour (with single window on the left) so that the whole ground floor was, in effect, a single room. Stairs rose from the end of the parlour to chambers on the upper floors where, conversely, the ochre coloured wattle and daub panels were in perfect condition and retained their exquisite original patterns, hand-combed while the daub was still pliable. A panel is shown in the photograph on back cover. The little outshot on the right is a later addition.

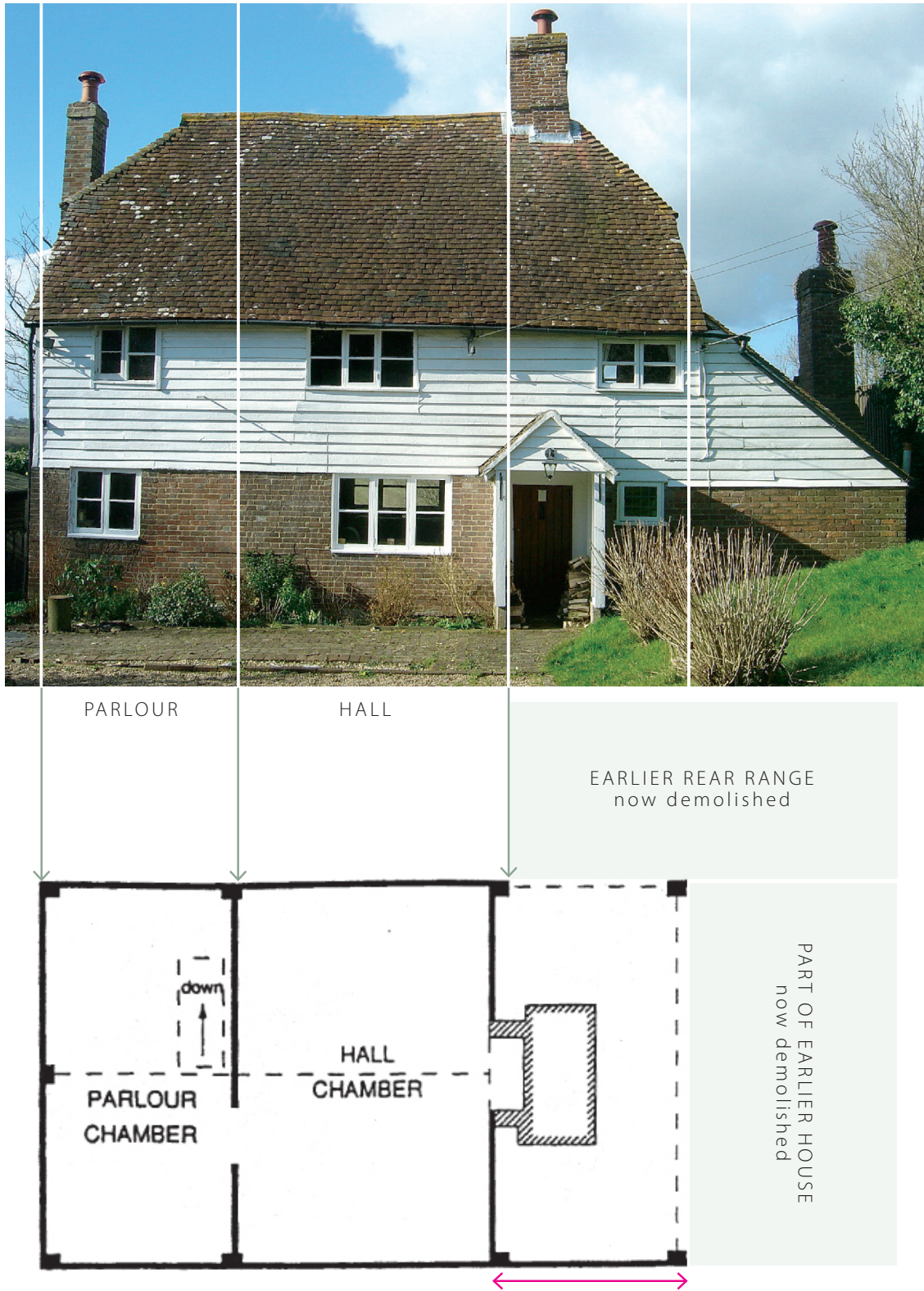


Figure 2

Figure 2 shows vertical divisions through the house, above the Martins' floor plan, defining the position of the gable, cross wall and chimney, built at the centre of the hall's end wall as a free-standing stack. It shows how the stack was built in an area bounded by two existing structures (in grey tones) and that this area was enclosed by framing a single wall across the front (shown by the magenta arrow) where the modern lobby entry front door and small window can be seen in the photograph.



Figure 3

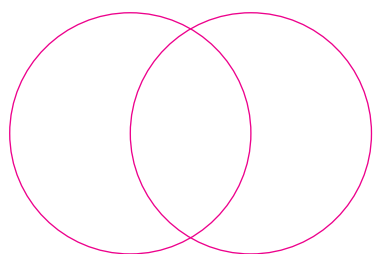


Figure 4

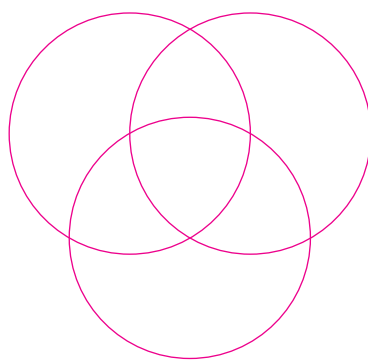


Figure 5

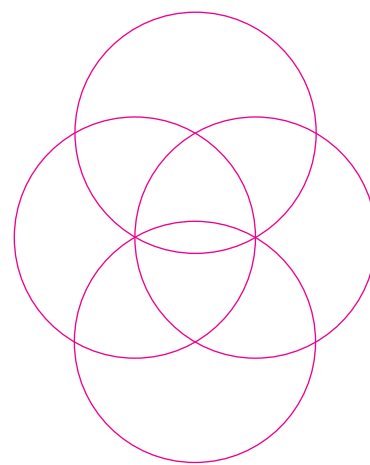


Figure 6

The geometrical symbol at Brays Hill Farmhouse

Figure 3 shows the geometrical symbol divider-scribed into the fireplace lintel at Brays Hill. The symbol comprises just four circles. The symbol's construction commences from a single circle with a second circle drawn from the circumference of the first so that each circle passes through the axis of its neighbour, figure 4. The two circles generate a vertical vesica piscis (the mandorla or almond-shaped sector where they overlap). The points of intersection at the vesica's upper and lower ends are the centres for two further circles. Figure 5 shows a third circle drawn from the vesica's lower intersection. Figure 6 shows a fourth circle drawn from the vesica's upper intersection. The third and fourth circles overlap at the centre of the symbol to give a small horizontal vesica. All four circles are drawn to identical radius and the pin points from which they were scribed can be seen in the photograph.

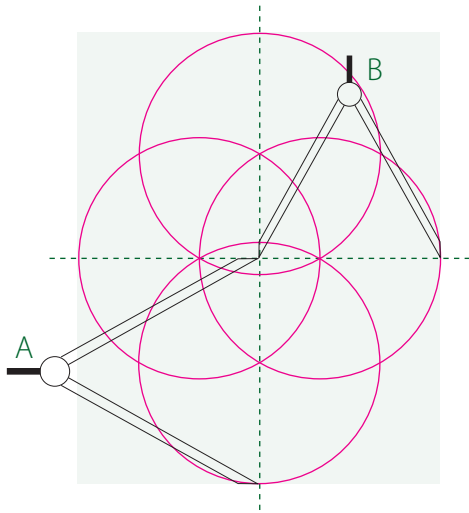


Figure 7

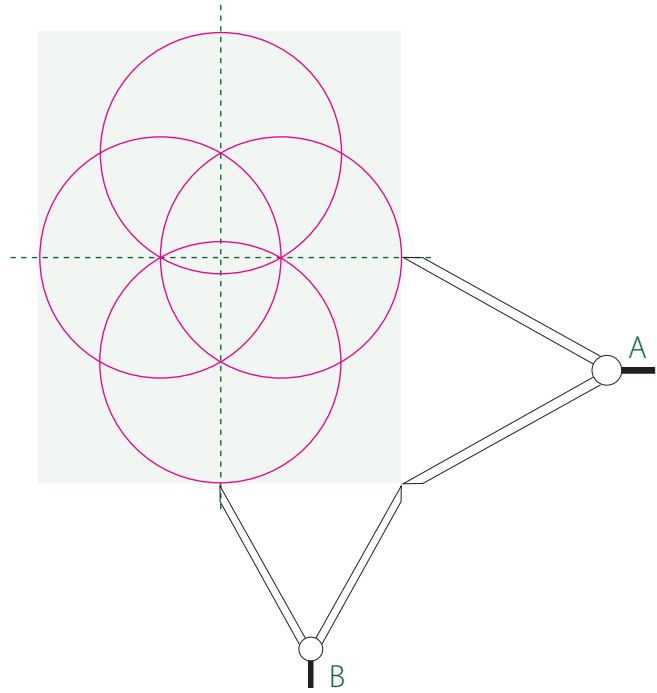


Figure 8

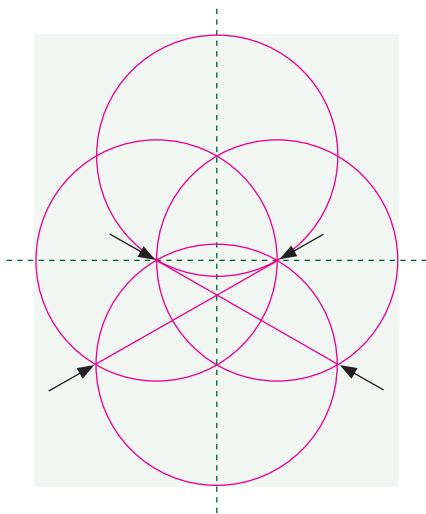


Figure 9

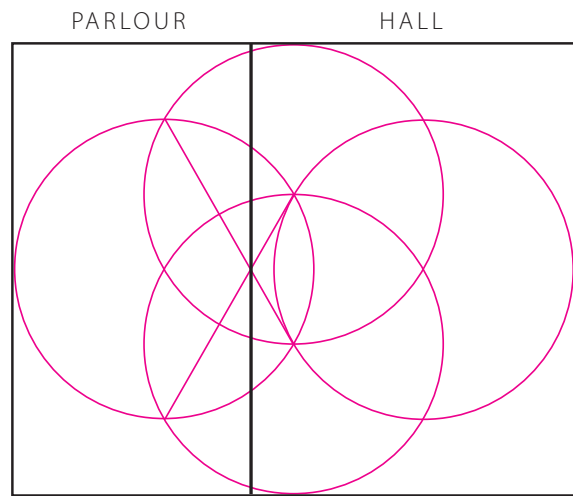


Figure 10

The geometrical symbol's proportional guidance

Because the four circle configuration generates two vesicas, one large and vertical, the other small and horizontal, it is easy to draw two perpendicular centre lines through the symbol (along a straight edge) by cutting the vesica intersections. The centre lines cut the four circles at their poles, figure 7. Figure 7 also shows how the distances from the symbol's centre to its poles can be taken by dividers and repositioned to establish the corner angles of a rectangle that is tangential to all four of the symbol's circles, figure 8. Figure 9 shows two diagonal construction lines that link the ends of the small vesica to the intersections of three of the original circles. These diagonals intersect at the alignment of the ground floor cross wall that divides the hall from the parlour. Figure 10 is rotated through 90° to show the geometry and floor plan at a larger scale.

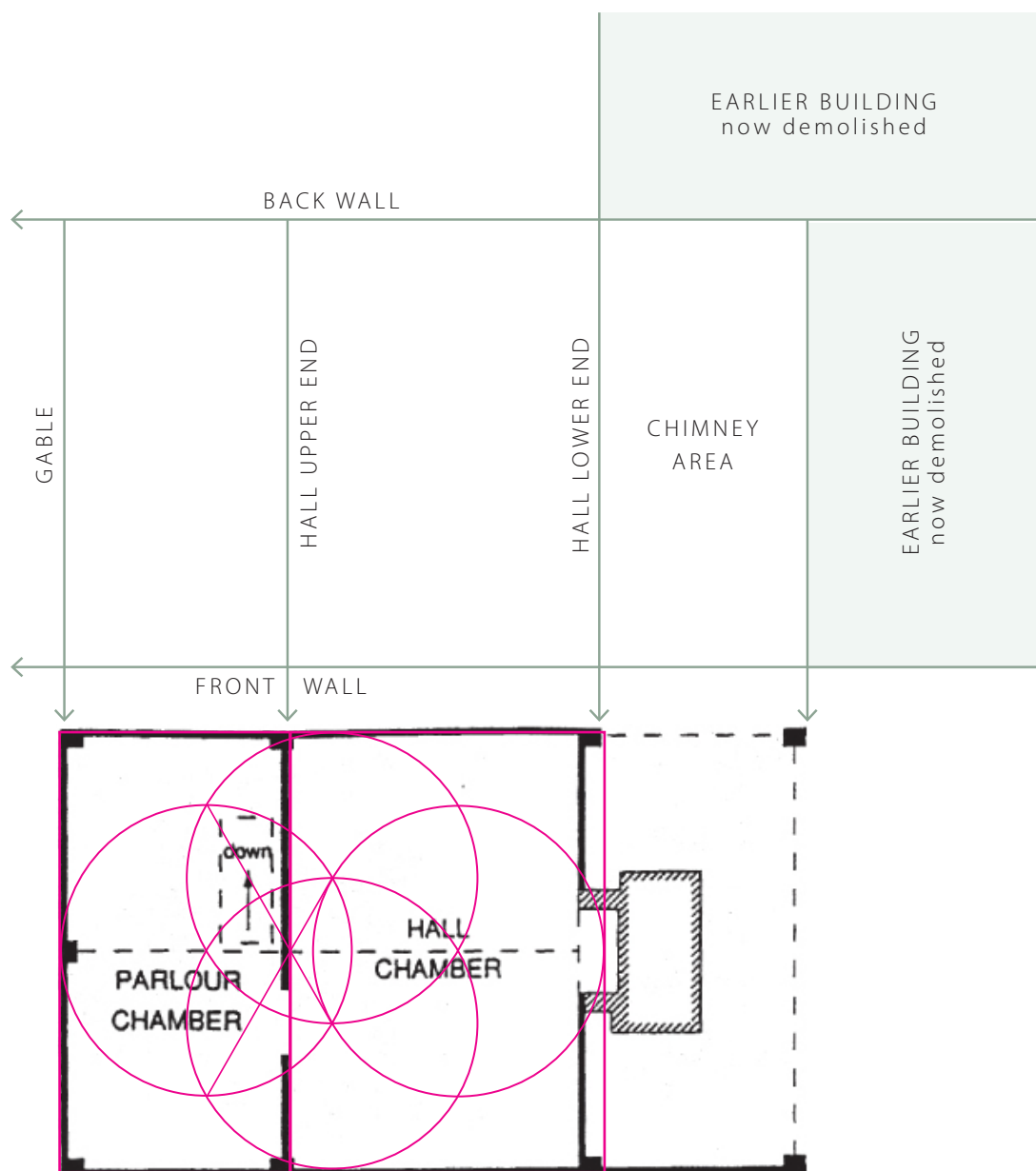


Figure 11

The floor plan

The first thing to establish is why the new Brays Hill Farmhouse frame was built where it was. Archaeological evidence from the site revealed that, at the time of the new build in c1560, two existing but undefined buildings stood in the positions shown in grey tone in figure 11. Alignments from these elements automatically generated the depth of the house from front to back as well as the width of the area occupied by the chimney so that both were, in effect, pre-designed. It only remained to establish the length of the house frame and to extend its front wall across the chimney. This is where the symbol's geometry was used to establish the proportions of the floor. The figure also shows the geometry of the symbol superimposed over the measured floor plan to give upper face alignments on the outer faces of the front and rear walls, the gable and the hall's upper and lower end walls. It is noticeable that the hall's lower chimney cross wall is *inside out*, with the superior carpentry of its upper face visible from within the hall. Placing the corner posts *outside* the new frame (where they would not be weatherproof) is clear evidence that the chimney area was to be roofed and incorporated into the body of the house from the outset.

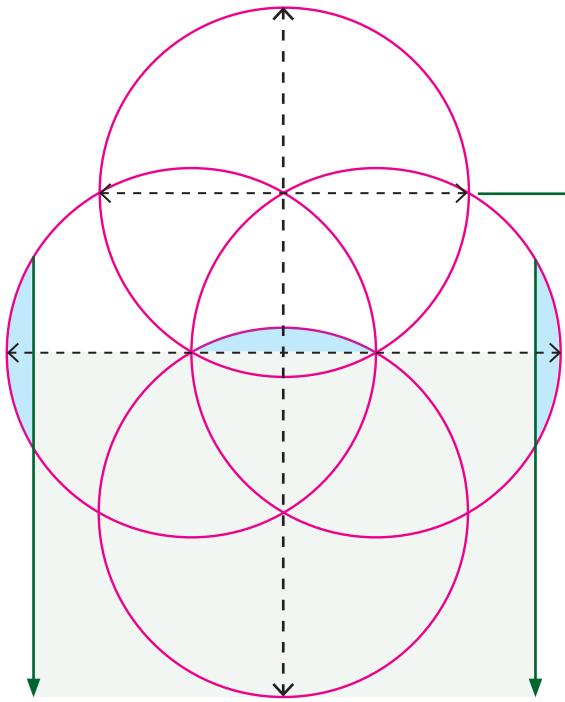


Figure 12

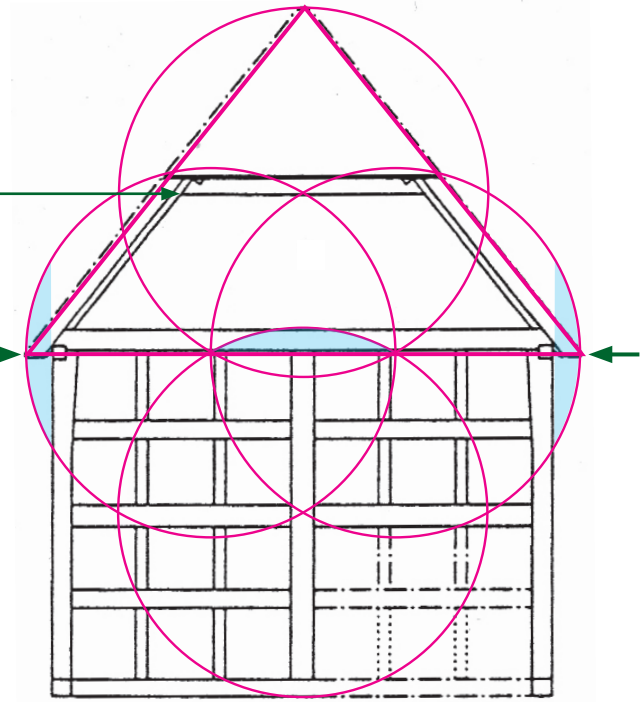


Figure 13

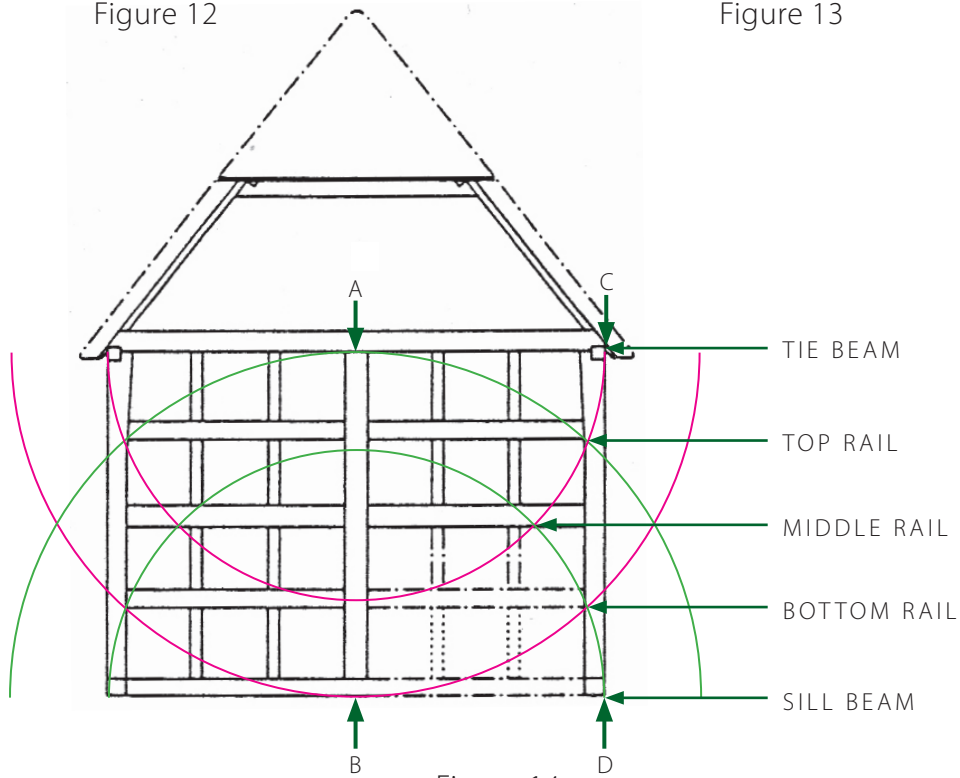


Figure 14

Gable framing: geometrical proportions

The geometrical symbol can be used to generate the gable wall's timber configuration. Figure 12 shows how bisection of the symbol's small horizontal central vesica defines the depth of the tie beam and the level of the tie beam's lower face (shown in the blue tone in figure 13). Figures 12 and 13 also show how the half vesica (blue tone) is applied in the outer circles to define the location of the corner posts' outer faces and how triangulation within the top three circles defines the roof pitch (shown in figure 13).

An alignment through the top of the large central vesica defines the level of the collar's lower face. The two central circles cut the roof triangulation at intersections defining the collar's upper face. Figure 14 shows how four arcs of circle intersect to give the levels of the gable's top, middle and bottom rails. The magenta arcs are drawn from A (radius AB and AC) and the green arcs are drawn from B (radius BA and BD).

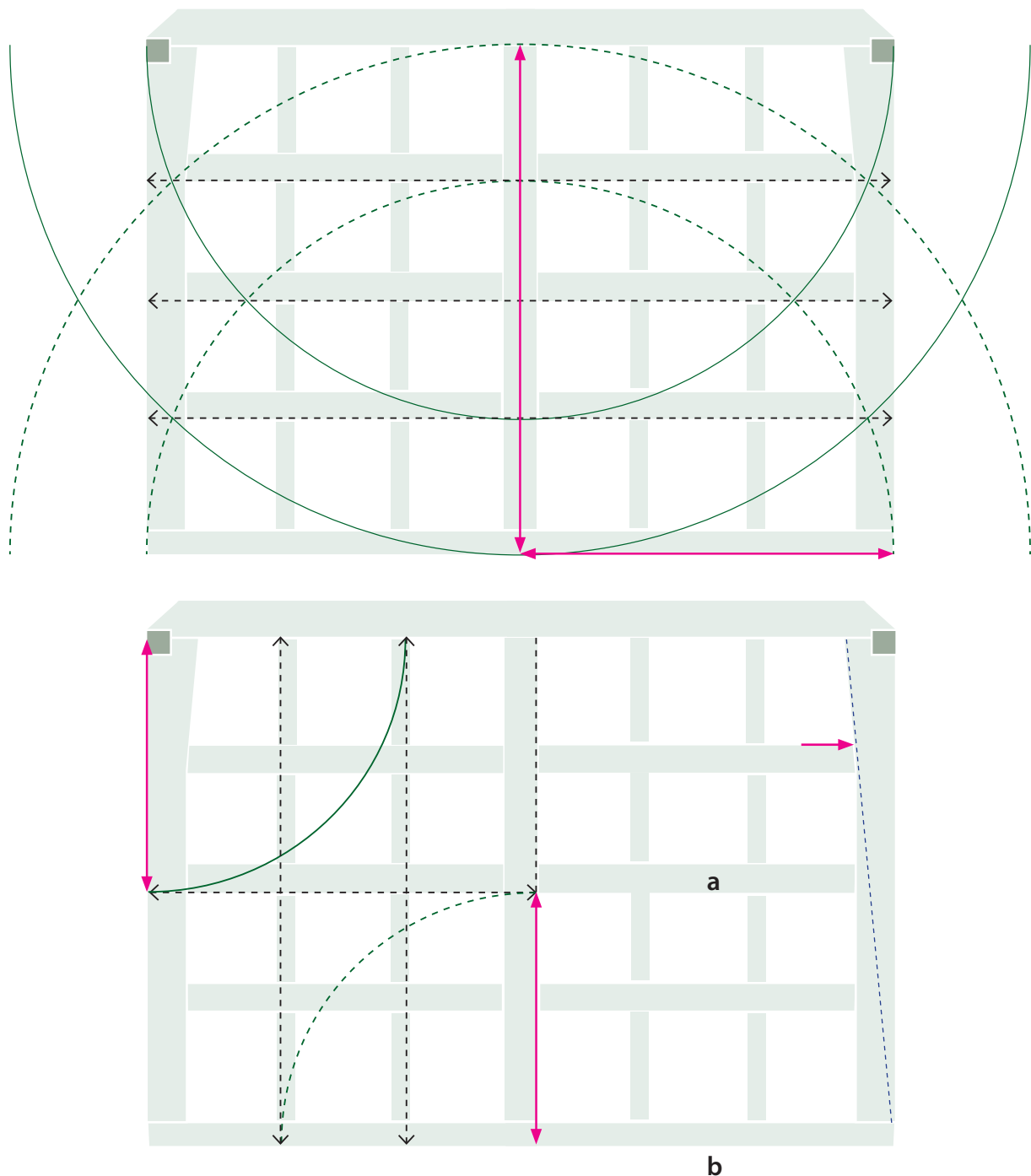


Figure 15

Gable framing: sub-geometry

Figure 15 summarises the simplicity of the wall's geometrical layout, the upper drawing defining the horizontal levels of the top, middle and lower rails and the lower drawing defining the small vertical ties between them. The drawings indicate the three radii: the wall's full height, half height and half width, shown as magenta arrows, that generate all the rail and tie locations and are simple to take from the frame's boundary and vertical centre line. The vertical tie arcs are taken from the outer faces of the corner posts and central stud (half the wall width). This is all geometry that could be set out easily on the framing floor after the frame's sill, tie beam and corner post outline has been defined. The large arcs in the upper drawing are shown beyond the frame so that their full structure is visible but, in reality, they only need to intersect with the smaller arcs to give the cardinal points required for the horizontal rail alignments. The lower drawing also shows how the jowl angle is derived from the diagonal of the post between the sill and the level of the upper rail from where it expands to the tie beam to allow for the English tying joint.

The ground floor fireplace

The previous pages demonstrate how the Brays Hill geometrical symbol was used to define the proportions of the floor plan, including the dividing wall between hall and parlour, and the gable elevation, including horizontal rails and vertical ties. Some of this geometry, for the dividing wall, rails and ties, is a development from the basic symbol but none of these could be developed without it. The symbol determines every element of the frame's design.

The archaeological report states that the chimney stack was built at the same time as the cutting and raising of the frame, against the lower end of the hall on the ground floor. The symbol itself was scribed into the left hand end of the chimney lintel, facing into the hall. In figure 16 the upper drawing gives the fireplace and lintel dimensions, measured on site, and the lower drawing indicates the symbol's precise location on the lintel. As can be seen from the drawing, the symbol is placed about 5 feet above floor level above the left hand brick pier, a position where it would be approximately on eye level, visually noticeable and, indeed, difficult to avoid seeing.

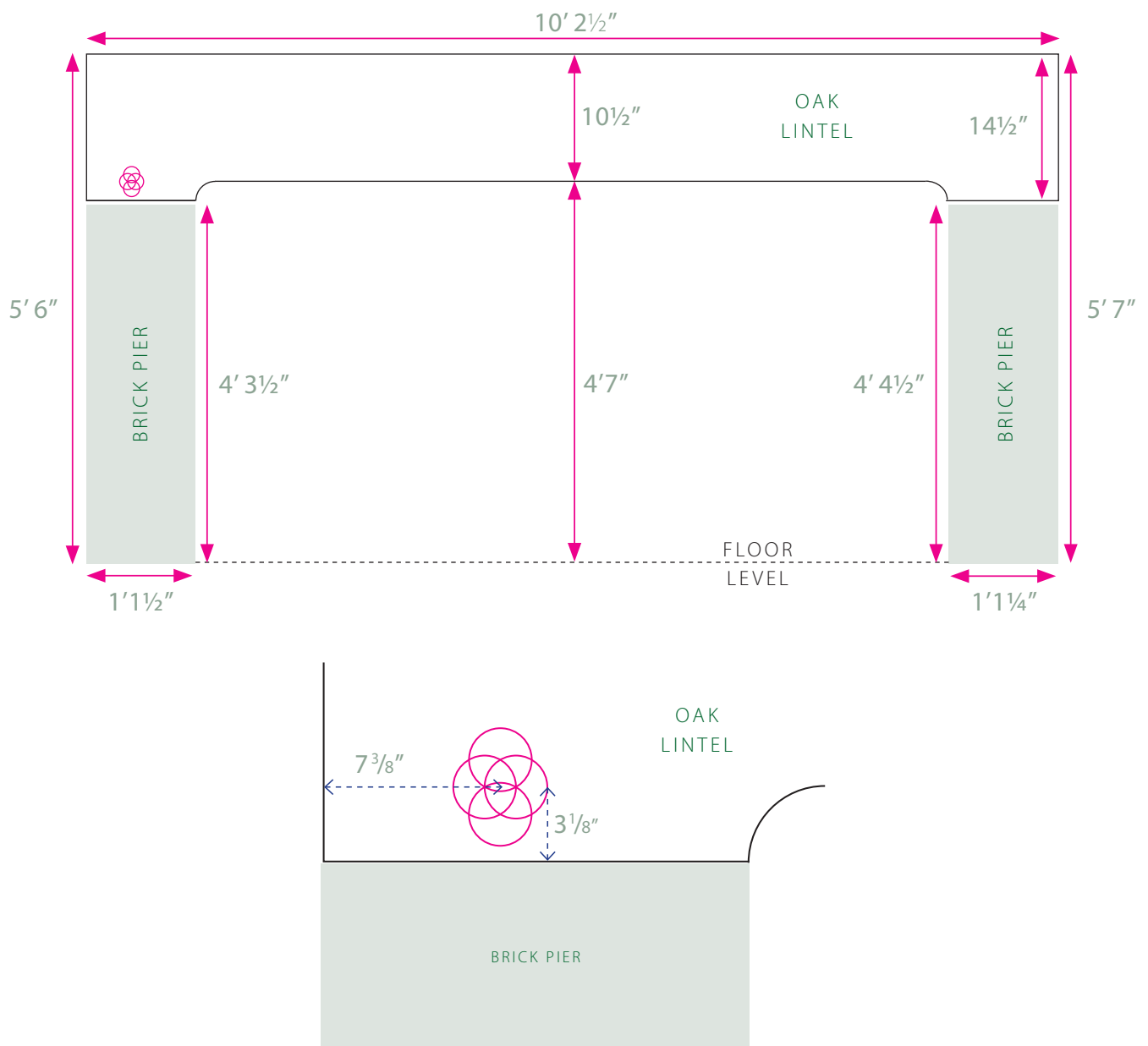


Figure 16

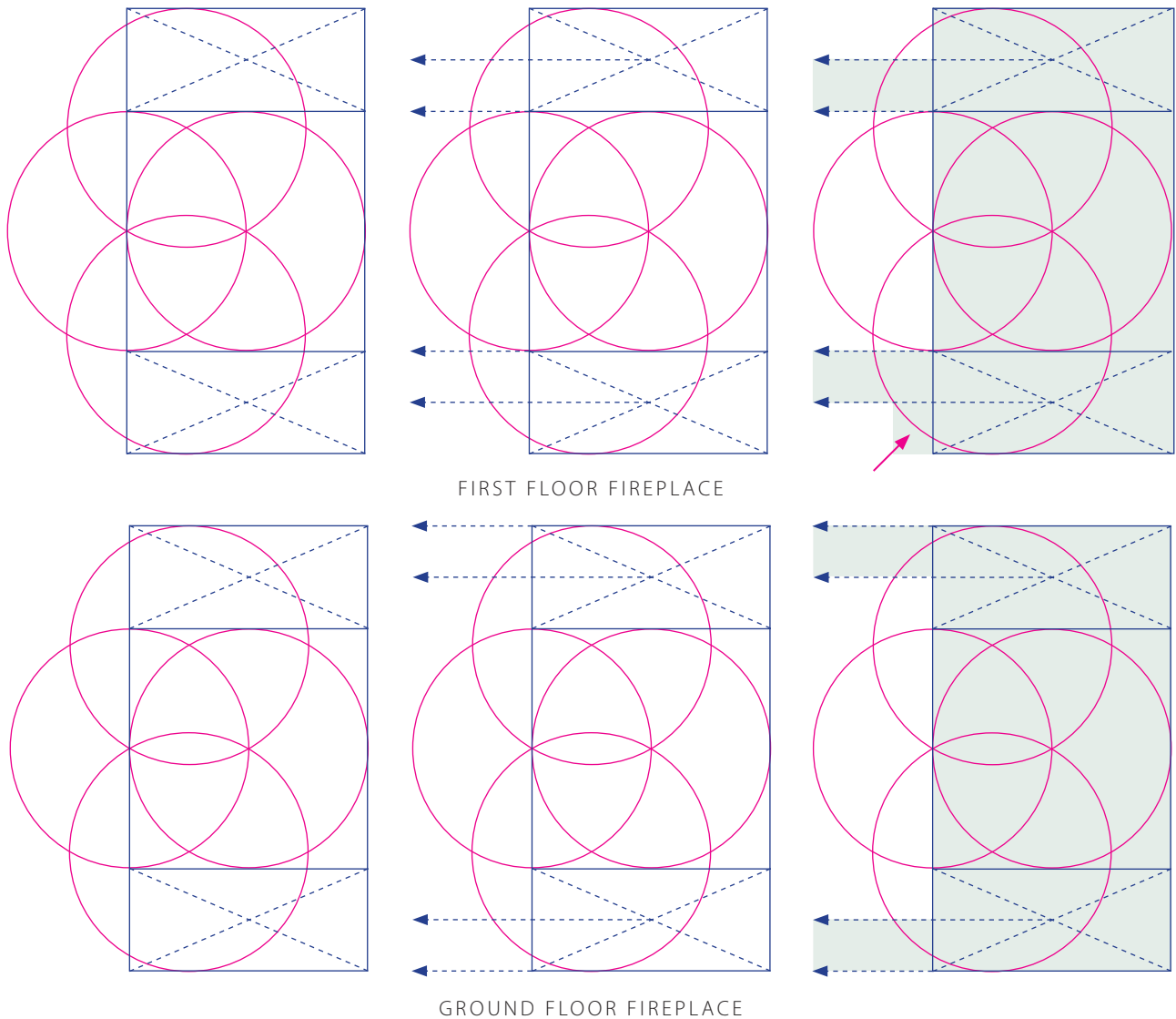


Figure 17

Ground and first floor fireplace plans

Figure 17 shows how the symbol is applied to the design of the ground floor and first floor fireplace plans, the upper drawings for the first floor and the lower drawings for the ground floor. It is noticeable that the ground floor fireplace is wider than that of the first floor to allow for the cooking that would have taken place there.

The symbol's geometry is subdivided into three sectors governed by tangents to the symbol's circles. The narrow upper and lower sectors are governed by semi-circles and the deep central sector by full circle height. Diagonals across the narrow upper and lower bands intersect at the bands' centres to give the choice of two pier positions at the outer edges of the fireplace, the upper drawing showing the narrower spacing of the first floor piers and the lower drawing showing the wider spacing of the ground floor piers. In the first floor geometry there is a small asymmetric detail, indicated by the magenta arrow, at the bottom of the tonal plan that is also shown in the measured drawing.

Figure 18 shows the relationship between the ground floor fireplace facade and floor plan, the floor plan's three-dimensional depth utilising the whole geometrical construction but the facade, which is essentially two-dimensional, using a selected, central sector of the geometry. This is a matter of choice on the part of the carpenter or mason, or as this case suggests, a team working to a geometrical design.

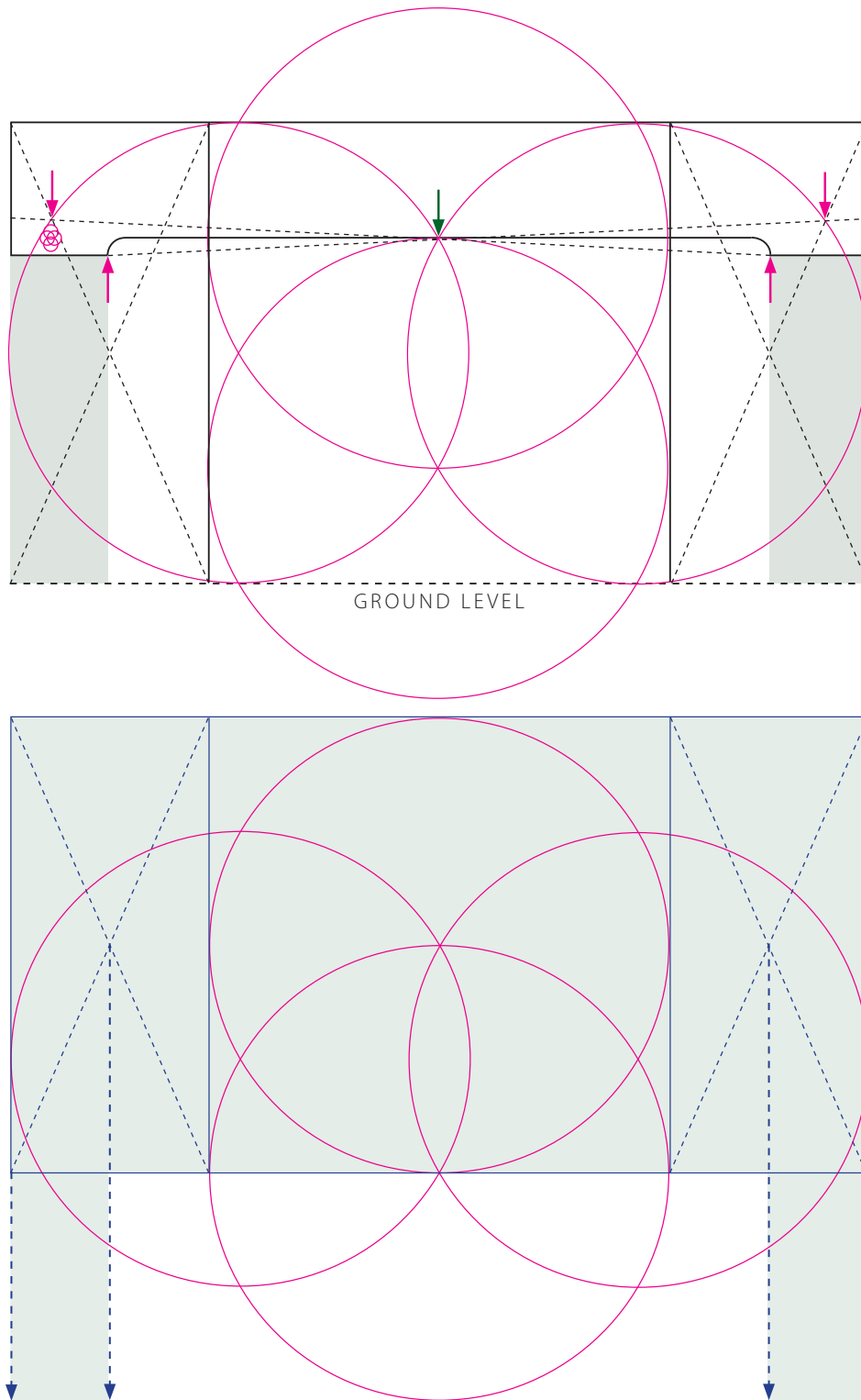


Figure 18

Plan and elevation of the ground floor fireplace

It is noticeable, in the upper drawing of figure 18, that the long alignments between the brick pier tops and the intersection of diagonal and circle on the opposite sides (marked by magenta arrows) intersect to define the lintel's height (at the green arrow) and the location of the symbol on the lintel's left side. The symbol occupies a precise geometrical location, within a small triangle immediately beneath the intersection of diagonals and left circle, a position that would be unknown unless the geometry was known from a drawing. The symbol is shown at its correct scale but its line thickness is slightly increased to aid visibility.

The geometrical symbol in use

The geometrical symbol scribed into the ground floor fireplace lintel in Brays Hill Farmhouse is clearly visible to anyone standing before the fire to warm their hands. The presumption is that it has been there for just over four hundred years, since 1610, because, as has been demonstrated on the previous pages, it can be used to generate the complete house footprint and standing frame, the chimney footprint and fireplace elevations on the ground and first floors. It is therefore intricately and inextricably inter-connected with the frame and its design. Because the symbol is divider-scribed into the lintel and because dividers are a carpenter's tool it was almost certainly scribed by the frame's carpenter with the same dividers used to set out the frame.

The symbol has characteristics that make it particularly useful for the layout of timber frames, figure 19. First, the drawing is simple because all the symbol's circles are drawn to the same radius. The first two circles are drawn on a common horizontal centre line so that each passes through the axis of the other and this generates a vertical vesica piscis¹ where the two circles overlap. This is shown in the left side of figure 19 where it can also be seen that the circles cut the centre line into three equal sectors. The optical illusion is that the vesica is narrower than the two outer sectors because the circles encompass it but the reality is that each sector of the centre line equals the circle's radius so that the symbol's centre line length is divided precisely into three. This has a specific benefit at Brays Hill because the gable width of the house was recorded as 196 inches², just two inches short of a medieval Rod of 198 inches (= 16½ feet) where two thirds are 11 feet and one third is 5½ feet. A symbol and developed drawing using a 5½ inch radius would be at 1:12 scale, a drawing 16½ inches wide by 20¼ inches tall. Figure 20 shows how divider readings from the scale drawing could be transferred to full scale by stepping out twelve times along chalk lined timbers or, more accurately, doubling the initial divider reading and stepping out six times along the chalk line. Doubling converts the circle's radius into its diameter, thus halving the number of steps and ensuring that counting errors are minimised.

Once the first two circles are drawn, two further circles are drawn from the intersections of the first, at the points of the central, vertical vesica. This is shown in the right side of drawing 19. The additional circles generate a second, smaller horizontal vesica within the boundary of the larger vertical vesica. The vertical and horizontal vesicas facilitate the drawing of vertical and horizontal perpendiculars that intersect at 90°, the essential centre lines necessary for laying out the frame, either as a scale drawing or at full scale on the framing yard. The symbol's geometrical construction is the simplest way to generate the perpendiculars and the vertical perpendicular automatically defines the alignment of the frame's first and second floor spine beams. The frame's outer walls are all tangents to the symbol's four circles.

There is simplicity, certainty, precision and elegance in this geometry. The less drawn, the less chance for error, either in drawing or interpretation. The less drawn, the fewer the number of points of intersection from which to make choices and inter-connections which, in turn, keeps the design simple. It is this initial simplicity that gives medieval buildings their sense of balanced proportion and visual composure. As the design evolves, more points of intersection come into play and the potential for detail increases.

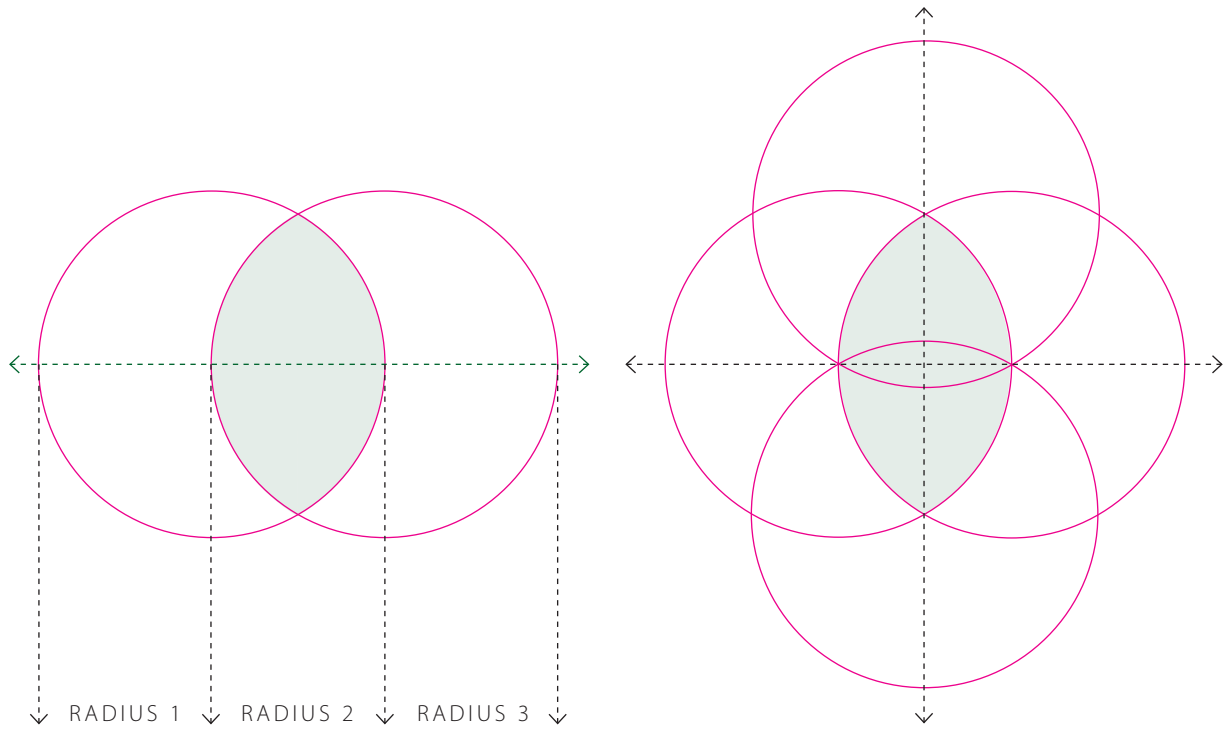


Figure 19

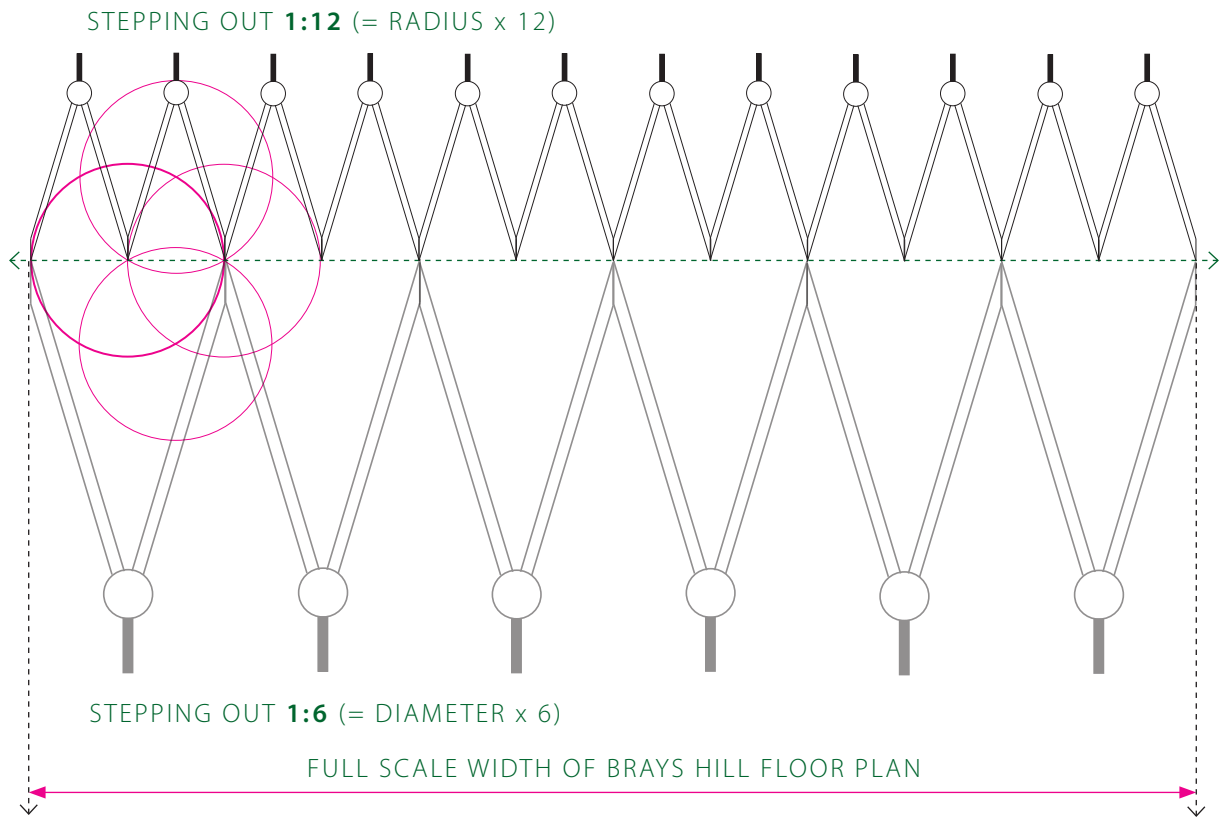


Figure 20

FOOTNOTE 1

Figure 19 shows the geometrical construction of the vesica piscis, left, and quatrefoil, right, that incorporate the vesica. Both the vesica piscis and quatrefoil have ecclesiastical significance. The vesica piscis often appears in cathedral and church sculpture as a mandorla surrounding the body of Christ and, on a smaller scale, as the form of jewels and rings worn by archbishops. The literal meaning of the term vesica piscis is *fish bladder*, fish from its shape as the cross section of a fish and bladder in the sense of an inflated sac or capsule. The fish was the earliest Christian symbol, predating the cross and dove. The quatrefoil was symbolic, in medieval thought, of holy ground and is often found repeated as a continuous openwork balustrade around the top of church walls.

The geometrical construction of the vesica, although drawn from only two circles, generates the third form of the vesica and can be seen as a Trinity symbol, two circles plus the vesica piscis. The horizontal distances across the widest parts of the vesica and its two adjacent crescents divide the centre line into equal thirds despite the visual illusion that the vesica is narrower.

There is no suggestion here that the Brays Hill symbol had ecclesiastical significance or that the house had been in ecclesiastical ownership, rather that geometry was a curriculum subject during the period when the house was built and that geometry was the state of the art design system at that time. In other buildings that display geometrical symbols it has been demonstrated that the symbol functions as a design icon or module that can be used to generate the proportional relationships of the building's plan, section and elevations. As this article demonstrates, the geometrical symbol scribed into the fireplace lintel at Brays Hill Farmhouse has the same function. The suggestion here is that the symbol was the design signature of the carpenter who laid out, cut and raised the frame to its proportional values.

FOOTNOTE 2

The dimension of 196 inches for the gable wall width and its two inch short fall in relation to the medieval Rod of 198 inches (16½ feet) can be explained by a number of factors. Figure 21 shows facade and gable views of the house where it is clear that the timber frame has been replaced from ground to first floor level by brick and there may have been a small dimensional change of 1 inch per side in this replacement.

In a second possibility, the dimensions taken by the owner, Fay Merrick, and sent to me included a note saying that the gable was awkward to measure because the shed was in the way (the shed is just visible on the lower left of the left gable photograph). The later external chimney also obstructs a straight line measurement. So the obstacles may have generated a slight dimensional error.

The third possibility lies in the original scale design drawing where the dimension of divider line thickness can be a contributing factor to dimension creep when expanded to full scale.

The view in this article is that the dimensional differences are so slight that the geometrical design intention was clearly a 1 Rod width for the gable. When Brays Hill Farmhouse was built the Rod was also a dominant dimension in land measurement and would be a natural, related choice for a farmhouse frame.

ACKNOWLEDGEMENTS

I am indebted to Fay Merrick, owner of Brays Hill Farmhouse for encouraging me to visit the house to take photographs, for supplying measurements in response to my questions and, of course, for her delicious refreshments when I was there.

My thanks are also due to David and Barbara Martin of Archaeology South East whose measured drawings enabled me to test the symbol's geometry against the building's plan and elevation. Without their work the symbol's function would remain theoretical. With their work to underpin it, the symbol's design function is proven beyond doubt.



Figure 21



Figure 22

ADDITIONAL DAUB FOOTNOTE

Figure 22 shows one of the superb wattle and daub panels that can be seen on the upper floor of the house. To have one would be remarkable but the survival of almost every wall surface is extraordinary. Sadly there are no surviving panels on the ground floor. It can be seen that the linear pattern is drawn by hand from the base of the panel in a flowing upward movement on the left hand side, across the head of the panel and down the right hand side, each swirl over-riding the trail as it crosses it. Conversely, the vertical lines are more easily drawn with a downward movement. In both cases the pattern is made by a simple wooden tool, known to potters as a comb, and, being carried out while the daub is flexible, the action is closer to combing rather than carving. The white line shows the rising direction of the combing on the left. The comb, a short stick with notches cut or filed out, is easy to make and was probably purpose made for the four grooves that leave a triple relief pattern.

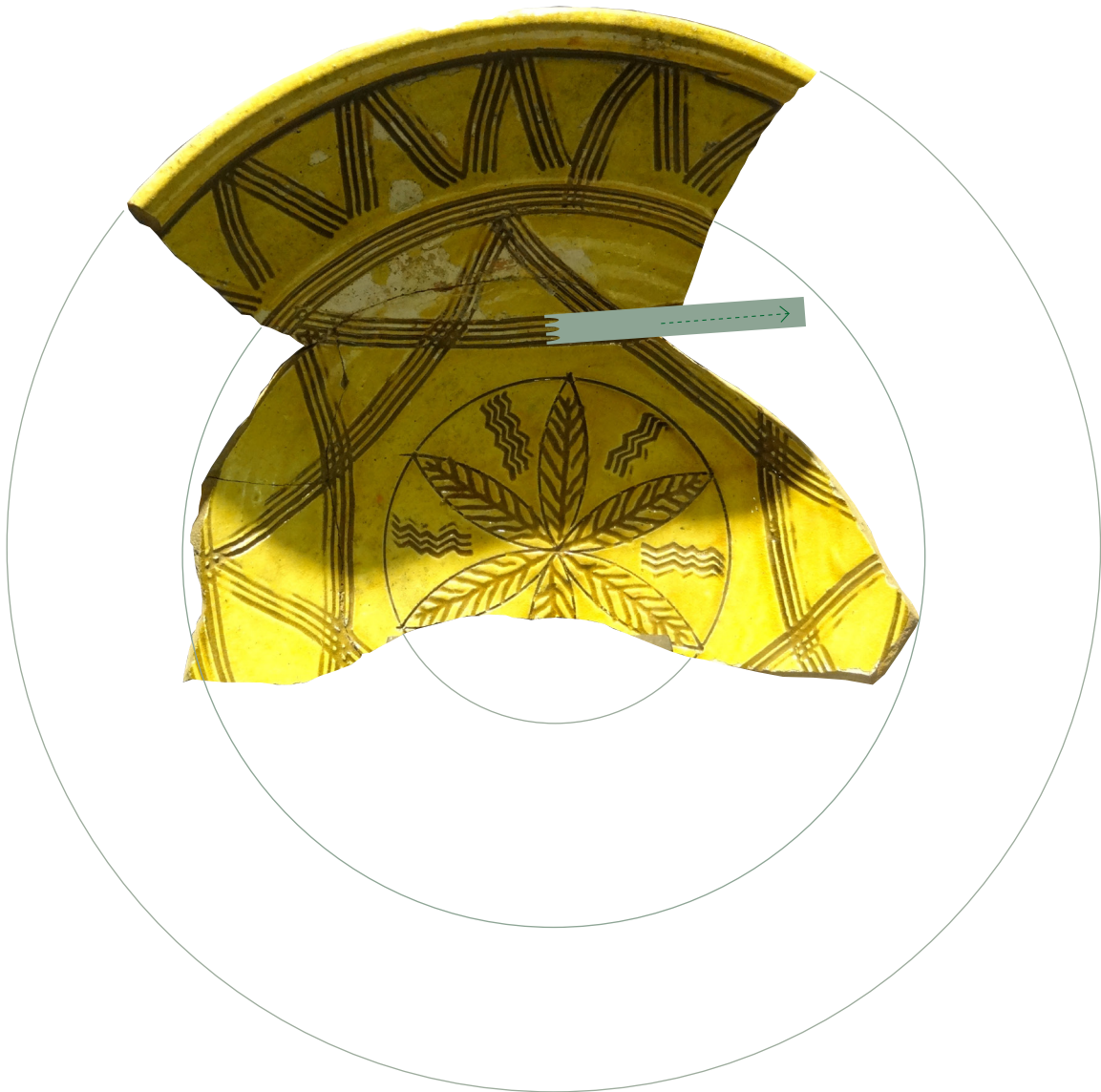


Figure 23

Figure 23 shows the same technique used on ceramic slipware. The body of the pot is formed from red clay which, when leather hard is coated internally with white slip (a liquid clay). When the slip has also become soft leather hard the comb is dragged through its surface to reveal the pot's red body. This is a variant of the potters technique of sgraffito (scratching) where a knife or scalpel is used to score through the slip layer. The divider-scribed daisy wheel can be regarded as sgraffito as can the veins of the leaves inscribed within the wheel's petals. This example is in the fine slipware collection in the Burton Art Gallery and Museum at Bideford in Devon.

www.historicbuildinggeometry.uk

