THE TETRAHEDRON CAIRN

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I have often found inspiration in classical design, not the modern reproduction of Georgian architecture about which I am extremely doubtful, but rather the incorporation of classical ideas into contemporary design. Following this thinking I have over the years made three large scaphe dials in turned slate, which are of course direct descendants from the hemispherium of Berossus.

In 2014 I was asked by my friend David Heathcoat-Amory to design a sundial to be constructed on a cairn that he wished to build in Scotland, to celebrate his lifetime of love for a beautiful family property in the hills of Perthshire. A cairn is a marker and can be described as a visual metaphor for the occasional visit by people to its location, and a sundial likewise can be called a visual metaphor for the passage of time. The combination of the two was most appropriate to express David's intentions, and I am glad to say that an idea came to me quickly. There were five regular solids known to the Ancients: the cube, tetrahedron, octahedron, dodecahedron and icosahedron. Why not build a cairn in the shape of a tetrahedron, with three inclined triangular faces, two of them with sundials, one to the south west and one to south east, the third north face with something decorative; and the base forming the fourth triangular side?

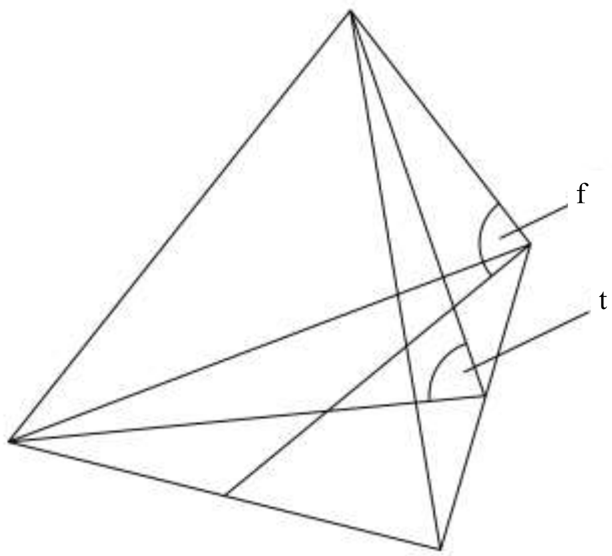

Fig. 1. f *is the angle the edge makes with an adjacent plane. In a regular tetrahedron this is 56.13° but if this angle is increased to 56.78°, equal to the latitude of the site ,then the angle* t*, the angle of inclination of the face with the base, is 71.86°. This is the angle of the reclining sundial faces.*

Fig. 2. View of the cairn showing the south-western and north faces.

The idea seemed to me a development of classical geometry, and so appropriate to my thinking and taste. It was also in the tradition of polyhedral dials so prevalent in 17th-century Scotland. The object would have two declining reclining sundials on the two faces adjacent to an edge which would be in line with the local meridian. I proceeded to investigate the geometry of a tetrahedron further and calculated that the edges of a regular tetrahedron form an angle of 56.13° with one of the faces. This point is explained by the sketch in Fig. 1. However, the latitude of the Scottish site is 56.78°, a difference of 0.65°, and it occurred to me that it might be more interesting to make what might be called a semi-regular tetrahedron, with an equilateral base and three isosceles faces so that one of the edges was parallel to the axis of the Earth. These isosceles triangles would be not noticeably different in shape and dimension from equilateral triangles. Some of the geometry of a regular and this semi-regular tetrahedron is explained in Fig. 1.

The cairn was completed in July 2015, built in the form of a tetrahedron which is between 9 and 10 feet high and can be seen standing proudly in Fig. 2. The faces are of Brandy Crag grey slate from Burlington, the gnomons are of bronze, and the other material was scavenged from some

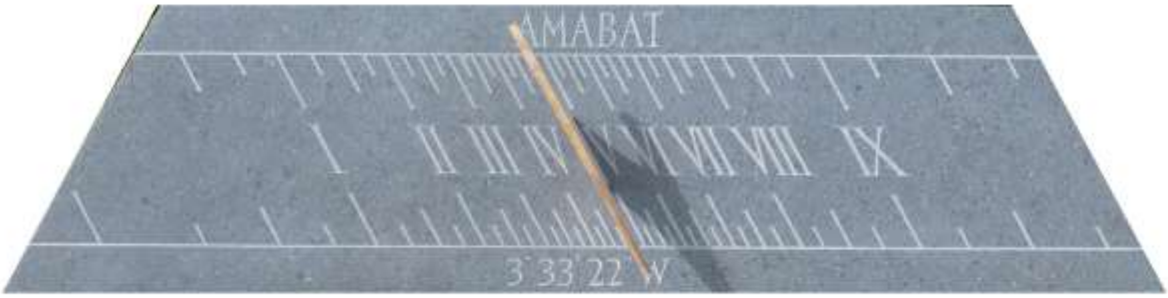

Fig. 3. The south-eastern face.

Fig. 4. The south-western face.

Fig. 5. The north face.

collapsed stonework in the area. There are several elegant consequences that flow from the design concept. As mentioned, the north-pointing edge is parallel to the Earth's axis. So of course are the two gnomons. It follows that they are parallel to the north-pointing edge and that all time lines are parallel to each other and also the two gnomons. These interesting features are illustrated in Figs 3 and 4, while Fig. 5 shows the north face.

I knew that Ben Jones should engrave the faces. I decided that the north face should depict some approximate corrections in minutes for the Equation of Time, and that the dials should incorporate the displacement from the Greenwich meridian, and be calibrated in BST, for at a height of 1000 feet in this latitude the cairn will be covered in snow during the winter months. I designed the faces in the software package Shadowspro. Both faces incline 71.86°, one declines 30° west, the other 30° east. Following my drawings and sketches Ben then designed the numerals and lettering on the faces. My regular breathing down his neck was no doubt sometimes an irritation to him. The central logo on the north face was my idea to portray the initials of our patron. The initials of myself, Ben and Colin Meldrum the builder of the cairn are also to be seen, together with the co-ordinates of the location.

To establish the dial faces accurately on a rough stone cairn was inevitably extremely difficult. A technique which I had successfully devised for the Buscot obelisk[1] was followed. John Huddlestone, my neighbour in Lancashire and skilled metal worker, made a stainless steel cage, perhaps better called a frame (Fig. 6), to which the three faces were bolted, and which could rotate slightly on another stainless steel cut-out base plate which was established precisely level on a pillar. The foundation of the cairn was made by Colin, the pillar built and the assembly delivered by Ben to Scotland. It was Ben's responsibility to fix and align the dials. This he did with some difficulty because he needed a long shadow to align the dials accurately. Fortunately, one day Ben was able to get a good fix at 12:00 BST on

Fig. 6. The stainless steel frame in John Huddlestone's workshop. The three oblongs to which the faces are bolted are reclining at an inclination of 71.86°. The base on which the frame rotates slightly can be seen together with the upright levelling bolts.

the south-western face and Fig. 7 shows the assembly established in position. The illustration may appear a little misleading because in high summer the shadow cast by the gnomon on this face has moved off it by 12:00 (the dial can be read at this time on the other face). However, by clamping a strip to the gnomon Ben could get a nice long shadow and accurately fix the assembly. The concept

Fig. 7. The dials established in position. There was a brief moment of sunlight and by means of a strip clamped to the gnomon of the south-western face Ben was able to adjust the frame to the right time at 12:00 LST.

behind the design does not lead to very great accuracy in reading the time. Inevitably the angles of steel frame will, however well made, be very slightly inaccurate and the dials require at times very long shadows. Any inaccuracy in the construction will lead to considerable inaccuracy in reading times. Furthermore the corrections on the north face are very approximate. However, the dials after a few test readings appear to give values accurate to within about two minutes, after correction for the Equation of Time.

Once the steel frame with the dials was in place and fixed Colin built the surrounding cairn and filled the void inside with stones and concrete, taking great care not to damage the dials. The areas at the ends of the dial faces caused me some concern. I knew it would not be possible to make the slates long enough and accurate enough to meet neatly at the cairn edges, and decided to finish each of the three end areas with stepped triangular layers of slate slanted and roughened on the edges. These features can be seen in Fig. 8.

Fig. 8. The south-eastern face showing its bronze gnomon and two of the roughened and stepped slate ends at the corners of the cairn.

David asked a scholarly friend to devise a suitable inscription in Latin: MONTES AMABAT SEMPITERNOS – He used to love the eternal hills.

David is delighted with the cairn as are Ben, Colin and I; and if on a clear night an invited visitor walks up the hill and crouches with one eye looking up its southern edge the pole star will be clearly visible.

REFERENCE

1. M. Lennox-Boyd: 'The Buscot Obelisk', *BSS Bulletin*, 25(iii), 2–5 (September 2013).

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