

## INTRODUCTION

### Measure: Towards the construction of our world

*Colin Renfrew and Iain Morley*

It was a profoundly significant step when, in the remote past, a human being, in undertaking an act of measurement, formulated the notion of measure. For to measure – whether in the dimensionality of weight, or of distance or of time – is to develop a new kind of material engagement with the world that is at once practical and conceptual. It is an act of cognition – a cognitive act. Such an act has philosophical implications, for measurement allows us to transcend the limitations of the here and the now. It involves observation, and it facilitates construction. It encapsulates the seeds of mathematics and of science. It makes possible architecture and design. It is the basis for systematic observation and prediction. It leads on towards astronomy and cosmology. It is the basis for any complex economic system. It is one of the foundations of all urban civilisations.

This volume, arising from the Roots of Spirituality project conducted at the McDonald Institute for Archaeological Research, sets out to explore the new and creative relationships with the world implied by the first deliberate development of measurement and of systems of measure in the early days of the human story.

The theme was chosen as a means of investigating, at a global level, some fundamental issues in the origins of human cognition in the early days of the different trajectories of cultural development. These issues bear upon the very process of becoming fully human in an increasingly complex world.

#### The dawn of human cognition

How does one define what it is to be human? What special qualities distinguish the human species from other animals? And how does one set about tracing the origins of those special qualities back through time to the origins

of humankind? Or, reversing the process of inquiry, how can one detect the first emergence of those special qualities in the material record that has come down to us from prehistoric and from historic times?

These are questions that must occur to anyone who contemplates the human story in a wide perspective. At once it is clear that these are not easy questions to answer. For among the first responses must be the observation that communication by means of a fully developed language is a feature of all human societies and of none other – even though students of animal behaviour can show that members of other species do communicate in an impressive variety of ways. If we could trace the origins of language from the earliest times, we would certainly be outlining the development of one important element of what constitutes the human condition.

Yet, in reality, language was not directly recorded until the inception of writing, just over 5,000 years ago. That is a relatively recent period. It does not take us far enough back in the human story, which extends back over at least 150,000 years. So we have to look for evidence that will take us further. That inescapably leads us to the field of prehistoric archaeology. For prehistory deals with the human past before written records are available, and archaeology deals with the investigation and reconstruction of the past on the basis of its material remains.

The archaeologist can ask the big questions – when did language develop, when did self-consciousness emerge, what were the first coherent belief systems, when were religion and ritual first practised, when did the first artists create painting and sculpture, when did the first musicians play? But to answer them with more than mere speculation requires evidence of some kind. And there one must turn primarily to prehistoric archaeology. For it is there that some evidence for and some understanding of the early development of human cognition must originate.

Prehistoric archaeology has its limitations. It is dependent primarily upon the archaeological record – upon the material remains of past cultures and civilisations, where the archaeologist can hope to excavate, and so to find evidence of human activity from the period that is of interest. There may be other sources of relevant information; molecular genetics is certainly one. But in general the procedure must be to dig: to excavate in order to recover those material remains and to make some sense of the archaeological record that emerges.

The task is made much easier, however, by the existence already of a broad outline for the basic narrative of the human story. In *On the Origin of Species*, Charles Darwin (1859) set out a framework that later scholars

including anthropologists have been able to flesh out. The human species is descended from ancestors, in effect apes, who lived in Africa several millions of years ago. We can now say that it was in Africa between 200,000 and 150,000 years ago that our species, *Homo sapiens*, emerged. And expansions out of Africa by members of that species, from around 60,000 years ago, led to the peopling of the world. The first sedentary societies, where communities formed permanent settlements and began to practise farming, were founded some 10,000 years ago. The first cities, with their more sophisticated way of life, emerged nearly 6,000 years ago, and in some cases their development was accompanied by the inception of writing.

It is among the material remains of these early activities that evidence relevant to the big questions about the development of humankind, and of the special attributes of humankind, is to be found. And it is the task of contemporary archaeology to explore the cognitive and spiritual dimensions of these developments as well as the purely practical ones.

### The roots of spirituality

In shaping a project, generously funded by the John Templeton Foundation, to seek to define and explore the origins of some of these specifically human qualities, it was first necessary to develop a strategy. The intention was certainly to take a global approach, recognising that by 15,000 BC humans had settled on all the world's continents (except Antarctica). On each, societies followed different trajectories of development. But in the early millennia after the out-of-Africa dispersals, those communities were not in long-distance communication with each other. In some respects they developed independently. So the development in many of them of such specifically human features as art and architecture, as a worldview that in most cases involved the practice of a religion, and of a range of analogous developments including the custom of burial, is a matter of enormous interest. To find a name for such a project was not easy. 'The Roots of Spirituality' was selected as sufficiently vague to cover many areas of interest, yet sufficiently specific to indicate the focus of our concerns.

A first international symposium, devoted to early beginnings in the Palaeolithic period, before 10,000 BC, was held in 2004. The resulting volume, *Becoming Human: Innovations in Prehistoric Material and Spiritual Culture* (Renfrew and Morley 2009), addresses some of the issues touched on earlier. One theme of central interest to the project is the emergence of religious thought,

reflected in the construction of temples or other buildings for the purposes of cult practice. But existing studies in archaeological theory and practice (e.g., Renfrew 1985) have shown how difficult it is to infer the practice of religion from the material remains, unless there are accompanying written records or at least a rich figurative iconography. It is the case that human representations – small sculptures, some of them perhaps regarded as idols – make their appearance in the archaeological record on most continents much earlier than do temple complexes or shrines that can confidently be identified as serving a religious function. So for the first focus of study of the project we decided to examine the inceptions of human representation, on a global basis. Such representations are not necessarily a feature of all religious rituals, yet in favourable cases they may give an indication that religious rituals were possibly being practised, and certainly may provide insights into their makers' views of humans, nonhumans, the natural and the supernatural. The result of this global study of the inception of figurative representation, *Image and Imagination: A Global Prehistory of Figurative Representation* (Renfrew and Morley 2007), is now available. And while it does not set out to resolve the problems of identifying early religious practices in each area under review, it certainly presents much of the evidence on which such an analysis must be based.

For a further component of our project we selected what is perhaps a less obvious element in the development of human cognition: measure.

### Measure and early symbolic relationships

In the development of human cognition, the emergence of symbolic thought is highly significant. Words, of course, are in one sense symbols. The spoken word 'bird' evokes (for a speaker of our language) an image, and if the word is appropriate for several bird species, it implies that a category ('bird') has already been formulated. This degree of abstraction is presumably a feature of all human communities, since all have a spoken language.

To understand the word 'bird' implies some knowledge and experience of the world: you have to have seen a bird to know one. Any notion of measure implies experience of the world in a more involved way. It involves also some notion of equivalence. For to measure some feature of the world means to compare it with some other feature of the world. It implies the formulation of an aspect or quality in respect of which things may be compared: a scale. One obvious example is the notion of 'weight'. If one is to have some measure of heaviness,

one needs to have a sense or vision of two things balancing, being equal in terms of that dimension of measure. The most obvious instance is the balance arm, where a metrical object (which we refer to as a ‘weight’) is balanced at the end of one arm of the scales against the object being measured, placed symmetrically at the end of the opposite arm. The metrical object, if the scales do indeed balance, can be used to represent the specific quantity in terms of the aspect being measured of the object under study. That is the quality (and the quantity) that we call the ‘weight’ of the object under study. And we measure it with standard objects that are frequently also termed ‘weights’.

The use of units of measure can be recognised, in favourable cases, quite early in the archaeological record. They document the construction of symbolic relationships, of the kind just described. Indeed these are among the earliest symbolic relationships that we can recognise. Yet they do not appear as early as the figurative representations discussed in *Image and Imagination*. These are among the earliest cases where we document the functioning of symbols archaeologically. Yet the significance of these new symbolic relationships, implicit in the practice of measure, is vast.

When we review the broad span of human existence, in a broad evolutionary sense, it is possible to speak of two phases of development (Renfrew 2007, 97): the speciation phase and the tectonic phase. The speciation phase represents that considerable span of time, from several million years ago down to 150,000 or 100,000 years ago, when our hominin ancestors were already using stone tools (in the so-called Lower and Middle Palaeolithic periods), but when our own species *Homo sapiens* had not yet fully emerged. With the out-of-Africa dispersals of that new species, some 60,000 years ago, and in particular with the emergence of sedentism, some 10,000 years ago, it is possible to speak of a tectonic phase (i.e. a constructive phase – the name is taken from the Ancient Greek word *teuton* for a constructor, a carpenter). With the development of permanent dwellings and indeed of settled village communities, a new, more constructive span of human existence began, with the development of buildings, property rights and ownership, and of course the origins of agriculture. It is around, or shortly after, this time in most trajectories of development that direct indications of the practice of measure can be observed.

To formulate a notion of measure, and then to formulate a unit of measure in order to quantify, is a very large conceptual step. That observation holds whether we are speaking of the measurement of length or volume or weight or time or of other features such as pitch or

temperature. It represents a degree of abstraction that many will have considered radical. Such a step could at once be highly practical: it was constructive, in the literal sense. In the field of architecture, if you want rectangular rooms you must be able to measure walls of equal length. The notion of planning may well lead to the construction of a model or a plan using the concept of deliberate scale, involving the definition of the specific ratio by which the model must be scaled up to match the intended reality. Measure is a fundamental component of the constructive or tectonic arts.

Considering the use of standard units of weight allows one to define the relative values of commodities – that a unit of bronze may be ‘worth’ (regarded as equivalent to) 100 units of wheat. These abstractions enable individuals and societies to reach out in a systematic way, and to give effective structure to their world.

These abstractions do more than that. In some cases they offer a suggestion, a hint of order in the world. Yet these indications of order in the natural world are difficult to observe and record until we ourselves have developed some concepts of order and of measure. The successive cycles of the Maya calendar, for instance, offer a picture of time flowing steadily forward through a series of eras. Such ideas must first have been stimulated by the practice of measuring time. And they lead on to offer the possibility also that human affairs can be ordered in such a way as to fall into step with the harmonious structure that may have been detected.

Measurement also allows speculation about dimensions on a larger scale than those encountered daily. The measurement of time, in particular, involving astronomical observation and systematic contemplation of the cosmos, often became involved with formulations conceiving of the universe and of the spiritual or religious forces postulated as motivating it. From the stones of Stonehenge to the alignments and calendars of Mesoamerica, measurement stands at the dawn of cosmology. The term ‘cosmology’ is used here not just in the sense of explanation of the celestial, but in the sense of the conception of the universe – the set of beliefs about the world, material and immaterial, and the rules through which interaction with it can occur. Cosmology represents one of the serious attempts by human communities to reach an understanding of their place in the world.

The study of early measure can thus, in favourable cases, bring us close to very early speculations by a range of societies about their place in the world. Such speculation is, of course, an important part of what is intended by the term ‘spirituality’.

The forms and underlying principles of the belief systems of different societies have, of course, formed the

focus of much anthropological research over the last century or so (see, for example, Lévy-Bruhl 1935; Evans-Pritchard 1965; Horton 1993). ‘Belief systems’ can naturally be concerned with all aspects of the world, terrestrial, celestial, natural and supernatural, often without the same distinctions made between those categories as we might make. The relationships between religion and state have formed the stock trade of studies of ancient ‘civilisations’ (and their influence on worldview formed the particular focus of Frankfort et al.’s 1942 monograph); rarely, however, have the relationships between spirituality and measurement activities within those systems been thematically explored, in studies of either recent-contemporary or past societies.

### The archaeology of early quantification and cosmology

It is our intention that this volume explore how the various aspects and implications of measuring activities discussed previously were developed in a broad selection of past cultures from around the world, and to allow comparison of how different or how consistent were the local developments. This book considers, on a cross-cultural basis, the origins and early development of counting and of measurement in a number of different areas of the world and periods of time, using the available archaeological evidence. It grows out of a symposium that took place at the McDonald Institute for Archaeological Research, Cambridge, from 13 to 17 September 2006. In inviting contributions the intention was to achieve coverage of as wide a range as possible of expertise, method, period and place; areas covered include Europe, Mesoamerica, South America, India, China and the Near East, and periods encompassed range from the Palaeolithic through to early history in the different parts of the world. The papers were each read by every contributor in advance, discussed communally at the

symposium, and subsequently revised for this volume by the authors in light of the discussions.

The volume is organised into five sections dealing with different aspects of measurement and cosmology, grouped by linking themes rather than by geography or period: I. Number: Counting, Mathematics, and Measure; II. Materialising the Economy; III. Dimensions and Belief; IV. Calendar and Cosmology; and V. The Spirituality of Measure. Each of these sections features an editorial introduction and, in the case of section 5, some concluding remarks.

It should be noted that there would have been other possible ways of arranging the contributions to this volume, and many of the chapters contain considerations relevant to more than one of the sections. The inclusion of a given chapter in a particular section should not be taken to indicate an absence of content related to other sections in the book; it is indicative of what we have identified as a prominent theme.

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## SECTION I

# Number: Counting, Mathematics and measure

The volume opens with a section that deals with the conceptualisation of number and measurement, how systems of thought and recording impacted upon the capabilities for measurement activities and numerosity in different parts of the world.

Direct archaeological evidence for measurement activities is the focus of the vast majority of the contributions to this book; however, it begins with a consideration of the extent to which measurement capabilities of various kinds are inherent requirements for other activities for which we have archaeological evidence – activities that do not themselves provide *direct* evidence of measurement. Amongst prehistoric hunter-gatherer populations there is no unambiguous direct evidence of numeracy of the kinds discussed in the other contributions to this volume, but many of the activities they carried out would have required various kinds of relative and absolute reckoning, including time, distance and division. This first chapter seeks to deconstruct measuring activities into key types, to identify the significant differences and interdependencies between them. It does so in the context of some of the types of reckoning and measurement that would have been required for activities that we know were essential parts of hunter-gatherer life and discusses how these should be conceived. The principal focus of the latter part of this first chapter is the identification of time, cycles and causal relationships, and how these impact on ritual practice and belief systems.

Helen Farr's chapter explores in detail the measuring activities and capabilities requisite for one particular such activity that we know was an important part of prehistoric behaviour: marine navigation. Much archaeological evidence, especially from the trade of obsidian, which in the Mediterranean area, as in the Pacific, is sourced primarily from islands, indicates that extended marine voyages were made by prehistoric peoples. These would have

required a considerable set of skills including conception of distance, its relation to time, vectors, and relations between celestial cyclical and terrestrial spatial measurements. Farr explores the implications of archaeological, environmental and ethnographic evidence for the nature of such skills and their relation to early measurement and cosmology.

Denise Schmandt-Besserat gives a concise overview of her theory of the stages of development of representation of number in the Near East and how this relates to the development of complexity in counting, conceptualisation of quantity, abstraction of reality and the development of writing. She outlines how the earliest accounting systems are associated with contexts corresponding to advent of agriculture and exhibit the practice of *concrete counting*, in which specific shapes/representations stand for specific commodities and are replicated to stand for different quantities. There is a transition from *objects* representing commodities, to *markings* representing commodities and separate markings representing quantities. According to her thesis it is this step that allows the emergence of a concept of abstract number – the process of externalising and abstracting quantities and commodities allowed for the manipulation of these concepts in new ways, being able to record objects that were not present, that were owed, or yet to be produced, for example.

Turning to the other side of the world and another, quite different type of numerical recording, Gary Urton focuses in his contribution upon the recording and measuring system used by the pre-Columbian Inka of Peru, the *kipu* knotted string. These hierarchically organised sequences of knot markers constituted a complex information-storage system, including a decimal accumulative (and possibly double-bookkeeping) accounting system. Not all of the dimensions of their meaning have yet been

deciphered, but Urton's work has been pivotal in interpreting their numerical content in the context of Inka archaeology and economy. Much has been learnt from the khipu regarding native South American accounting and numeracy, which developed quite independently of that in the Near East and, by extension, Europe.

The khipu could be used for accounting Inka measures, for accounting land, commodities, and the work-time contributed by provinces in the form of labour-tax, but were also used for recording relative values such as 'species' types of livestock, colours of livestock, and their quality. The system of their use was widespread, spanning the whole empire, and with a very large number of specialists involved in the process. In addition to situating interpretations of individual khipu records in their economic and social context, Urton goes on to propose how such a system was likely to have functioned on the large scale.

John Justeson starts with an overview of number terms in different languages, and how the cognition of number can relate to the way in which it is linguistically expressed. He goes on to discuss the presence – and absence – of a linguistic concept of zero in different traditions, evidence that suggests that zero is not an innate element of human numerical cognition, but appears to have been 'added on' to some traditions of numeracy.

He suggests that the significant correlations between cultures in the way that humans talk about number are suggestive of their emergence from a shared numerical cognition. Basic number terms, which exist in all cultures, correspond with those quantities that are cognisable in

a single glance – one, two, three. Furthermore there is a strong relationship between the body and numerical cognition, and concepts of numbers as metaphors with other objects/containers/collections. However, the development of numerical systems more complex than these, including a concept of zero, seems to be related specifically to cultural practices and the interpersonal interactions they define. Zero cannot be conceived in basic number terms, or in terms of the body or objects and containers, and it seems that it has to arise in the context of specialised notational systems. Justeson goes on to explore the emergence of a concept of zero, and its numerical representation with a sign, in the development of ritual calendrical and counting systems in Mesoamerica.

Continuing the exploration of cognition of number, Lambros Malafouris's chapter discusses the mechanism and timing of the shift from approximating and subitizing capacities (the ability to discriminate between the numerical values of small sets of objects), which are exhibited by infants and other primates, to the ability to manipulate exact numerocities and deal with abstract number. Taking an innovative approach, Malafouris examines findings from neuroscience relating to the location of numerical cognition functions in the brain, and their relatedness to other functions such as spatial cognition and language. He then goes on to relate these to the archaeological record of the Near East, as discussed by Schmandt-Besserat, proposing a scenario for the emergence of numerocity in this context as a consequence of the interaction between material culture and cognition.

## Conceptualising quantification before settlement: Activities and issues underlying the conception and use of measurement

*Iain Morley*

### Introduction

This chapter discusses a number of different aspects of measurement relevant to past societies, and the archaeological record. First, it explores some of the concepts underlying different types of measurement, the differences between them, and the implications of those differences for how measurement might be, and has been, conceived. Different types and concepts of measurement are labelled with specific terms, and the relationships between them considered. Whilst it is hoped that the concepts discussed and terms used might be useful in wider considerations of measurement, the chapter is written keeping in mind the nature and implications of the types of measurement activity that are likely to have been important in the context of hunter-gatherer subsistence, especially concepts of time, cycles and distance. In particular, this chapter seeks to highlight the fact that a great many of the activities that were carried out by past societies would have involved quantification in some form. In order to explore fully the use of measurement of the world and beyond in past societies we must explore the implications of the activities for which we do have archaeological evidence, in addition to looking for direct evidence of quantification.

The final sections of the chapter in particular relate some of these conceptualisations – especially of time and cycles of events – to supernatural and spiritual systems of belief for their explanation, and ritual systems of practice for their mediation.

### Early measurement – circumstances and types

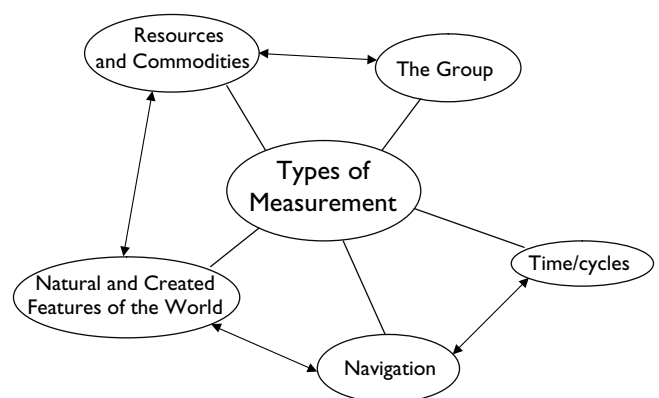
Direct archaeological evidence for measurement amongst prehistoric hunter-gatherer populations is sparse, or

perhaps sparsely identified. Apart from notational systems such as are proposed by the analyses of Marshack (1964; 1972; 1991) and others (see D’Errico 1991, and Bednarik 1991, for a consideration and replies), there is little direct evidence to suggest systems of reckoning such as addition (as opposed to ‘accumulation’), division, assessment of weight, and so forth. However, measurements of a variety of forms must have underpinned many activities that we do know about, and an exploration of these activities illustrates that we would be wrong to dismiss any past societies as ‘nonmeasuring’ or even innumerate, on the basis of a lack of direct evidence for ‘conventional’ measurements such as weights, currency or architectural dimensions, for example.

Amongst most, if not all, societies there is a variety of aspects of daily life that involve the use of concepts of measurement. These can be thought of as falling into five main areas, or foci, for measurement: (1) the group itself, (2) resources/commodities, (3) natural and created features of the world, (4) navigation, and (5) time (see Figure 1.1). There are overlaps between aspects of at least some of these categories, as will be seen (for example, concepts of distance and time), but there are elements that are particular to each category, and these will be considered in turn. A particular emphasis will be placed on their manifestation within a hunting-gathering context.

#### (1) The group itself

There are several ways in which aspects of an understanding of the group might rely on quantifiable or relative assessment, from fundamental characteristics such as the number of people in the group or subgroups, to concepts such as relatedness, hierarchy, contribution and age (see Figure 1.2).



**Figure 1.1.** Types of measurement. There are practical relationships between all types; arrows indicate conceptual and methodological overlaps.

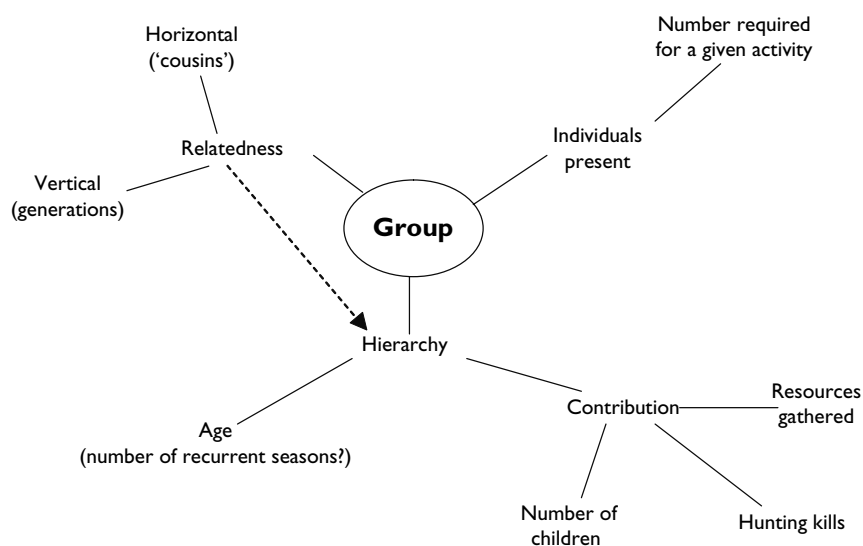


Figure 1.2. Concepts of measurement related to the group.

In what ways does an awareness of the total collective of people in a group, or in a household, or of households in a group, relate to quantification? People may be capable of reckoning (recognising) the presence of all persons in a group, or absence of some, through the recognition of the presence or absence of individuals, without ever needing to explicitly ‘head-count’ – rather, undertaking ‘head recognition’. Nevertheless one might expect beliefs to be held regarding an optimal number of individuals to take part in a hunting or foraging foray, such as the number of individuals required to bring down a particular animal, or in line with expectations regarding the potential yield of the environment at that time or location (in itself a quantification). It could be argued that all that might be in place is a concept of ‘the more people the better’, but this would not be adequate when the group is required to divide its labour resources between more than one task at a time, which would undoubtedly be the case much of the time. Unless individual members of the group always fulfilled the same task roles, with no redistribution of labour according to requirements – which could be true for some, but not all of the time – such considerations, whilst not necessarily requiring numerical quantification, would rely on a finely honed sense of optimal labour input versus potential yield – that is, relative values.

In addition to values associated with the group and subgroups there are other aspects of the group the assessment of which might be considered to require quantification of a sort. Vertical and horizontal relationships within a group might be quantified – if not numerically, then in relative terms. For example, in a vertical direction, the number of generations alive: your grandfather, your mother, yourself and your daughter. This

is a numerical concept but is not likely to require the use of greater reckoning than can be provided by the digits of one hand. In a horizontal direction, degree of relatedness may be considered important – cousins, second cousins and so forth. Whilst this seems on the surface to be numerical – it can be quantified in a similar way to generations in that it is possible to identify ‘number of points removal’ from one person to another – in practice it could equally be a far vaguer attribution of level of ‘connectedness’ between one individual and another.

Any kind of hierarchy requires some conception of relative seniority. This relative measure may rely, for its

reinforcement, on comparatively nebulous concepts such as relatedness, but it might also be predicated on attributes such as age (e.g. number of cycles of seasons an individual has been alive), number of children, or tally of hunting kills, for example, all of which are judged on the basis of quantity.

Concepts such as an individual’s contribution to the group’s well-being (or survival) tie in with considerations of the value of resources and commodities. This contribution may be easily quantifiable, in discrete units, such as number of animals caught or number of tubers gathered, or may be reckoned in more subjective terms. These ideas are explored further in the next section.

## (2) Resources and commodities

The size of the group (and any subgroups) would be relevant to not only planning and executing foraging and hunting activities, but the division of the resources consequently gathered. Even (or, perhaps, especially) within a system whereby all resources gathered were considered to be communal and people helped themselves, there would be an enormous potential for abuse of the system and a concomitantly strong sense of what would be considered ‘fair’ and what would be considered ‘unfair’, or greedy, in terms of peoples’ allocations. Where such a communal system does not exist, the sharing of resources frequently relates to finely honed responses to perceived need of individuals or collection of individuals within the group (for a discussion of the complexities of forms of sharing see, for example, Ingold 1999), a process that requires not just summation, but division and sharing. The process of dividing and sharing resources involves dealing with quantities



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of whole objects, division of whole objects into parts, as well as, possibly, creating collections of smaller collections (which involves conceiving of collective units of units and multiples of multiples).

Quantification of resources and commodities can be said to involve *'fundamental'* quantification, in the sense of the reckoning of whole objects (e.g. 1 reindeer, 20 shells), and *'attributive'* quantification (measurement of attributes of the object such as mass, length etc.). A commodity may also be said to have *'relative'* value, which is its value relative to other commodities/resources; this may be fixed or variable (e.g. in a barter system). Variable relative value would be influenced by factors including *'survival value'* (physical need) and *'social value'* (quality). Quality might be determined socially by considerations such as time or labour required, longevity or contribution to the group and may or may not be officially sanctioned (see Figure 1.3).

There are clearly many potential overlaps between survival value and social value, of the order typically manifest in any debate about the relative importance of *'culture'* and *'biology'*. It could be argued that survival value is a factor in determining social value, and, conversely, that *'survival'* involves both physical and social well-being. Social value might constitute a determining factor in the true survival value of an object, with socially created *'needs'* that directly impact on membership of the community, and thus survival. These are more akin to physical needs than the concept of *'quality'* intended here.

Conceptions of the value of one thing in relation to another (*relative value*) would be necessary for a barter

system of trade. We know that in the Upper Palaeolithic commodities were transported or exchanged over very great distances (e.g. Gamble 1999). Would a barter system have been necessary for such long-distance transport? This is one likely mechanism, but it is important to consider other ways in which such exchange can be conceptualised. Rather than a set of beliefs about equivalent *commodity* values, the exchange could also occur through reciprocal gift giving. In this case there would be some perception of relative values of gifts or actions, but the emphasis could lie with the action of the exchange itself (reciprocation) rather than the objects exchanged. The exchange of one *thing* for another might be entirely meaningless; gift giving may not be seen as a *swap* of objects (with the objects thus having a directly comparable value) but as the giving of a gift, followed by the reciprocation of that action; it is the exchange of *actions* rather than *objects*.

Returning to direct exchange of objects, there are several aspects of the conception of such a system that require further consideration. If one conceives that 1 reindeer is fair exchange for 20 pierced shells, and one also knows that 3 foxes is fair exchange for 1 reindeer, does it automatically follow that 3 foxes is fair exchange for 20 pierced shells? Such rationalising relies both on the ability to conceive of this three-way relationship of commodities, and on practical predicates – the idea that someone with foxes needs shells may be laughable, whilst the idea that someone with reindeer needs shells and that someone with foxes needs reindeer may be well established. It is here that the *'social'* and *'survival'* values

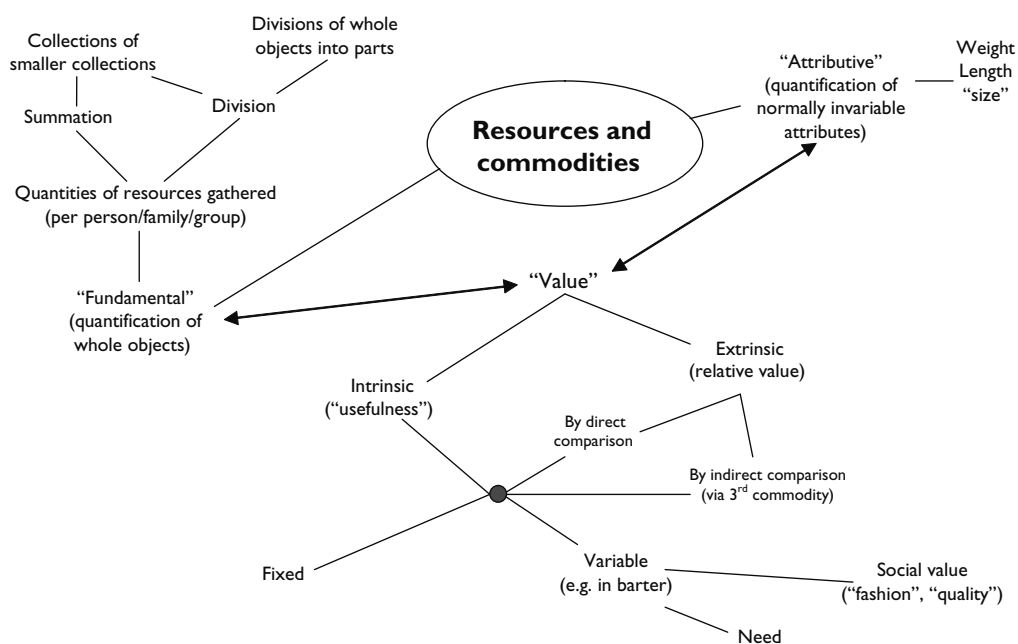


Figure 1.3. Concepts of measurement associated with resources and commodities.

discussed earlier come into play. Further, there is no point in thinking of 3 foxes as being worth 20 pierced shells if there is no prospect whatever of encountering someone with 20 pierced shells at the time when one has 3 foxes.

At the risk of seeming to impose a modern economic construct, in practical terms the three-way relationship of equivalence of value effectively relies on the presence of a ‘market’, where multiple commodities are available at once, or a situation (and the ability) via which one can envisage such a market as a longer-term prospect (i.e., a market spread over time rather than space – not all of the commodities and potential exchange partners being available at the same place and time, but all being available within a year, for example). This latter case relies on the ability to conceive of long-term needs, not just of yourself (which Upper Palaeolithic populations certainly possessed) but also of others with whom you hope to trade. It also requires the individual mental capability, the social constructs and the environmental circumstances that allow or even encourage deferment of short-term gain/need for potential long-term prospects of recompense.

### (3) Natural and created features of the world

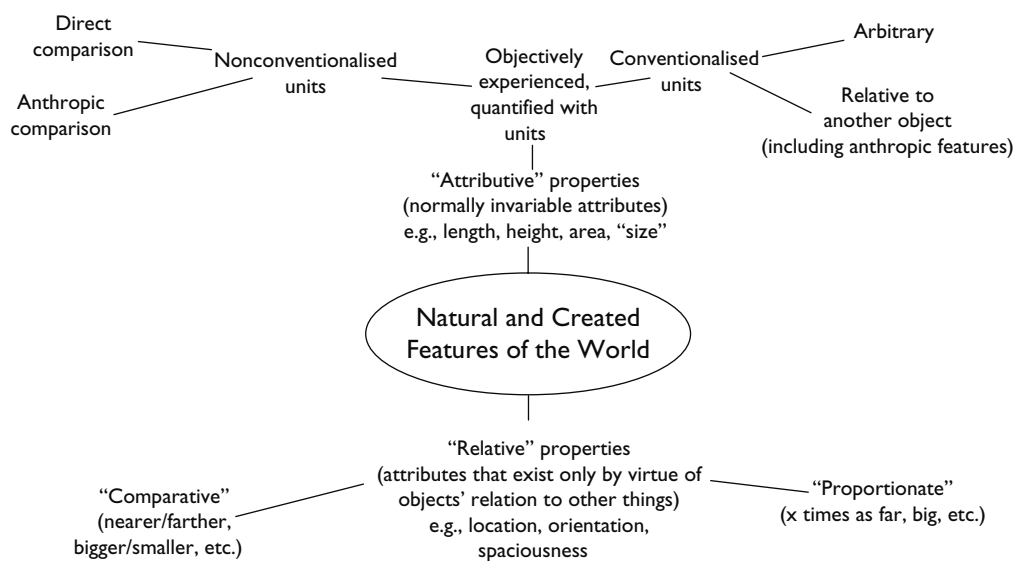
Properties of an object that are not dependent upon or affected by anything outside the object can be considered ‘absolute’ or ‘attributive’ properties of the object<sup>1</sup> (e.g., mass, volume). Properties of an object that are only attributable to it by virtue of its relation to other things can be considered ‘relative’ properties of the

object, such as orientation, location (nearer, farther, left of, right of) (see Figure 1.4). The reckoning of ‘relative’ properties of objects, in this sense, has an important role in navigation; this activity is discussed in its own right in section (4).

Whilst the properties themselves can be ‘attributive’ or ‘relative’, quantification of those properties is always relative, in the sense that attributes of an object can only be reckoned in terms of something else. For example, the length of a given object can be considered to be either one whole unit of itself long, or, alternatively, some multiple (or fraction) of some other unit long. The former could be considered to be an absolute measure of that object but is of absolutely no use for telling you anything about the object, and the latter would be a relative measure, whatever the unit. We can only usefully consider any property of anything in relation to that property of something else.<sup>2</sup>

So, whilst the *attribute* of the object may be absolute – in the sense that it exists independently of other objects – there is no such thing as an absolute unit of measurement *of* that attribute. Measurement of ‘absolute’ properties of anything has to be in terms of something else, namely, (multiples of) an agreed standard unit. In this sense we only *ever* measure things in relative terms – there is no such thing as ‘absolute’ *measurement*.<sup>3</sup>

The units by which a property is measured may be part of a conventionalised system whereby the numerical units are agreed and standardised (perhaps arbitrarily, or relative to another object). Such relative standardisations may be derived from naturally occurring and



**Figure 1.4.** Properties of features of the world that may be variously subject to measurement concepts. Note that this represents *properties* of natural and created features of the world, not techniques for quantification. For example, ‘attributive properties’ may be quantified using relative (comparative) measures, and ‘relative properties’ may be quantified in comparison to attributes of other objects.