The Recumbent Stone Circles of Aberdeenshire

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Archaeology, Design, Astronomy and Methods

By

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Cambridge Scholars Publishing

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This book is dedicated to:

Dr Joan J Taylor (1940-2019)
Dr Aubrey Burl (1926-2020)
"*What was once considered on the fringe of archaeology, now becomes mainstream*"

and to Rocky (2009-2020)
"*My faithful companion who walked every step of the way with me across the Aberdeenshire landscape*"

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Finally, last but not least, special thanks to my wife, Carole, for her patience, assistance, companionship, and providing all the "packed-lunches" for our solitary picnics at many of the stone circles within the beautiful, sacred landscape of Aberdeenshire.

INTRODUCTION

Dotted across North-east Scotland are the extant remains of 71 prehistoric stone circles referred to as Recumbent Stone Circles (RSCs); so called because, when originally built around 2500 BC, they all contained an outlandishly large stone that was deliberately laid flat in the southern quadrant of the stone circle. All of these circles were built across the Aberdeenshire landscape but only a few remain today (see Table 5-1 for list of sites). A recent survey confirmed that the 71 RSCs still survive and it is also possible that the remains of a further somewhat ruinous 85 stone circles could fall close to being classed in the recumbent category (Welfare 2011, 272-8). Of course, 4,500 years ago, other architectural styles of stone circles were built across most of the British Isles; however it is the presence of the huge recumbent that is laid flat and lodged between two upright standing stones (referred to as flankers) that makes this style of architecture unique (Fig. 0-1).

Much has been written and debated about the architectural style of the RSCs, especially regarding the connection between a circle's southerly positioning for the recumbent stone and its astronomical association with the midsummer full moon. No doubt it has been the presence of the monstrous recumbent and its link with the southern horizon astronomy that has attracted most of the attention. As such, many researchers have tended to focus their attention predominately upon the RSC's association with astronomy. Unfortunately, what I have found lacking with these astronomical propositions is that, though they explain very well the link between a circle's recumbent stone and the astronomy, they do not describe how the circle was originally set out in order to capture the astronomy. Alternatively, a small number of other researchers have investigated how these circles could have been designed. But their solutions, in my opinion, are far too difficult to follow or work out without resorting to complex geometry. Undoubtedly, such solutions that involve both anachronistic astronomy and mathematics are often challenged by archaeologists as going beyond the mental capabilities of the Late Neolithic communities of Aberdeenshire.

Fig. 0-1. Midmar Kirk RSC: the recumbent and its flankers. Note the chocking stones underneath the recumbent which were used to keep it perfectly horizontal.

In this book, I present the findings from my own original research using experimental archaeology with lengths of rope at the RSCs. I am confident that the results of my experiments can explain a great deal as to how these marvellous stone circles were not only designed, but how they also captured the astronomy. In brief, I will explain how the original builders used a practical operation of field geometry with lengths of rope to construct such magnificent stone circles. Additionally, I will provide instructions so that the reader can test my findings for themselves.

Importantly, the reader need not be a qualified astronomer, mathematician or surveyor to follow my instructions. In fact, I sincerely hope that the reader will visit the case studies mentioned in this book and test my theories. All that is required is that reader can fold lengths of rope, measure the sun's shadow at midday and count on their fingers. Certainly, experimental archaeology using lengths of rope to test my results at the stone circles is a fun way of investigating these prehistoric measuring systems and their associated astronomy.

Therefore, before I begin with an overview of the forthcoming chapters, I should briefly discuss the nature of this book. Undoubtably, this book is not

a general, archaeology book about the RSCs of Aberdeenshire per se. Rather it is a book specifically about the design, astronomy and methods associated with constructing an RSC. Furthermore, the scant remains of internal features, such as the disturbed central cairns and ruinous, stony-platforms that are often found inside these circles are not discussed here. Thus, the focus of this book being solely upon the circle stones, flankers and recumbents. Nor is this book just a theoretical thesis. Rather, as stated above, it provides a practical set of instructions for others to physically test my ideas. Of course, I realise that not every reader will have the opportunity to visit Aberdeenshire. However, I still believe that there is a way to test my ideas. That is, by studying both the finger reckoning mathematics and the geometry associated with the design of these stone circles which I offer. Indeed, by following my geometrical reconstructions one will be able to produce reconstructed, scaled site plans for those case studies presented in this book. So much so, you could draw-up these plans or even reconstruct them without the need to visit Aberdeenshire. Now, having clarified the nature of this book, let me move on to an overview of what follows in the forthcoming chapters.

In Chapter One, I introduce the practical methods which I use for my experimental archaeology. The idea that prehistoric monuments (especially stone circles) were deliberately designed is not a view widely accepted across academia and, in this chapter, I highlight the two opposing arguments before I offer my own views on the subject. I then lead on to discuss why the RSCs of Aberdeenshire offer fantastic case studies for consideration. Finally, I conclude the chapter with a discussion explaining how experimental archaeology can provide solutions as to how the prehistoric communities could have planned their monuments using rudimentary methods, methods which I believe were within both the mental and physical capabilities of the communities who built the stone circles: that is, they followed the same concept of folding lengths of rope, measuring the sun's shadow and finger reckoning as I have asked of the reader above.

Chapter Two looks at the archaeology of stone circles in general. If it were not for the presence of the colossal recumbent, then there would be little to distinguish an RSC from any other type of extant stone circle found elsewhere across prehistoric Britain. Therefore, it would be prudent to provide some context as to how these Aberdeenshire circles fit into the "family" of the other thousand or so surviving stone circles spread out over the British Isles. Chapter Three then discusses the archaeology directly associated with the RSCs of Aberdeenshire. The important questions to consider with both these chapters is what archaeology can tell us about these

circles and, especially, the RSCs. For instance, how were they built? When were they built? What were they used for? Why were they built?

Chapter Four leads the reader into the findings of my experimental archaeology relating to design. Simply put, prior to the construction of a stone circle, the builders used a length of rope to set out on the ground the circle's diameter and then they folded that length of rope into shorter proportions in order to perform other tasks associated with building a circle i.e. such as identifying the positions for where the stones would stand (as well as measuring the distances between each stone). Then, folding that same length of rope, the builders could both determine the dimensions of the individual stones as well as digging appropriately sized holes for those stones to stand in. The whole concept of this type of measuring works around proportions or ratio. The chapter then ends by exploring an interesting theme as to how a prehistoric workforce could have been both supervised and organised during the construction of an RSC, i.e. was it possible that they were using a prehistoric "division of labour".

Chapter Five continues with the theme of design, proportions, and ratio, but this time its attention focuses upon the megalithic recumbent stones. Continued archaeological experimentation at these RSCs has uncovered a mathematical connection between a circle's diameter and the length of its respective recumbent stone. In short, there is a proportional relationship between a circle's diameter and the length of its recumbent. After discussing this important discovery, I provide the reader with some case studies to enable them to investigate this relationship for themselves, by simply using a tape measure.

Chapter Six looks at the astronomy. It will not be necessary for me to review all that has been previously said about the astronomy associated with these stone circles as I do not intend to challenge any of the work of the previous researchers, a brief summary will suffice. Rather, I will concentrate on presenting my own original findings which, I believe, contribute further to the astronomy associated with the RSCs. One of the main objectives of this chapter is to bring to the reader's attention a repeated, geometrical pattern found amongst the ground plan of an RSC; this pattern consists of four of the circle stones that, if they were to be joined by imaginary straight lines, would form a rectangular pattern which is comparable with Stonehenge's famous Station Stones rectangle. I refer to the Aberdeenshire pattern as the *"Station Stones rectangles of Aberdeenshire"* and, significantly, these Scottish rectangles capture the same astronomical alignments as not only one and another, but also those at Stonehenge.

Chapter Seven returns to the concept of design and considers the actual shapes of the stones. I believe that the standing stones (or orthostats as archaeologists refer to them) selected for building an RSC were not just randomly picked out of the landscape. No, the stones were specially chosen for their shape. Shapes that must have held some important, symbolic significance to the eye of the beholder. Undoubtedly, Chapters Five and Six substantiate the fact that the orthostats were picked out for their dimensions, but this chapter goes further, it was also their shapes that were important. Obviously, they must have provided "visual" information as to what their symbolic functions represented? Perhaps today we can only take an educated guess as to what these symbolic functions were, but the main objective of this chapter is to help the reader to recognise the most recurring shapes for themselves.

Chapter Eight continues with the theme of astronomy, but this time the chapter looks at the wider astronomical alignments that link each of the RSCs together into a vast, astronomically-aligned network that covered the entire Aberdeenshire landscape. I will describe how Global Positioning Satellite (GPS) technology substantiates the statement that these stone circles were, firstly, set out in "longer" alignments across the landscape, joining them all in a regional network of alignments. Secondly, the orientation of these "longer" alignments corresponded to the very same astronomical alignments associated with an individual circle's station stones rectangle (which I discuss in Chapter Six). So, if a person followed the directions of a stations stones' astronomical alignment from one stone circle and then set off walking in that very same direction across the landscape, they would be travelling along the route of the "longer" alignment and eventually they will arrive at another stone circle, which itself would point towards further RSCs. One of the implications of this observation is that the circles could synchronise both time and direction across a very large and broad area of the landscape. In short, this network of RSCs enabled the people to observe the same calendar: thus, allowing the potential for them to meet at specific times of the year and at precise positions in the landscape.

No doubt this network of inter-aligned stone circles would cater for several socio-economic functions such as facilitating trade and exchange, coordinating the days for markets as well as various sacred, ritual ceremonies. But who was building these RSCs so that they were astronomically aligned towards each other? The answer to this question is difficult, more so because of the absence of substantial archaeological evidence. However, I will present in Chapter Nine an interesting narrative that, hopefully, goes some way to answer the question as to who was building these circles, and how they

managed to develop such an array of inter-aligned stone circles. Positively, using such a narrative allows me to not only assume the role of a "specialist builder" but also discuss the resources that such a specialist could have utilised during the Late Neolithic. Indeed, could it be that a single individual supervised the building of all 71 RSCs?

Finally, I provide two Appendices. Appendix A provides worked-out examples showing how to calculate the "important" angles of azimuths for the rising and setting positions of both the moon and sun during the Late Neolithic for Aberdeenshire. If the reader has access to a scientific calculator then following my instructions should not be too difficult a task.

Appendix B is, perhaps, the most interesting "section" of this book. Basically, I will be providing a script for the reader(s) to perform for themselves using some simple techniques of experimental archaeology at the Easter Aquhorthies RSC. The script will guide them to look at elements of design, units of measurement and astronomy. For instance, using measured lengths of rope they could test the concept of ratio, whereby a length of rope used for setting out the diameter of the circle is proportional to the length of the recumbent stone. Additionally, one can check that by standing at one particular stone and looking toward another stone, you would then see an astronomical event at a certain time of the year (as well as looking in the direction of other RSCs that Easter Aquhorthies is aligned with). That is not all! They can see how the shapes of the orthostats at this stone circle are repeated at other stone circles. And there is more, but I will leave the rest till Appendix B.

I state that Appendix B may in fact be the most interesting "section" because I would recommend to those readers who live either in the Aberdeenshire area or are currently visiting this area on holiday that they have a go at performing these practical demonstrations first and then use the rest of the book to catch up on the theory. Otherwise, for those who plan to visit the area, then read the theory first and make haste in all preparations to visit Aberdeenshire and perform these experiments during your stay in this beautiful landscape. Without a doubt, the people living across modern day Aberdeenshire are fortunate to have such a rich, prehistoric heritage network of inter-connected stone circles on their doorstep.

The use of Imperial and Metric measurements and the degrees of accuracy

I do need to clarify the use of some conventional terms that I shall be using throughout this book. In the first instance, I shall be using the imperial

format for presenting both my "shorter" and "longer" units of measurements, followed, where applicable, by their metric equivalents. Alternatively, for my GPS measurements, I revert to using the metric format. Hopefully, as it will become clear, I have chosen this format simply for convenience. I have used the imperial format because it is physically easier to read (at least for me) feet and inches from a tape measure (when crouched over) than it is to read centimetres and millimetres, especially when the tape measure is being used in wet weather and stretched out to measure the longest length of a "bulbous" recumbent stone! In no way am I implying at all that the British prehistoric communities were using a similar imperial measuring system (or its equivalent metric system).

Regarding the accuracy of both measurement and orientation data presented in this book, I should also point out the difficulties of measuring those standing stones that have stood in the ground for over 4500 years. Whilst I have meticulously surveyed the extant stones, measuring both their dimensions and the distances between each orthostat, it is a task not without its difficulty. The stones do lean, the ground upon which they stand swells or sinks depending upon factors such as rainfall, and their bases are not smooth and straight-edged; they bulge, lean and buckle both inwards and outwards. Also, for measuring orientation and direction, when standing and looking at a "target" from one side of a standing stone, as opposed to the other side of the same stone, can create a variance of one or two degrees of azimuth with either a prismatic compass or a theodolite. As such, I introduce a degree of tolerance (or a margin of error) with my presented data; thus for measuring the longitudinal baselines of the individual orthostats, these measurements are listed at plus or minus half an inch (measurements being taken at the base of the orthostat). For both the "longer unit of measurement" (i.e. the distances between the stones), and for the measurements of the length of the circle's respective recumbent stone, they are presented at plus or minus one inch; similarly, for both heights of the stones and the diameters of their respective circles, an error rate of plus or minus one and a half inches is also applied. For GPS data, this is shown at plus or minus 1-degree azimuth (orientation being based upon the direction of true north) and the GPS distance measurements are provided at plus or minus 10m.

Site and stone numbering

There are a variety of stone numbering systems used in some "older" publications for the site plans of RSCs (e.g. Thom 1967; Burl 1980). Archaeologist Adam Welfare has now provided a recent re-assessment

following his surveys of the extant 71 RSCs; as such I follow his numbering systems as published in his book *The Great Crowns of Stone* (Welfare 2011). Basically, it works this way: stand in the centre of the stone circle and look directly towards the recumbent, if the flankers are present then the flanker on your right is always numbered stone no 1, the recumbent is then numbered stone no 2, the other flanker (on your left) is stone no 3 and the rest of the circle stones (stone no 4 onwards) follow in sequence running in an anti-clockwise direction (Fig. 0-2).

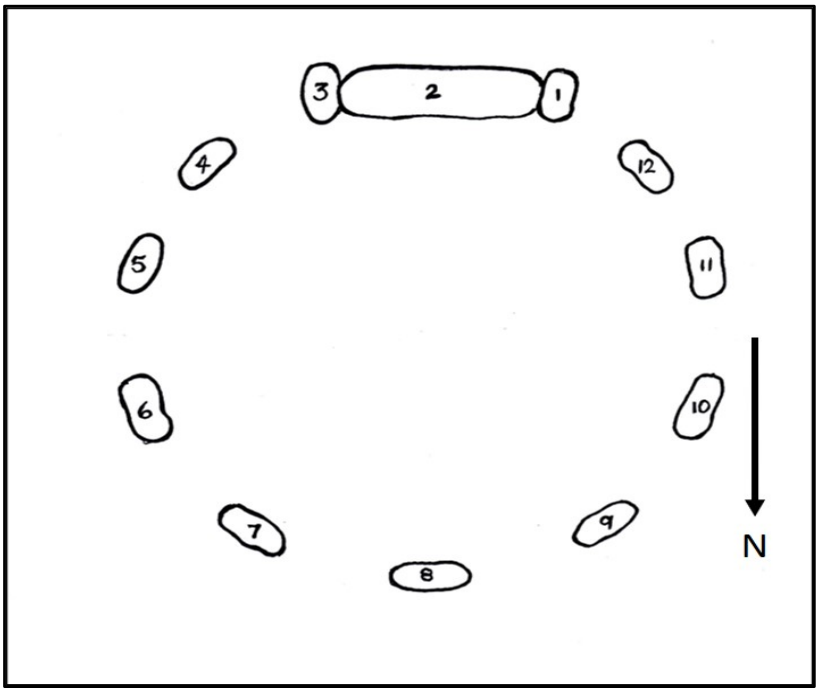

Fig. 0-2. The typical numbering sequence for the orthostats at an RSC. Drawn not to scale.

CHAPTER ONE

METHODS PART ONE: OCCAM'S RAZOR AND TROTTER'S DILEMMA

In this chapter, I start my deliberation by asking whether the construction of British prehistoric stone circles was the result of intentional planning. I then lead on to clarify the reasons as to why I think that the RSCs of Aberdeenshire make an excellent case study to support the argument for deliberate design. After that, without injecting too much complexity into my experimental archaeology (in other words, I offer my "Occam's Razor Solution"), I mention the three experimental methods which I use to demonstrate how the Late Neolithic people of Aberdeenshire could have designed their stone circles using relatively simple, rudimentary methods and yet achieved quite sophisticated results.

Neolithic Architecture: Designing a monument that was fit for purpose

From the beginning of the British Neolithic we see the construction of earthen, timber and stone architecture on a scale never matched before 4000 BC (Bradley 2007, 33): a practice that was not only adopted across the British Isles but one that continued for a period of about two and a half thousand years, taking us well into the Bronze Age, *circa* 1600 BC (Scarre 2007,7). Although the architectural forms of these structures varied considerably they can be classified into a number of styles: earthen and megalithic long barrows; passage graves; long cairns; cursuses; stone and timber lined avenues; causewayed enclosures; stone circles; timber rings; henge-circles; mortuary enclosures; and round and oval shaped barrows. Providing a total as to how many of these structures were built in Britain during this period of two and a half thousand years is not possible. Estimates can sometimes be only as good as a guess, but I would agree with archaeologist Andrew Fleming that we are looking at a total somewhere in the thousands (Fleming 1973). And this total does not include the hundreds of domestic structures, such as houses, that were also built during this period.

No doubt, most of these structures were constructed for the purposes of some very complex, sacred activities to take place (Scarre 2007, 23), but they were probably also used for profane purposes as well. For example, archaeologist Aubrey Burl presented a convincing argument proposing a link between the proximity of early British stones circles in relation to Neolithic stone axe factories, with the former being used as formal, recognized places for trade and exchange with the latter "industries" (Burl 2000, 95-102). Additionally, archaeologists John Barnatt and Vicky Cummings have suggested that ritual monuments such as henge-circles were designed to bring together large groups of people for social gatherings (Barnatt 1989,3; Cummings 2008, 144).

If these researchers are right, then Fleming is also correct when he states that the formal architecture of a monument had to be precisely designed so that its appearance visibly indicated the specific types of rituals that could be legitimately held there (Fleming 1973, 189). Accordingly, the design and construction of any monument would have had to been well thought out: its physical appearance had to meet the expectations of the people; anything less would not do. All in all, one is led to consider the possibility that monument construction was the result of deliberate, intentional planning and that the builders were working to specific plans. Therefore, it should be possible to identify archaeological evidence to support this statement.

However, seeking such evidence is not as easy as it may sound. The British Neolithic communities were a preliterate culture and they have left behind no schematics or written records as to how they designed and built their monuments. Indeed, archaeologist Richard Bradley expresses caution when he states that researchers investigating the remains of prehistoric monuments for evidence of intentional design face a few difficulties. Firstly, the researcher is possibly looking at the final form of a structure that might have been periodically modified many times. Secondly, even though he or she may recognise similar architectural styles amongst a certain range of monuments, the similarities between them could just as well be explained by fortuitous developments created along separate lines (Bradley 2007, 46).

For sure, Bradley's comments are made from the advantage of hindsight, based on knowledge which has accumulated from the numerous archaeological excavations that have taken place and continue to do so in modern times. Unfortunately, such knowledge was not available to those earlier scholars who have attempted to explain the involvement of purposeful design within the construction of British prehistoric monuments. Often charged with projecting their own intuitive ideas onto the prehistoric

architecture, some scholars have debated solutions as to how they were designed. In fact, since the seventeenth century the subject has been one of "hot" debate. As a result, there are today two opposing views about how a monument's design can be explained. On the one hand, it is seen to be the handiwork of specialist engineers (e.g. Thom 1967). Alternatively, it is seen as requiring no planning at all. Instead, the setting out of a monument's design could have been achieved simply by eye (e.g. Barnatt and Moir 1984). Surprisingly, both these opposing views continue to influence the way researchers think about this subject. But I believe that there is much more to consider before we decide one way or the other regarding the question of calculated design. Unfortunately, space prevents me from presenting a full account for all the Neolithic architectures I have studied using my experimental methods. Therefore, I shall confine my discussions to the RSCs, a distinctive class of stone circle of which the remains of 71 can still be seen across Aberdeenshire.

The RSCs: An excellent choice for case studies

There are good reasons for choosing these stone circles, both archaeological and geographical. Firstly, they were built during the Late Neolithic, around 2500 BC, and they have been described as one of the most distinctive categories of megalithic architecture in the British Isles (RCAHMS 2008, 59). Geographically, they are confined to a remote corner of North-east Scotland, perhaps residing in a "Late Neolithic-pocket", isolated by the imposing Grampian Mountains to the west and the North Sea to the east (see Fig. 1-1). Thus, (in my opinion) they could have developed an insular style of architecture without minimal "outside" influence.

My second reason is that many of the circles are in good states of preservation; thus, making them convenient case studies for the reader to visit and validate my findings for themselves. And it is here that I hope I can tempt the reader to perform their own fieldwork. I will be introducing some "very user friendly" techniques which require little knowledge or practice of either surveying or archaeo-astronomy (the technical term used by archaeologists for studying a prehistoric culture's reliance upon the sun, moon and stars as a practical resource for determining their ritual ceremonies and agricultural calendars). Certainly, no expensive equipment is required: a tape measure, lengths of rope, a prismatic compass, and either a GPS handset or alternatively a suitable "mapping" app on one's mobile phone will do.

Fig. 1-1. The general location of the RSCs of Aberdeenshire.

Tackling the anachronisms: Trotter's Dilemma

Every now and then I receive, via my Liverpool University email address, correspondence from researchers living around the world and their messages are generally about ideas as to how British prehistoric monuments might have been astronomically and / or geometrically designed. Undoubtably, these ideas are interesting, but occasionally I feel that I must ask myself how well some of them would stand up to a concept that I refer to as "Trotter's Dilemma".

An important question I always ask of my own experimental methods, as well as those from other researchers, is whether or not any geometrical or astronomical solution for explaining Neolithic architectural design could be

physically tested without the aid of either modern survey equipment or pen and paper to "work things out" (of course, using pen and paper automatically assumes that one is literate, which the Neolithic communities were not). My Trotter's Dilemma developed out of a question that was posed in a paper as far back as the 1920's when the scientist Alexander Trotter questioned the likes of the astronomer Sir Norman Lockyer about his computations regarding Stonehenge. Indeed, Trotter asked:

> "What instruments did they use?...surely..that no astronomical knowledge, no calculation, no mathematical instruments, no acquaintance with geometry or surveying was needed. Lockyer brought a theodolite with verniers and magnifiers capable of measuring 360 degrees of a circle, the 60 minutes of each degree, and the 60 seconds of each minute, and large scale Ordnance maps, observations of the North Star, corrections for the level of skyline, and for refraction and parallax, in order to make observations… It may be asked: - What did the builders of Stonehenge know of such refinements, and what instruments did they use?" (Trotter 1927, 53).

I approach the Dilemma in two ways. Firstly, how do we explain the methods used by the Late Neolithic builders when they went about designing complex monuments such as Stonehenge or an RSC, especially without them having access to modern surveying materials. Secondly, once a monument like Stonehenge or an RSC was built, then how did the Late Neolithic communities relate to that structure and know what to look for? For example, when I visit an RSC today, I will use my prismatic compass to identify the cardinal points, monitor my GPS handset to confirm my latitude and then utilise both astronomical data tables and a scientific calculator in order to tell me where and when the sun would rise and set, say sometime during 2500 BC (See Appendix A). But what astronomical knowledge would a "prehistoric" person possess? How would they know where the sun and moon rose or set? Two questions I will return to later in Chapter Seven.

Experimental Archaeology

In this book I will be proposing that the builders of the Late Neolithic RSCs were using some medium of rope to facilitate the design and construction of their stone circles. Essentially, the rope was used for the purposes of measuring and setting out on the ground the design of a ring of stones. This is of course a hypothesis because I have no evidence that I can offer to prove that the people of prehistory were using rope in this manner. Therefore, to support my hypothesis, I will present the results my "rope experiments" conducted at the RSCs whereby I have successfully recreated their designs

using lengths of rope. But the important question to ask here is whether or not my rope experiments were conducted in the proper, scientific manner and the answer to this question is not easy, as it raises another question, what is the proper, scientific manner for conducting Experimental Archaeology?

According to the Experimental Archaeologist John Coles (1979, 1), archaeologists use many techniques in their attempts to both understand how people lived and why they behaved as they did. One way in which archaeology can reach back and experience this type of behaviour is by experimentation or as it is formally called, Experimental Archaeology. As Coles explains:

> "By building copies of houses, palisades, and fortresses we can appreciate better the scale of ancient enterprise, and the organisation of labour required…and by trying to actually live as our ancestors did, by experiencing the concerns of the past, we may become aware of our prehistory" (ibid).

Hence, my experiments can offer an opportunity for researchers to gain an appreciation of what cognitive abilities the Late Neolithic communities of Aberdeenshire used when building their RSCs. They can then use that experience to acquire a better understanding not only to the technical abilities used during design and construction but also the reasons why the builders chose one course of action as opposed to another (ibid, 2). Now, having defined how useful experimental archaeology can be, I return to the question of how to perform my rope experiments in the proper, scientific manner. Fortunately, Coles (ibid, 46-7) has also defined several "rules" or guidelines, some of which I have used to not only regulate and control my experiments, but these same rules also help me to satisfy my own Trotter's Dilemma:

1) The materials employed in the archaeological experiment should be those considered to be originally available to the society under examination: in my case I propose that the people were not only capable of making rope, but that they were also using it for the purposes of measuring and setting out, and I will expand upon this method below.

2) The methods used in the work should be appropriate to the society and should not exceed its presumed competence: in my case, the important point to remember here is that the Late Neolithic communities were preliterate and so I have avoided using any form of mathematics or astronomy that needs pen and paper to work "things" out.

3) Repetition of the experiment is important in order to avoid a freak result: this is the fundamental rule of all scientific experimentation and for this reason I have provided instructions to allow the reader to repeat my experiments and validate the results for themselves.

The Occam's Razor Solution

There are three experimental methods which I use to explain how rudimentary methods (which I believe the prehistoric communities used to design their stone circles) can produce impressive, sophisticated results. I refer to these methods as my Occam's Razor Solution (Hill 2009d). Scientists use the principle of Occam's Razor when they are faced with a quandary: the principle relates to the idea that given any number of theories that can equally explain the data (in our case, the various astronomical / mathematical theories associated with designing stone circles), then the preferred solution is often the one that involves the least number of variables i.e. the simpler, the more likely the solution (Snow and Brownsberger 1997, 6-7). Of all the various experimental methods I have tried for reconstructing stone circles (e.g. pacing, yard sticks, gauging by eye, etc.) as well as avoiding anachronistic astronomy and mathematics (i.e. not resorting to the Iron Age Greek geometry), I eventually settled upon my three "Occam's Razor" methods; there was just no simpler way of "doing things" that I could think of. The first experimental method proposes that the Late Neolithic people of Aberdeenshire used lengths of rope to set out the design of their intended stone circles. My second method states that they orientated the design of their circles by using the sun's shadow as cast at midday in order to identify the direction of true north. The final method accepts that the people used a rudimentary form of finger reckoning for calculating how their ropes should be folded when setting out their stone circles.

Method one: the use of rope for setting out

Method one purports that the builders of not just the RSCs but other styles of stone circles elsewhere were using lengths of rope for setting out their circles. But I have no archaeological evidence to confirm this statement. My conclusion is based upon the results of my experimental archaeology. Certainly, it can be accepted that the people of the Neolithic and Bronze Age were making rope. Perhaps the earliest evidence for the use of ropes during the British Neolithic can be implied from the numerous attrition marks found at the Cissbury, Grimes Graves and Blackpatch Neolithic flint mines, *circa* 4000-3000 BC (Russell 2000, 105-6). Although the precise

material of the rope used at the flint mines remains unknown, they were used to assist with the transport (in wooden buckets) of quarried flint from the deep shafts to the surface. These early ropes were most likely made from either animal sinew or plant-based bast (Burl 2002,159-60), but unfortunately the fragile materials from which the ropes were made rarely survive in the archaeological record (Renfrew and Bahn 1998,316). However, we are fortunate to have a few surviving ropes from prehistoric Britain. One example includes the bast rope (*circa* 2010 BC) made from Honeysuckle which was found tied to a tree-trunk at the Norfolk "Sea-henge" (Pryor 2001, 264); whilst another rope was found still attached to the remains of a wooden bucket from the Bronze Age Wilsford Shaft (*circa* 1800 BC), Wiltshire (Richards 1996, 119). Undoubtably, the physical use of rope as a tool for setting out is not an activity that would leave an imprint in the archaeological record. However, due to the circularity of both the stone circles and henge-circles it is reasonable to assume that a peg and rope technique was used. Such an assumption led archaeologist Richard Atkinson to propose that parts of Stonehenge's earthwork were marked out in this manner (Atkinson 1986,103-4). My own experimental archaeology substantiates Atkinson's assumption that rope was used in this way at Stonehenge (Hill 2009d). But how does this assumption translate into reality? And what do I mean by using ropes for setting out and measuring? At this early stage of this book, I think it would be prudent for the reader to formulate in their minds a conceptual image of what I mean by both setting out and measuring with lengths of rope. Therefore, I recommend to the reader that they view my freely available, online YouTube video *"Ancient Knowledge: the sacred geometry behind British Stone Circles"* (Hill 2013). A short documentary showing me performing experimental archaeology at the Neolithic Arbor Low henge and the Nine Ladies stone circle, both of which are located in Derbyshire. I realise that the Derbyshire monuments are different in the architectural styles to that of the RSCs, but the principle of using rope as a surveying and measuring tool remains the same.

Interestingly, there are several historical-ethnographic examples demonstrating how rope was used as an ancient surveying tool and I shall briefly summarise two of them, one from Egypt and the other from India. In Egypt, we can safely assume that ropes were used for measuring at least as far back as the Eighteenth Dynasty, *circa* 1550-1291 BC, as we have pictorial reliefs of the Egyptian Rope Surveyors in action (Arnold 1991, 252). Just what materials the Egyptians used to make their ropes remain unknown but the historical Greek scientist Hero (*circa* first century AD) records a technique which the Egyptians used to prevent their measuring ropes from stretching and thus avoid any unnecessary errors manifesting into their measurements.