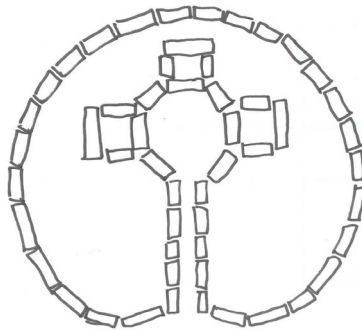


## Comments on the 'Earth Mound' project

by Aaron Watson and David Keating

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### 1. The structure



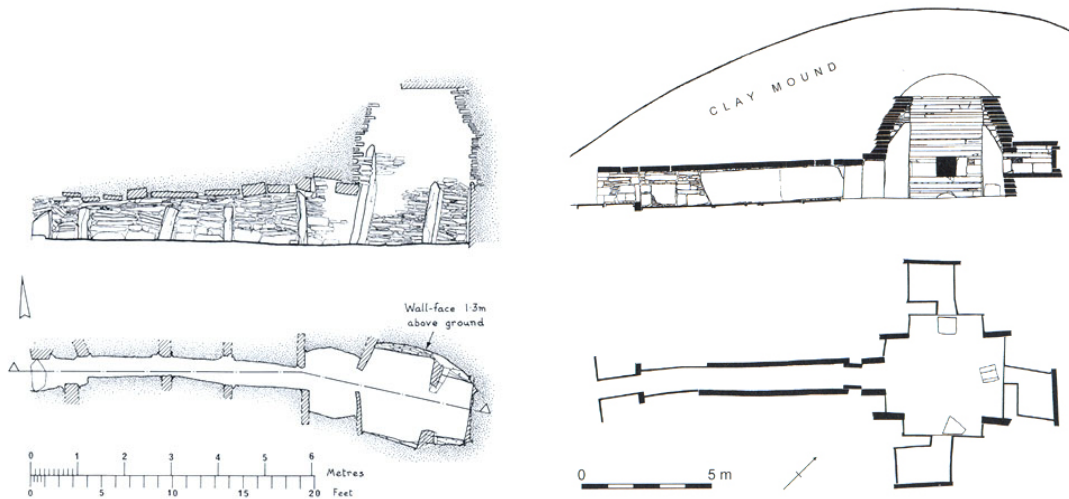
This sketch plan of the Earth Mound was very useful in giving us an idea of the kind of site you would like to construct. A number of issues arose:

#### *The passage*

In the diagram the passage is shown as straight and, although there is no scale, appears to be quite short. This might have implications for Helmholtz Resonance (see below), but it also impacts upon the overall experience of the structure. One of the defining characteristics of Neolithic passage graves is that you cannot see into the chamber from outside. Indeed, the passageways are usually rather longer, and are almost never straight (see plans below). This might not have acoustic implications, but it does contribute to a sense of separation in the chamber and a sense of exclusion to people who are outside because there is almost no direct line of site to the chamber. In the prehistoric monuments, confinement and separation seem key elements of their experience – in some cases this can even feel oppressive and claustrophobic. The confined passages at many sites can be quite an unpleasant ordeal to traverse and thereby create

an impression of a larger and more extraordinary space when the central chamber is finally reached. At a number of sites there is evidence to suggest that the passage might even have been blocked during activities there.

While we understand that you have specific interests in creating a particular kind of experience for meditation etc, such issues raise the question of whether you are trying to recreate a prehistoric space, or build something else altogether.



Camster Round (from Davidson and Henshall 1991)

Maeshowe (after RCAHMS 1946, 308).

### ***The central chamber***

We are not certain whether the elliptical central chamber you have shown in your diagram is most effective for the acoustics of the chamber. In a relatively confined space an effect such as standing waves would be best achieved with straight and relatively flat walls. Indeed, a square would be the ideal shape because it is possible to achieve the same resonance in two directions. In the same way, a domed roof will have rather less interesting acoustics than one that is flat or stepped – a dome only has one resonance, whereas a site like Maeshowe has many. In terms of predicting the primary resonances for standing

waves, flat and parallel surfaces will be rather more predictable. Both Cuween Hill and Maeshowe are ideal in this respect (see photos below).



Cuween Hill (Photo: A. Watson)



Maeshowe (Photo: A. Watson)

Since we have begun to analyse our own measurements from Newgrange and Maeshow, we have realised how much more effective Maeshowe is at creating fundamental acoustic effects. Standing waves in its regular chamber are far stronger than at Newgrange which has a rather less regular format. Your Earth Mound plan is rather more reminiscent of a site like Newgrange, so you would not maximise the potential for standing waves in this space.

### ***The side cells***

In our experience, cells leading off from a main chamber contributed a great deal to the effects of standing waves. In particular, it can appear that a sound is emerging from within them, an illusion which might even be controlled with practice.

### ***Sensory deprivation chamber***

Although no specific details of this feature were supplied, we felt that there was an issue with achieving total silence. Our experiences with large stone structures have shown that it can be quite difficult to totally mask loud sounds such as drumming, so it is worth considering whether this room is intended to be totally isolated or whether faint sounds or vibrations might be felt within. Obviously, this is rather dependent on activities in the main chamber.

### ***Camera obscura***

Again, no details were supplied, but it might be worth confirming that an acceptable image can be achieved in the size of space that will be available. We are not sure of the lenses required and their focal length, but there is a possibility that the resulting image could be rather small.

### ***Air exchange***

An issue which will be investigated in relation to prehistoric sites is the degree to which fresh air reaches the chamber. If these spaces were occupied by groups of people and fires were burnt for light (there is good evidence for this from Orkney) it seems likely that a degree of oxygen debt might have been experienced – especially in those instances where the passage was blocked. We are not sure of how to calculate air exchange within these structures, but wondered if it might be a factor that you should consider in relation to the Earth Mound. It might have implications for the safety/comfort of participants. It is also possible that scents and smells e.g. from organic matter, might accumulate within the chambers.

## 2. Helmholtz Resonance

### *Chamber/passage proportions*

If you are interested in reproducing the Helmholtz resonance that has now been demonstrated at Maeshowe and is suspected at other passage graves, remember that the ratio of the dimensions has to remain similar. For example, any reduction in the size of the chamber would require an equivalent reduction in the passage, potentially making it too small to access.

While Helmholtz Resonance will occur in any structure that has an enclosed vessel and a passage, it can be very difficult to predict precisely what the resonant frequency will be.

### *The wind and thunderstorms*

Dave Keating was especially concerned about possible implications of building a Helmholtz Resonator with regard to the design of the entrance. If wind is able to blow directly across the entrance, this might excite substantial resonances within that might be detrimental to the kinds of experience you are trying to achieve. Large amplitudes between 10 and 20 Hz in particular could make participants feel ill and uncomfortable. A possible solution would be to shelter the entrance in some way to prevent this, and the concave entrance arrangement you have shown in your plan might also help to reduce the effect of wind.

We also feel that there might be problems with thunderstorms (and earthquakes too), which excite large amounts of low frequency sound, even when they are distant and inaudible. We would certainly be very cautious about spending time in a passage grave during a thunderstorm, especially while we do not have empirical evidence of what the effects might be.

### 3. Construction and materials

We were a little concerned about your plans to use concrete in terms of its aesthetic effects. A great deal of the experience of prehistoric sites is constituted from their use of stone – in particular, the combinations of shapes, colours and textures – often carried to the site from significant places in the surrounding landscape. You have mentioned that images would be incised or painted onto the walls, but we feel that you should pay particular attention to avoiding the rather bland appearance of concrete and the associations it can have with modern forms of architecture and civil engineering.

Have you considered using a breeze block mode of construction rather than pre-cast concrete. This would allow the site to be progressively constructed *in situ* and might allow effects such as corbelling to be reproduced, capturing the stepped appearance of most of the prehistoric sites. A skim of plaster or dry stone walling could be used to conceal the blocks and this could be incised or painted with images. It is interesting that part of the significance of the prehistoric sites may well have been bound up with their construction as a process in itself – an act to which a wider community actively contributed. Have you thought about this aspect in the construction of the Earth Mound?

In terms of acoustics, we have had a great deal of success with building a scaled down model of a site in wood and experimenting inside with loudspeaker testing equipment. This has proved a reasonably reliable method for predicting basic effects in the full size site. From your perspective, a model might also be used to experiment with the visual appearance etc. There is now a potential to visually simulate architecture with relatively inexpensive computer software, but our understanding is that acoustic modelling in this way remains expensive and problematic.

## Concluding comments

From our experiences the most dynamic and impressive acoustics effects relate to standing waves. While these are fundamental to acoustics, they are so rarely explored in the modern world (indeed, they are undesirable to most architects). The peculiar nature of these sounds and their ability to transform an environment has never failed to impress us.

Helmholtz Resonance remains a rather less certain phenomenon. While we have measured it within Maeshowe, it was not present during identical tests within Newgrange. This was probably due to the fabric of the Irish monument being rather less air tight – indeed a breeze can sometimes be felt blowing through the chamber. In contrast the Maeshowe chambers are sealed within a mound of compacted clay. The significance of Helmholtz Resonance in prehistory remains uncertain. The best we can say at present is that it might have contributed to the ‘special’ qualities within some sites, but may not have been an intentional aspect of their design. With our own research, a great amount of work remains to be done on the possible impact of infrasonic sounds upon people within these monuments. So little is known about their impact that it is difficult to say precisely what the effects might be – and they may vary considerably between individuals. All we have been able to say at present is that published psycho-acoustic experiments in relation to road transport and air travel have suggested that such sounds can, in some instances, alter consciousness. However, we cannot be certain how this relates to your own intentions in relation to Earth Mound and how you hope to utilise Helmholtz Resonance. We feel that you should consult specialists in these fields.

Over the past ten years of working with the acoustics of megalithic monuments, the most striking aspect to emerge is the way in which sound integrates with other aspects of the experience of these places. They are truly multi-sensory, and we feel that it would not be appropriate to consider any of the senses in

isolation. This is not to suggest that you should avoid emphasising sound in your designs, but to suggest that there will always be compromises and unexpected effects. We cannot be certain of the extent to which all of the experiences of prehistoric sites were deliberately intended 5000 years ago, and we do not know how they were interpreted and understood.

We wish you luck with the project!

### **References for plans**

Davidson, J. and Henshall, A. 1991. *The chambered cairns of Caithness*. Edinburgh: Edinburgh University Press.

RCAHMS. 1946. *Orkney and Shetland 2: Orkney*. Edinburgh: Royal Commission on the Ancient and Historical Monuments of Scotland.