Chapter Eighteen

On weaving a basket

Artefacts are made, organisms grow: at first glance the distinction seems obvious enough. But behind the distinction, as I aim to show in this chapter, lie a series of highly problematic assumptions concerning mind and nature, interiority and exteriority, and the genesis of form. We have only to consider the artefactual status of such an everyday object as a basket to realise that the difference between making and growing is by no means as obvious as we might have thought. I shall begin this chapter by showing that the reasons why the basket confounds our expectations of the nature of the artefact stem from the fact that it is woven. If the basket is an artefact, and if artefacts are made, then weaving must be a modality of making. I want to suggest, to the contrary, that we should understand making as a modality of weaving. This switch of emphasis, I believe, could open up a new perspective not just on basketry in particular, but on all kinds of skilled, form-generating practices. But it would also have the effect of softening the distinction between artefacts and living things which, as it turns out, are not so very different after all.

Making and growing

What is implied about artefacts by their characterisation as things that are made rather than things that grow? First of all, a division is assumed between form and substance, that is between the design specifications of the object and the raw materials of which it is composed. In the case of living things, it is supposed that the information specifying the design of an organism is carried in the materials of heredity, the genes, and thus that every new life-cycle is inaugurated with the injection of this specification into a physical medium. But with artefacts, this relation between form and substance is inverted. Form is said to be applied from without, rather than unveiled from within. The very distinction between a within and a without of things, however, implies the existence of a *surface*, where solid substance meets the space of action of those forces that impinge upon it. Thus the world of substance – of brute matter – must present itself to the maker of artefacts as a surface to be transformed.

In commonsense, practical terms, this is not hard to imagine. Many of our most familiar artefacts are (or were, before the days of synthetic materials) made of more or less solid stuff such as stone, metal, wood or clay. The very usefulness of these objects depends on their being relatively resistant to deformation. We ourselves, however, inhabit a gaseous medium – air – which, offering no such resistance, not only allows complete freedom of movement, but also transmits both light and sound. Quite apart from the obvious fact that we need air to breathe, and thus simply to stay alive, the possibilities of movement and perception (visual and aural) that air affords are crucial for any artefact-producing activity. There is, then, a pretty clear distinction between the gaseous medium that surrounds us and the solid objects that clutter our environment; moreover the patterns of reflected light off the surfaces of these objects enable us to see them for what they are (Gibson 1979: 16–22).

These practical considerations, however, all too easily become confused in our thinking with speculations of a more metaphysical kind. To show why this is so, consider the case of the beehive. Is this an artefact or not? Surely, hives don't grow. Insofar as it results from the application of exterior force to raw material, the hive would appear to be as much 'bee-made' as the human house is 'man-made'. Or is it? Musing on this question, Karl Marx famously came to the conclusion that 'what from the very first distinguishes the most incompetent architect from the best of bees, is that the architect has built a cell in his head before he constructs it in wax'. In other words, the criterion by which the house is truly artificial – and by comparison the beehive only figuratively so – is that it issues from a representation or 'mental model' which has been fashioned in the imagination of the practitioner prior to its execution in the material. We may assume that bees, by contrast, lack the powers of imagination, and have no more conception of their hives than they do of their own bodies, both of which are formed under genetic control (Ingold 1983, cf. Marx 1930: 169–70)

Here, the exteriority of the forces that shape artefacts is understood in quite another sense, in terms not of the physical separation of gaseous medium and solid substance but of the *meta*physical separation of mind and nature. Unlike the forms of animals and plants, established through the evolutionary mechanism of natural selection and installed genetically at the heart of the organisms themselves (in the nucleus of every cell), the forms of artefacts are supposed to have their source within the human mind, as preconceived, intellectual solutions to particular design problems. And whereas organic growth is envisaged as a process that goes on *within* nature, and that serves to reveal its inbuilt architecture, in the making of artefacts the mind is understood to place its ideal forms *upon* nature. If making thus means the imposition of conceptual form on inert matter, then the surface of the artefact comes to represent much more than an interface between solid substance and gaseous medium; rather it becomes the very surface of the material world of nature as it confronts the creative human mind.

This is precisely the kind of view that lies at the back of the minds of anthropologists and archaeologists when they speak of artefacts as items of so-called 'material culture'. The last thing they mean to suggest, in resorting to this phrase, is that in the manufactured object the domains of culture and materiality somehow overlap or intermingle. For nothing about their substantive composition *per se* qualifies artefacts for inclusion within culture. The materials from which they are made – wood, stone, clay or whatever – are in any case generally available in nature. Even with objects manufactured from synthetic materials for which no naturally occurring counterparts exist, their status as items of material culture is in no way conditional upon their 'unnatural' composition. A child's toy made of plastic is no more cultural, on that account, than its wooden equivalent. It is the form of the artefact, not its substance, that is attributed to culture. This is why, in the extensive archaeological and anthropological literature on material culture, so little attention is paid to actual materials and their properties. The emphasis is almost entirely on issues of meaning and form – that is, on culture *as opposed* to materiality. Understood as a realm of discourse, meaning and value inhabiting the collective consciousness, culture is conceived to hover over the material world but not to permeate it. In this view, in short, culture and materials do not mix; rather, culture wraps itself around the universe of material things, shaping and transforming their outward surfaces without ever penetrating their interiority. Thus the particular surface of every artefact participates in the impenetrable surface of materiality itself as it is enveloped by the cultural imagination.

Surface, force and the generation of form

Let us consider the most ordinary of everyday objects, one that crops up in a surprising range and variety of cultural settings around the world: a coiled basket. Has the basket been created through working on the surface of some raw material? Have the forces impacting on this surface been applied from without? Did they serve to impress onto the material a pre-existent, conceptual design? In every case, as I show below, the answer is 'Not exactly'. Thus the basket is not 'made' in the sense in which we normally understand the term. Nor, evidently, has it grown of its own accord. Thus neither of the available alternatives seem to work for the basket. It does not fit our stereotype of the artefact, and it is not a life-form. Let us start instead from the simple observation that constructing a basket is a process of weaving. In what follows, I shall consider what weaving entails, respectively, with regard to the topology of *surface*, the application of *force* and the generation of *form*.

We have seen that making, in what for convenience I shall henceforth call the 'standard view', implies the prior presence of a surface to be transformed. Thus the flint knapper chips away at the surface of stone, the carpenter carves and chisels the surface of wood, the blacksmith hammers on the surface of molten metal, and the potter applies manual pressure to the surface of clay. But once it has been cut and prepared for weaving, the basket-maker does nothing to the surface of her fibrous material. In the process of weaving, the surface of the basket is not so much transformed as built up. Moreover, there is no simple or straightforward correspondence between the surface of the basket and the surfaces of its constituent fibres. For example, the two outer surfaces of the transverse wrapping fibres that stitch successive loops of the coil are alternately 'outside' and 'inside' so far as the surface of the basket is concerned (see Figure 18.1). Indeed it is in the nature of weaving, as a technique, that it produces a peculiar kind of surface that does not, strictly speaking, have an inside and an outside at all.

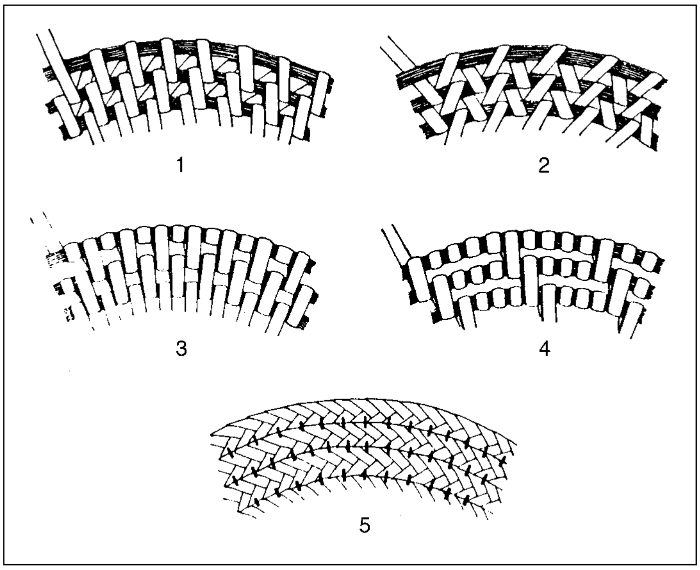

Figure 18.1 Patterns of wrapping in coiled basketry: (1) plain; (2) figure-of-eight ('Navajo'); (3) long and short ('lazy squaw'); (4) Peruvian coil; (5) sewn coil.

From H. Hodges, *Artifacts: an introduction to early materials and technology*, published by Duckworth, 1964, p. 131.

In the special case of coiled basketry, there is a limited parallel with the technique of coil-building in pottery. Here the clay is first rolled out into long, thin, worm-like strips, rather analogous to the lengths of bundled fibres making up the basketry coil. These strips are then wound around and around to form the base and sides of the vessel. In this case too, a surface is built up. In the process, however, the original surfaces of the coiled strips congeal into a single mass, and the final smoothing leaves no trace of the original mode of construction. But there is another difference, equally critical, which brings me to the issue of force. The potter may have to contend with the force of gravity (his material, being both heavy and pliable, is inclined to sag). But the clay does not exert any independent force. This is not the case with basketry, however, which involves the bending and interweaving of fibres that may exert a considerable resistance of their own. Indeed the basket holds together, and assumes a rigid form, precisely because of its tensile structure.[1] In short, the form of the basket is the result of a play of forces, both internal and external to the material that makes it up. One could say that the form unfolds within a kind of force field, in which the weaver is caught up in a reciprocal and quite muscular dialogue with the material.

This point leads me to the final question concerning the generation of form. According to the standard view, the form pre-exists in the maker's mind, and is simply impressed upon the material. Now I do not deny that the basket-maker may begin work with a pretty clear idea of the form she wishes to create. The actual, concrete form of the basket, however, does not issue from the idea. It rather comes into being through the gradual unfolding of that field of forces set up through the active and sensuous engagement of practitioner and material. This field is neither internal to the material nor internal to the practitioner (hence external to the material); rather, it cuts across the emergent interface between them. Effectively, the form of the basket emerges through a pattern of *skilled movement*, and it is the rhythmic repetition of that movement that gives rise to the regularity of form. This point was made long ago by Franz Boas, in his classic work on *Primitive Art*.

> The basketmaker who manufactures a coiled basket, handles the fibres composing the coil in such a way that the greatest evenness of coil diameter results . . . In making her stitches the automatic control of the left hand that lays down the coil, and of the right that pulls the binding stitches over the coil brings it about that the distances between the stitches and the strength of the pull are absolutely even so that the surface will be smooth and evenly rounded and that the stitches show a perfectly regular pattern.
>
> (Boas 1955 [1927]: 20)

Spirals in nature and art

Boas illustrates the point with a drawing, which I reproduce here (Figure 18.2A). Opposite, I have placed another drawing, this time taken from the work of the great biologist D'Arcy Wentworth Thompson, *On Growth and Form* (Figure 18.2B). It depicts the shell of a certain kind of gastropod. Although both the coiled basket and the shell have a characteristic spiral form, they are spirals of different kinds: the first is an equable spiral, the second logarithmic (that is, the radius of each successive whorl increases arithmetically in the one instance, and geometrically in the other). The equable spiral, as Thompson explains, is characteristic of artificial forms that have been produced by mechanically bending, coiling or rolling up a given length of material, whereas the logarithmic spiral is commonly produced in nature as a result of growth by deposition, where the material is cumulatively laid down at one end whilst maintaining an overall constancy of proportion

(Thompson 1961 [1917]: 178–9). Either way, however, the form appears to emerge with a certain logical inevitability from the process itself, of rolling up in the former case and laying down in the latter.

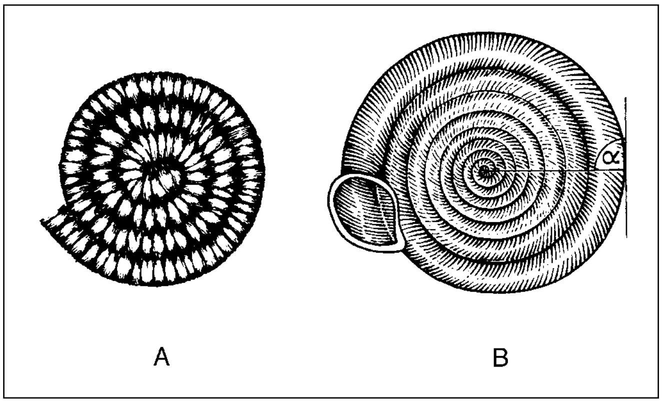

Figure 18.2 Artefactual and natural spirals: (A) Coiled basketry.

From F. Boas, *Primitive art*, published by Dover Publications, 1955 [1927], p. 20.

(B) Gastropod shell. The angle α is known as the 'spiral angle', which in this case is large.

From D. W. Thompson, *On growth and form*, published by Cambridge University Press, 1961 [1917], p. 192.

Now it is very often assumed, in the study of both organisms and artefacts, that to ask about the form of things is, in itself, to pose a question about *design*, as though the design contained a complete specification that has only to be 'written out' in the material. This assumption is central to the standard view which, as we have already seen, distinguishes between living and artificial things on the criterion of the interiority or exteriority of the design specification governing their production without questioning the premise that the resultant forms are indeed specified independently and in advance of the processes of growth or manufacture wherein they are realised. Thus it is supposed that the basic architecture of the organism is already established, as a genetic 'blueprint', from the very moment of conception; likewise the artefact is supposed to pre-exist, fully represented as a 'virtual object' in the mind, even before a finger has been lifted in its construction. In both cases the actualisation of the form is reduced to a simple matter of mechanical transcription: all the *creative* work has already been done in advance, whether by natural selection or human reason.[2]

How then, starting from this premise, might we set about accounting for the formation of spirals in nature and in art, in the shell of the gastropod and the coil of the basket? The account would likely run along the following lines: the form of the shell is internally specified in the gastropod's genetic inheritance, and revealed in its growth; the form of the basket is externally specified in the mind of the weaver, as part of a received cultural heritage, and revealed in its manufacture. Now natural selection, according to Darwinian orthodoxy, designs organisms to be adapted to their particular conditions of life, and as many scholars have suggested, a somewhat analogous process of blind variation and selective retention, operating in the arena of cultural ideas, could do likewise in designing artefacts that are well suited to their purpose. The fact that we come across spirals in the growth of living things (as in gastropods) as well as in the making of artefacts (as in basketry) may be purely fortuitous, or it may be the outcome of some kind of adaptive convergence – of natural selection and the human intellect, operating quite independently, arriving at parallel solutions to what might be, in essence, a rather similar problem of engineering design. If, to be more precise, the solution calls for a spiral of the equable type, or alternatively of the logarithmic type, then this is what we will find in the resultant forms, regardless of whether the design itself is encoded genetically or culturally. Hence by this account, the distinction between equable and logarithmic spirals would not, in itself, be relevant as an index of the organic or artefactual status of the objects concerned.

The limits of design

According to the standard view, as outlined above, form is fully explicable in terms of the design that gives rise to it. Once you have accounted for the genesis of the design you have, to all intents and purposes, explained the form. Or have you? Would it be possible, even in theory, for any design to specify the form of an organism or artefact *completely*? In his fascinating study of the design principles embodied in the construction of living organisms and manufactured artefacts, originally written as a textbook for students of engineering, Michael French (1988: 266–7) speculates on the question of just how much information would be needed to specify every aspect of the form of an organism. His conclusion is that the amount would be unimaginably large, far beyond what could be coded in the DNA of any known life-form. Nor is the situation any different with artefacts. True, even the greatest achievements of human engineering are no match for the most commonplace of organisms: thus the steam locomotive, as French wryly observes, 'is simplicity itself compared with the intricacies of the buttercup' (1988: 1). But then, no human design could approach the DNA of the genome in its informational content. Once again, a complete specification would apparently lie beyond the realms of possibility. In short, the forms of both organisms and artefacts seem to be significantly underdetermined by their underlying blueprints. That being the case, French suggests, we may have to recognise that a great many features of organisms and artefacts are merely accidental, due to chance, revealing not the designs themselves but their limitations.

Though intended to shore up the argument from design against the objection that no specification can be exhaustive, this appeal to chance is a *reductio ad absurdum* that does more to highlight the poverty of the argument itself. To show why, let me turn to another example of spiral formation: the vortex of bathwater as it runs out of the plug-hole. Is the form of the vortex a matter of chance? It is certainly not dictated by the specifications of any design. You can determine whether the spiral runs clockwise or anticlockwise by setting up a current through the water with your hand; beyond that, however, the spiral appears to form of its own accord. But its formation is anything but an accident. It can, in fact, be explained in terms of well-established principles of fluid dynamics.

The example of the vortex is not my own; it is taken from the work of the biologist Brian Goodwin (1982), who uses it to say something very important about the generation of spiral forms in living organisms. In a certain species of snail, the majority of individuals have shells with a right-handed, logarithmic spiral, but in some the spiral is left-handed. It has been shown that the direction of the spiral is controlled by the products of a particular gene, just as the direction of the spiral vortex in bathwater is controlled by the intentional movement of your hand. But – and this is the crucial point – the *form* of the shell is no more the product of a genetic programme than is the form of the vortex the product of a design in your mind. There is, in short, no design for the spiral of the gastropod shell. Rather, the form arises through a process of growth within what is known technically as the 'morphogenetic field' – that is, the total system of relations set up by virtue of the presence of the developing organism in its environment. And the role of genes in the morphogenetic process is not to specify the form, even incompletely, but to set the parameters – such as handedness and spiral angle (see Figure 18.2B) – within which it unfolds (Goodwin 1982: 111).

On the growth of artefacts

Returning from the growth of organisms to the manufacture of artefacts, a parallel argument applies. Just as organic form is generated in the unfolding of the morphogenetic field, so the form of the artefact evolves within what I have called a field of forces. Both kinds of field cut across the developing interface between the object (organism or artefact) and an environment which, in the case of the artefact, critically includes its 'maker'. Where the organism engages its environment in the process of ontogenetic development, the artefact engages its maker in a pattern of skilled activity. These are truly creative engagements, in the sense that they actually *give rise* to the real-world artefactual and organic forms that we encounter, rather than serving – as the standard view would claim – to transcribe pre-existent form onto raw material. Moreover as a moment's reflection on the example of the vortex in bathwater will show, the properties of materials are directly implicated in the form-generating process. It is therefore no longer possible to sustain the distinction between form and substance that, as we have seen, is so central to the standard view of making things. Finally, the templates, measures and rules of thumb of the artisan or craftsman no more add up to a design for the artefacts he produces than do genes constitute a blueprint for the organism. Like genes, they set the parameters of the process but do not prefigure the form.[3]

All these points apply to the making of a coiled basket. Thus the equable form of the spiral base of the basket does not follow the dictates of any design; it is not imposed upon the material but arises through the work itself. Indeed the developing form acts as its own template, since each turn of the spiral is made by laying the longitudinal fibres along the edge formed by the preceding one. Now D'Arcy Thompson was of course right to point out that there is a difference between *bending* material into shape, as in basketry, and an organism's *growing* into it, as with the shell of the gastropod, and that this can lead to forms with contrasting mathematical properties. Nevertheless, if the unfolding of the morphogenetic field is described as a process of growth, would it not be fair to suggest that there is a sense in which artefacts, whose forms likewise evolve within a field of forces, 'grow' too – albeit according to different principles?

We could describe that growth as a process of *autopoiesis*, that is, the self-transformation over time of the system of relations within which an organism or artefact comes into being. Since the artisan is involved in the same system as the material with which he works, so his activity does not transform that system but is – like the growth of plants and animals – part and parcel of the system's transformation of itself. Through this autopoietic process, the temporal rhythms of life are gradually built into the structural properties of things – or as Boas put it, with regard to artefacts:

> The rhythm of time appears here translated into space. In the flaking, adzing, hammering, in the regular turning and pressing required in the making of coiled pottery, in weaving, regularity of form and rhythmic repetition of the same movement are necessarily connected.
>
> (Boas 1955 [1927]: 40)

The artefact, in short, is the crystallisation of activity within a relational field, its regularities of form embodying the regularities of movement that gave rise to it.

I would like to conclude this comparison of the coiled basket and the gastropod shell by commenting on the reasons for the remarkable durability of their respective forms.

According to the standard view, since form emanates from design, the persistence of form can only be explained in terms of the stability of the underlying design specifications. In the case of the organism these specifications are genetic, in the case of the artefact they are cultural. The constancy of form is thus a function of the fidelity with which genetic or cultural information is copied from one generation to the next, combined with the effects of natural selection – or its analogue in the realm of cultural ideas – in weeding out less well-adapted variants.

The argument I have proposed here, however, is just the opposite. If forms are the outcomes of dynamic, morphogenetic processes, then their stability can be understood in terms of the generative principles embedded in the material conditions of their production. For the shell the principle is one of invariant proportion; for the basket it is the principle that every increment of longitudinal extension is coupled to what has gone before by transverse attachment. Whereas the first principle, through simple iteration, will always and everywhere generate a logarithmic spiral, the second will just as reliably generate an equable one. It is these generative principles, and not the fidelity of genetic or cultural copying, that underwrite the constancy of the respective forms, and explain their persistence over immense spans of both historical and evolutionary time.

Making as a way of weaving

I now return to my earlier suggestion, that we reverse our normal order of priorities and regard making as a modality of weaving, rather than the other way around. One intriguing observation points us in this direction. Our word 'loom' comes from Middle English *lome*, which originally referred to a tool or utensil of any kind. Does this not suggest that to our predecessors, at least, the surface-building activity of weaving, rather than any of those activities involving the application of force to pre-existing surfaces, somehow epitomised technical processes in general?

The notion of making, of course, defines an activity purely in terms of its capacity to yield a certain object, whereas weaving focuses on the character of the process by which that object comes into existence. To emphasise making is to regard the object as the expression of an idea; to emphasise weaving is to regard it as the embodiment of a rhythmic movement. Therefore to invert making and weaving is also to invert idea and movement, to see the movement as truly generative of the object rather than merely revelatory of an object that is already present, in an ideal, conceptual or virtual form, in advance of the process that discloses it. The more that objects are removed from the contexts of life-activity in which they are produced and used – the more they appear as static objects of disinterested contemplation (as in museums and galleries) – the more, too, the process disappears or is hidden behind the product, the finished object. Thus we are inclined to look for the meaning of the object in the idea it expresses rather than in the current of activity to which it properly and originally belongs. It is precisely this contemplative attitude that leads to the redesignation of the ordinary objects of the quotidian environment as items of 'material culture' whose significance lies not so much in their incorporation into a habitual pattern of use as in their symbolic function. In suggesting that the relation between making and weaving be overturned, my purpose is to bring these products of human activity back to life, to restore them to the processes in which they, along with their users, are absorbed.[4]

In what way, then, does weaving epitomise human technical activity? What sense does it make to say that the blacksmith in his forge, or the carpenter at his bench, in transforming the surfaces of metal and wood respectively, is actually weaving? Of course, to adopt this idiom is to interpret the notion of weaving more broadly than is customary. It does however help to draw attention to three points about skill which are exemplified in basketry but which are nevertheless common to the practice of any craft. First, the practitioner operates within a field of forces set up through his or her engagement with the material; secondly, the work does not merely involve the mechanical application of external force but calls for care, judgement and dexterity; and thirdly, the action has a narrative quality, in the sense that every movement, like every line in a story, grows rhythmically out of the one before and lays the groundwork for the next. In the following chapter, I shall explore these dimensions of skill at greater length.

This broad interpretation of weaving, though it may sound strange to modern, Western ears, is fully in accord with the understandings of the Yekuana, a native people of southern Venezuela. In his study of Yekuana baskets and basketry, David Guss observes that the master craftsman in this society, a person accredited with exceptional wisdom, 'not only weaves the world when making a basket, but *in everything he does*' (1989: 170, my emphasis). Yet this creative process of world-weaving, Guss shows, is not limited to the experts. It rather engages all Yekuana people throughout their lives – albeit at a lower level of perfection – in their manufacture of the essential equipment of traditional livelihood. In every case, from building houses and canoes to fabricating manioc graters and baskets, making is regarded as a way of weaving.

Paradoxically, however, in translating the indigenous term by which such locally produced items are distinguished from imported, commercially manufactured 'stuff' (such as tin cans and plastic buckets), Guss renders them as things not woven but *made*. Moreover the essence of making, in his view, lies in loading the object with metaphorical significance or semiotic content, such that artefacts become a mirror in which people can see reflected the fundamentals of their own culture. The symbolic capacity of artefacts, Guss insists, 'far outweighs their functional value' (1989: 70). Weaving the world, then, turns out to be a matter of 'making culture', of submitting the disorder of nature to the guidelines of traditional design.

Now the epistemology by which Guss converts the manifold products of world-weaving back into 'things made', instances of the cultural transformation of nature (1989: 161), is one that I reject. It is, as I have shown, an epistemology that takes as given the separation of the cultural imagination from the material world, and thus presupposes the existence, at their interface, of a surface to be transformed. According to what I have called the standard view, the human mind is supposed to inscribe its designs upon this surface through the mechanical application of bodily force – augmented, as appropriate, by technology. I mean to suggest, to the contrary, that the forms of objects are not imposed from above but grow from the mutual involvement of people and materials in an environment. The surface of nature is thus an illusion: the blacksmith, carpenter or potter – just as much as the basket-maker – works from within the world, not upon it. There are surfaces of course, but these divide states of matter, not matter from mind (see Chapter Thirteen, pp. 240–1, for further discussion of this point). And they emerge within the form-generating process, rather than pre-existing as a condition for it.

The philosopher Martin Heidegger expressed the very same point through an exploration of the notions of building and dwelling (see Chapter Ten, pp. 185–6). Opposing the modernist convention that dwelling is an activity that goes on within, and is structured by, an environment that is already built, Heidegger argued that we cannot engage in any kind of building activity unless we already dwell within our surroundings. 'Only if we are capable of dwelling', he declared, 'only then can we build' (1971: 160). Now dwelling is to building, in Heidegger's terms, as weaving is to making in mine. Where making (like building) comes to an end with the completion of a work in its final form, weaving (like dwelling) continues for as long as life goes on – punctuated but not terminated by the appearance of the pieces that it successively brings into being.[5] Dwelling in the world, in short, is tantamount to the ongoing, temporal interweaving of our lives with one another and with the manifold constituents of our environment.

The world of our experience is, indeed, continually and endlessly coming into being around us as we weave. If it has a surface, it is like the surface of the basket: it has no 'inside' or 'outside'. Mind is not above, nor nature below; rather, if we ask where mind is, it is in the weave of the surface itself. And it is within this weave that our projects of making, whatever they may be, are formulated and come to fruition. Only if we are capable of weaving, only then can we make.

Chapter Nineteen

Of string bags and birds' nests

Skill and the construction of artefacts

Beyond art and technology

'Art' and 'technology' are mere words. And as with all words, their meanings are not fixed but have changed significantly in the course of their history. They are still changing. But I believe it remains true of modern – if not post-modern – thought, that the meanings of art and technology are held to be somehow opposed, as though drawn from fields of human endeavour that are in certain respects antithetical. This opposition, however, is scarcely more than a century old, and would have seemed strange to Anglophone ears as late as the seventeenth century, when artists were still considered no different from artisans, when the methods of working in any particular branch of art could be described as 'technical', and when the term 'technology' had just been coined to denote the scientific study of these methods (Williams 1976: 33–4). Etymologically, 'art' is derived from the Latin *artem* or *ars*, while 'technology' was formed upon the stem of the classical Greek *tekhnē*. Originally, *tekhnē* and *ars* meant much the same thing, namely *skill* of the kind associated with craftsmanship (see Chapter Fifteen). The words were used, respectively in Greek and Roman society, to describe every kind of activity involving the manufacture of durable objects by people who depended on such work for a living, from the painter to the cobbler, from the temple architect to the builder of pigsties. This is not to say that customers failed to distinguish between aesthetic and utilitarian criteria in their estimations of the objects produced. But in every case, it was the craft skill of the practitioner that was supposed to ensure a successful outcome (Burford 1972: 13–14).

The connotation of skill is preserved in many words derived from the same roots and that remain in common currency today. On the one hand we have 'technics' and 'technique'; on the other hand such terms as 'artless' – meaning clumsy or lacking in skill – and, of course, 'artefact'. Yet the apparent continuity masks an important shift, towards abstracting the components of intelligence, sensibility and expression that are essential to the accomplishment of any craft from the actual bodily movement of the practitioner in his or her environment. Thus the technique of the pianist comes to refer to the practised ability of his fingers to find their way around the keyboard and to hit the desired notes, as distinct from the inherent musicality of the performance. 'A player may be perfect in technique', wrote Sir Charles Grove, 'and yet have neither soul nor intelligence'. Likewise, we have come a long way from the days when, as in the year 1610, it was possible to eulogise a certain composer as 'the most artificial and famous Alfonso Ferrabosco' (Rooley 1990: 5). As David Lowenthal has observed, 'time has reversed the meaning of artificial from "full of deep skill and art" to "shallow, contrived and almost worthless"' (1996: 209). By the same token, the artefact is regarded no longer as the original outcome of a skilled, sensuous engagement between the craftsman and his raw material, but as a copy run off mechanically from a pre-established template or design. This debasement of craft to the 'merely technical' or mechanical execution of predetermined operational sequences went hand in hand with the elevation of art to embrace the creative exercise of the imagination (Gell 1992b: 56). As a result, the artist came to be radically distinguished from the artisan, and the art-work from the artefact (Coleman 1988: 7).

The decisive break, according to Raymond Williams, came in the England of the late eighteenth century, with the exclusion of engravers from the newly formed Royal Academy, which was reserved for practitioners of the 'fine' arts of painting, drawing, and sculpture (Williams 1976: 33). It was, of course, symptomatic of a general tendency to distinguish intellectual from manual labour, along the common axis of a more fundamental series of oppositions between mind and body, creativity and repetition, and freedom and determination. But the more that 'art' came to be associated with the allegedly higher human faculties of creativity and imagination, the more its residual connotations of useful but nevertheless habitual bodily skills were swallowed up by the notion of technology. For by the beginning of the twentieth century this term, too, had undergone a crucial shift of meaning. Where once it had referred to the framework of concepts and theory informing the scientific study of productive practices, technology came to be regarded as a corpus of rules and principles installed at the heart of the apparatus of production itself, whence it was understood to generate practice as a programme generates an output. Technology, now, did not discipline the scholar in his study of techniques, but rather the practitioner in his application of them. He became, in effect, an operative, bound to the mechanical implementation of an objective and impersonal system of productive forces.[1]

Here, then, lies the source of the now familiar division between the respective fields of art and technology. An object or performance could be a work of art, rather than a mere artefact, to the extent that it escapes or transcends the determinations of the technological system. And its creator could be an artist, rather than a mere artisan, insofar as the work is understood to be an expression of his or her own subjective being. Where technological operations are predetermined, art is spontaneous; where the manufacture of artefacts is a process of mechanical replication, art is the creative production of novelty. These distinctions can be multiplied almost indefinitely, but they are all driven by the same logic, which is one that carves out a space for human freedom and subjectivity in a world governed by objective necessity. As I have shown in Chapter Seventeen (pp. 329–30), it is a logic that operates as much in the field of exchange as in that of production. Thus the modern distinction between the true work of art and the replicated artefact has its parallel in that between the 'pure gift' and the market commodity: the former given spontaneously and motivated (at least in theory) by personal feeling; the latter exchanged in line with impersonal calculations of supply and demand. But in both fields the distinctions are recent, and closely tied to the rise of a peculiarly modern conception of the human subject.

The division between art and technology, as it has come to be institutionalised in modern society, has affected anthropology as much as any other field of inquiry. Until fairly recently, the literatures in the anthropology of art and in the anthropology of technology remained almost completely isolated from one another. Technology was located within the sphere of ecological adaptation, mediating the material relations between human populations and their environments. For assorted cultural ecologists, cultural materialists, and Marxists, the conjunction of environment and technology – if not actually determinant of cultural form – constitutes the foundation upon which the house of culture is built. Art, by contrast, along with such forms as myth and ritual, is supposed to comprise the patterns on the walls, the world of sensory experience as it is refracted through the filters and lenses of the cultural imagination. It mediates a dialogue, not between human beings and nature, but among persons in society. Like language, it encodes meanings. Thus technology works; art signifies: technical action is aimed to produce results in a mechanically determined way, whereas the purpose of art is to communicate ideas. In short, art has been split from technology along the lines of an opposition between the mental and the material, and between semiotics and mechanics (see Chapter Sixteen, pp. 317–18).

Despite the apparent symmetry of this opposition, the respective trajectories of the anthropologies of art and technology have been decidedly asymmetrical. Having been placed beyond the pale of culture and society, as a quasi-autonomous system of productive forces, technology was largely neglected as a subject of anthropological inquiry. Only very recently has the anthropology of technology, as a subfield, begun to acquire a significant momentum of its own. The anthropology of art, by contrast, has long held a secure place in the discipline. But the very reasons that have led to the inclusion of art as an object of study for anthropologists – namely, that it is clearly positioned within a social context and embodies cultural meaning – have also given rise to persistent doubts about the cross-cultural validity of the concept of art itself. How can a concept that carries such strong evaluative overtones, and whose meaning is so closely bound up with widely held ideas about the ascendancy of Western civilisation, possibly be applied without courting accusations of ethnocentrism? Not for the first time, the very credentials that make a phenomenon eminently worthy of anthropological study have cast a pall of uncertainty over whether the phenomenon exists 'as such' at all. It happened with the study of kinship, it happened with the study of art, and now that anthropologists are at last beginning to recognise the social embeddedness of technological systems, it is happening to the study of technology too. No sooner is technology reclaimed for anthropological inquiry, than we cease to know, for sure, what we are dealing with.

The source of the problem, in my view, lies not in the concept of art, nor in that of technology, but in the dichotomy between them. It is this, along with the idea that art floats in an ethereal realm of symbolic meaning, above the physical world over which technology seeks control, that is tainted by its association with modernity. The idea would have made no sense to the craftsmen of Ancient Greece or Rome. They knew what they meant by *tekhnē* or *ars*, and it was a matter neither of mechanical functioning nor of symbolic expression, but of skilled practice. It is my contention that by going back to the original connotations of *ars* and *tekhnē* as skill, we can overcome the deep divisions that currently separate the anthropologies of art and technology, and develop a far more satisfactory account of the socially and environmentally situated practices of real human agents. In what follows I shall pursue three aspects of this task. First, I explain in more depth what I mean by skill. Secondly, I show how the continuity of tradition in skilled practice is a function not of the transmission of rules and representations but of the coordination of perception and action. Thirdly, I show how a focus on skill explodes the conventional dichotomy between innate and acquired abilities, forcing a radical reappraisal of the ways we think about what is 'cultural' and 'biological' in humans. I shall illustrate my argument by way of two examples: Maureen MacKenzie's (1991) study of the looping skills involved in making string bags (*bilum*) among Telefol people of Central New Guinea, and the study by N. E. and E. C. Collias (1984) of the nest building skills of the male weaverbird.

Five dimensions of skill

I begin by drawing attention to five points which I believe are crucial to a proper appreciation of technical skills. The first concerns what it means to say that practice is a form of *use*, of tools and of the body. In one of his dialogues, Plato has Socrates debate with a character called Alcibiades on precisely this question. 'What are we to say of the shoemaker?', asks Socrates, 'Does he cut with his tools only, or with his hands as well?' Alcibiades is forced to concede that he does indeed cut with his hands, and moreover that he uses not just his hands but his eyes – and by extension his whole body – to accomplish the work. Yet he had already agreed, with Socrates, that there is a fundamental difference between the user and the things he uses. So who is this user? If it be man, counters Socrates, it cannot be his body, which is used. Only one possibility remains, it must be the soul. 'So', he concludes, 'do you require some yet clearer proof that the soul is man?' Alcibiades is convinced (in Flew 1964: 35–7).

There is no reason, however, why we should have to follow suit. 'It would be wrong to assume', as Roger Coleman caustically remarks, 'that because Plato was a Greek he knew what he was talking about'. He was no craftsman, and had no practical experience whatever of shoemaking or any other trade. Plato's objective, in forcing a division between the controlling mind and subservient body, was to establish the supremacy of abstract, contemplative reason over menial work, or of theoretical knowledge over practical application, and thereby to justify the institution of slavery (Coleman 1988: 11–12). Resurrected in the Renaissance, Plato's division anticipated the debasement of craft that, as we have seen, came to be one of the hallmarks of modernity. To recover the essence of skill we need a different concept of use from the one invoked by Plato. Instead of thinking of use as what happens when we put two, initially separate things together – an agent with certain purposes or designs, and an instrument with certain functions – we can take it as the primary condition of involvement of the craftsman, with his tools and raw materials, in an environment. In this sense the hands and eyes of the shoemaker, as well as his cutting tools, are not so much used as *brought into use*, through their incorporation into an accustomed (that is usual) pattern of dextrous activity. Intentionality and functionality, then, are not pre-existing properties of the user and the used, but rather immanent in the activity itself, in the gestural synergy of human being, tool and raw material.

My second point follows from this. It is that skill cannot be regarded simply as a technique of the body. This was the position advocated in a now classic essay by Marcel Mauss (1979[1934]). Taking his cue explicitly from Plato, Mauss observed that technique does not, in itself, depend upon the use of tools. Song and dance are obvious examples. The dancer, according to Mauss, uses his own body as an instrument; indeed so do we all, he declares, for the body is surely 'man's first and most natural technical object, and at the same time technical means'. Moreover in the deployment of these means, the human agent experiences the resulting bodily movements as 'of a mechanical, physical or physico-chemical order' (p. 104). This reduction of the technical to the mechanical is an inevitable consequence of the isolation of the body as a natural or physical object, both from the (disembodied) agency that puts it to work and from the environment in which it operates. To understand the true nature of skill we must move in the opposite direction, that is, to restore the human organism to the original context of its active engagement with the constituents of its surroundings. As Gregory Bateson argued, by way of his example of the skilled woodsman notching with an axe the trunk of a tree he is felling, to explain what is going on we need to consider the dynamics of the entire man–axe–tree system

(1973: 433). The system is, indeed, as much mental as physical or physiological, for these are, in truth, but alternative descriptions of one and the same thing. Skill, in short, is a property not of the individual human body as a biophysical entity, a thing-in-itself, but of the total field of relations constituted by the presence of the organism-person, indissolubly body and mind, in a richly structured environment. That is why the study of skill, in my view, not only benefits from, but *demands* an ecological approach.

Granted that the foundations of skill lie in the irreducible condition of the practitioner's embeddedness in an environment, it follows – and this is my third point – that skilled practice is not just the application of mechanical force to exterior objects, but entails qualities of care, judgment and dexterity (Pye 1968: 22). Critically, this implies that whatever practitioners do *to* things is grounded in an attentive, perceptual involvement *with* them, or in other words, that they watch and feel as they work. As the Russian neuroscientist Nicholai Bernstein argued some fifty years ago, the essence of dexterity lies not in bodily movements themselves, but in the responsiveness of these movements to surrounding conditions that are never the same from one moment to the next (Bernstein 1996). Given the freedom of movement of the limbs as well as the elasticity of the muscles, Bernstein had observed, it is just not possible to control the movements of the body in the same way as one might the workings of a machine made up of rigid, interconnecting parts. From a close study of the movements of a skilled blacksmith, hitting the iron on the anvil over and over again with a hammer, Bernstein found that while the trajectory of the tip of the hammer was highly reproducible, the trajectories of individual arm joints varied from stroke to stroke. At first glance the situation appears paradoxical: how can it be that the motion of the hammer rather than that of the limbs is reliably reproduced, when it is only by way of the limbs that the hammer is made to move (cf. Latash 1996: 286)? Clearly, the smith's movements cannot be understood as the output of a fixed motor programme, nor are they arrived at through the application of a formula. The secret of control, Bernstein concluded, lies in 'sensory corrections', that is in the continual adjustment or 'tuning' of movement in response to an ongoing perceptual monitoring of the emergent task.

All this has implications for the way skills are learned, which brings me to my fourth point. If, as Bernstein contended, skilled practice cannot be reduced to a formula, then it cannot be through the transmission of formulae that skills are passed from generation to generation. Traditional models of social learning separate the intergenerational transmission of information specifying particular techniques from the application of this information in practice. First, a generative schema or programme is established in the novice's mind from his observations of the movements of already accomplished practitioners; secondly, the novice imitates these movements by running off exemplars of the technique in question from the schema. Now I do not deny that the learning of skills involves both observation and imitation. But the former is no more a matter of forming internal, mental representations of observed behaviour than is the latter a matter of converting these representations into manifest practice. For the novice's observation of accomplished practitioners is not detached from, but grounded in, his own active, perceptual engagement with his surroundings. And the key to imitation lies in the intimate coordination of the movement of the novice's attention to others with his own bodily movement in the world. Through repeated practical trials, and guided by his observations, he gradually gets the 'feel' of things for himself – that is, he learns to fine-tune his own movements so as to achieve the rhythmic fluency of the accomplished practitioner (for an example, see Gatewood 1985). And in this process, each generation contributes to the next not by handing on a corpus of representations, or information in the strict sense, but rather by introducing novices into contexts which afford selected opportunities for perception and action, and by providing the scaffolding that enables them to make use of these affordances. This is what James Gibson (1979: 254) called an 'education of attention'.

It is because practitioners' engagement with the material with which they work is an attentive engagement, rather than a mere mechanical coupling, that skilled activity carries its own intrinsic intentionality, quite apart from any designs or plans that it may be supposed to implement (see Chapter Twenty-three, p. 415). My fifth point follows from this, and has to do with what we mean by making things. Let me return for a moment to the example of Socrates and the shoemaker. Socrates had asked what it means to say of the shoemaker that he uses tools. The other side of the question is to ask what it means to say that he makes shoes. If use, as Socrates maintained, is what happens when you put an agent having a certain purpose together with objects having certain functions, then the purpose must precede the use through which it is realised. In these terms, to refer to an action as one of making is to refer back to the prior intention that motivates it. It is as though the form of the manufactured object were already prefigured, as a design, in the mind of its maker, such that the activity of making issued directly from the design and served only to transcribe it onto the material. The assumption that every form is the outward expression of design is, as we saw in the last chapter, as prevalent in biology as it is in technology. Thus the form of an organism is said to be given in an evolved design specification, the genotype, in advance of its phenotypic 'expression' in an environment. And in modern architecture the form of a construction is supposed exist in miniature, in models, drawings and plans, before any building work begins (Coleman 1988: 16). To take this view, however, is to deny the creativity of the very process of environmentally situated and perceptually engaged activity, that is of *use*, through which real forms emerge and are held in place. It is the activity itself – of regular, controlled movement – that generates the form, not the design that precedes it. Making, in short, arises within the process of use, rather than use disclosing what is, ideally if not materially, ready-made.

How to make a string bag

Among the Telefol people of central New Guinea, and indeed throughout this region, one of the most ubiquitous and multifunctional accessories to everyday life is the string bag or *bilum*. It is made by means of a looping technique from two-ply string spun from plant fibres. Children are introduced to the techniques of *bilum* making from a very early age. All young Telefol children, both boys and girls, help their mothers and elder sisters in preparing fibres for spinning. 'From the age of about two onwards they begin to experiment with roving, rolling the shredded fibres down their thigh to make a single ply, and progress to experiments with spinning. It is not uncommon to see very young girls, mere toddlers, diligently attempting to loop the string they have made into bilum fabric' (MacKenzie 1991: 101). Boys, as they grow older, do not go on to master fully the skills of looping, for the simple reason that they are soon removed, by the conventions of their society, from the sphere of women's activities. Men have no need to make their own bags, as these are willingly supplied for them by women, who thus maintain an effective monopoly on *bilum* making. Girls, by contrast, remain close to their mothers and other female relatives, and continue to develop their skills, quietly and unobtrusively following in their mothers' footsteps.

All the points I have made about skill, in the previous section, apply to the making of string bags. Apart from the maker's body – and especially her fingers – the only tools used are the mesh gauge (*ding*), made from a strip of leaf, to maintain the constancy of the mesh in an open weave (see Figure 19.1), and the needle (*siil*), made of bone, which is needed for making tightly looped baskets without the use of the gauge (MacKenzie 1991: 73). But in use the needle or the gauge, along with the fingers that hold it, are as much a part of the user as they are used. Moreover the accomplished *bilum*-maker does not experience the movements of her body as being of a mechanical nature. Far from answering to commands issued from a higher source, they carry their own intentionality, unfolding in a continual dialogue with the material. Telefol people liken this movement to the flowing water of a river. Thus the body-in-use is not moved, like a rigid object,

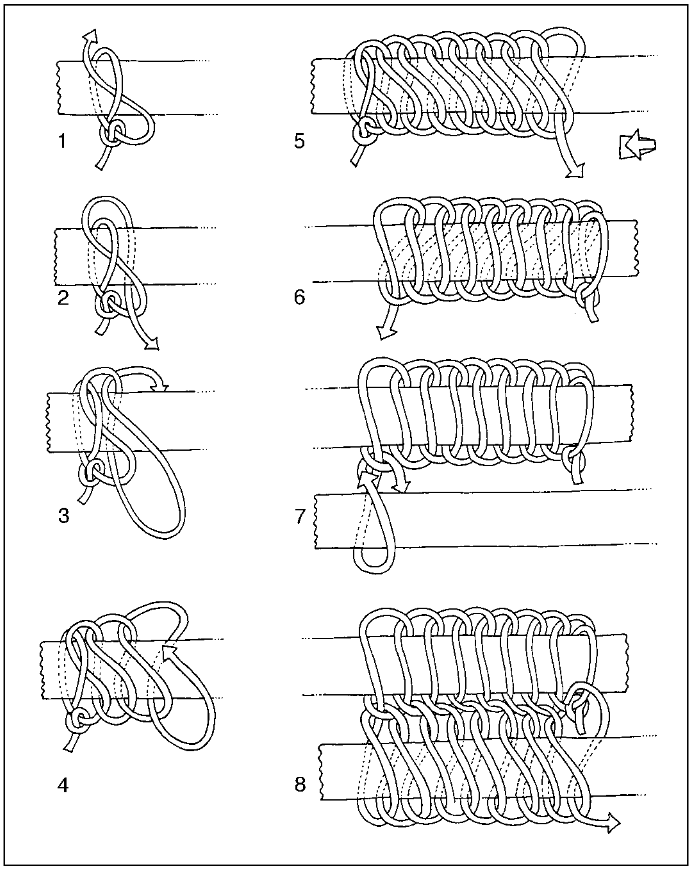

Figure 19.1 The step-by-step procedure for looping a flat strip of 'open, spaced' *bilum* fabric, as practised by Telefol people of central New Guinea. Steps 1–4 show how the first row of loops is constructed around the mesh gauge (*ding*), in a series of figure-of-eight loops with each loop connecting into the preceding one. By stage 5 the first row of loops is completed to the desired width. On completion of each row the work must be turned over so that the working thread is always on the left-hand side. In step 6 the work is thus reversed. Step 7 illustrates how a new strip of *ding* is inserted at the beginning of each successive row. This linear way of working, with each row connecting into the loops of the preceding one, is then repeated (step 8).

From MacKenzie, *Androgynous Objects: string bags and gender in central New Guinea*, published by Harwood Academic, 1991, pp. 86–7.

but rather becomes one with the flow (p. 102). However, in order to maintain the evenness of the string, in spinning, or of the weave, in looping, it is necessary to make continual adjustments in the course of the movement itself. 'By adolescence', MacKenzie writes, 'all girls have mastered the technique of spinning, gaining visual acuity in selecting equal assemblages of filaments during the roving process; and a sensitivity or balance in the amount of pressure applied between palm and thigh during the rhythmic plying motion' (p. 76). As this passage clearly reveals, dexterity in spinning depends on the fine-tuning of visual as well as haptic perception. And it is equally clear that the form of the *bilum* is an emergent outcome of rhythmically repeated, controlled movement in the processes of spinning and looping.

The issue on which I want to focus here, however, concerns how *bilum*-making skills are passed from generation to generation. MacKenzie herself describes this in terms of a fairly conventional model of social learning, according to which 'observation is followed by internalisation and then mimesis' (p. 100). Thus by watching the activity of her mother, a young girl absorbs and assimilates the 'intrinsic rules' of the craft. Once these are firmly implanted in her mind, she can proceed to execute them in the production of her own work. The fact that 'each daughter follows exactly the motor habits and bodily motions of her mother' leads to a remarkable cultural conformity from one generation to the next (p. 103). There is much in MacKenzie's own account, however, to suggest that conformity to tradition is *not* a consequence of the intergenerational transmission of rules or formulae, however intrinsic, but rather the result of a process of guided rediscovery in which the role of experienced *bilum*-makers is to set up the contexts within which novices are enabled to gain in proficiency for themselves, or in other words to 'grow into' the skills of spinning and looping.

First of all, it is clear that to advance in these skills it is not enough for the novice to know how their constituent movements look 'from the outside'; she has also to know how they feel 'from the inside' (cf. Bernstein 1996: 184–5). One young woman, recalling how she learned to loop as a child, told of how she had once tried to carry on with an unfinished *bilum* that her mother had left in the rafters of the house before leaving to work in the garden. She had been carefully watching the way her mother's hands moved as she looped the *bilum*. But on trying it out herself, the result was a disaster. When her mother returned, it took her hours to undo the mess. At first she was angry, but then she lectured her daughter with the following words of wisdom:

> You must practise to get the proper feel of looping. When you've made your first bilum it will be cranky but then we'll throw it in the river. The river will carry your wonky bilum away, and it will wash away your heavy handedness. Then your hands will be good at making bilums, your hands will move easily like running water.
>
> (from MacKenzie 1991: 102)

What does it mean to get the 'feel' of looping? It could mean that the observation on which learning depends is as much tactile as visual, or that the skill is embodied as a rhythmic pattern of movement rather than a static schema, or that the key to fluent performance lies in the ability to co-ordinate perception and action. All three are undoubtedly important, but none more so than the third. For it is this, as MacKenzie herself observes, that makes the difference between clumsiness and dexterity, between having heavy hands and hands that flow. 'Clumsiness, *iluum t'eb'e su* [to be heavy handed], is deemed natural at first, and must be practically worked through' (p. 103).

It seems, then, that progress from clumsiness to dexterity in the craft of *bilum*-making is brought about not by way of an internalisation of rules and representations, but through the gradual attunement of movement and perception. As in any craft, the skilled maker who has a feel for what she is doing is one whose movement is continually and subtly responsive to the modulations of her relation with the material. Conversely, the clumsy practitioner is precisely one who implements mechanically a fixed sequence of instructions, while remaining insensitive to the evolving conditions of the task as it unfolds. The hand that is heavy is experienced as a resistance to be overcome, and has to be moved from position to position in ways that seem contrary to its nature. The light hand, by contrast, finds its way of its own accord. The heavy-handed novice does not, of course, move in exactly the same way as her light-handed mother, nor can she be expected to produce such satisfactory results. This is precisely where the standard model of the social learning of technical skills goes wrong. For in attributing the intergenerational conformity of movements to rules that are transmitted and internalised *in advance* of their practical application in mimesis, the model assumes that practice is a matter of executing identical, rule-governed movements over and over again, leading to gains in speed, efficiency and automation. But a little girl, making her first *bilum*, is quite unable to produce these movements. Rather than repeatedly carrying out the same movements, generated from an already internalised schema, she is repeatedly set the same *task*, generated within the social context of mother–daughter relations. The ability to reproduce her mother's movements with precision, depending as it does on subtle sensory attunement, is not a natural foundation for enskilment but its consequence (cf. Reed and Bril 1996: 438).

Telefol women, according to MacKenzie, place great value on the standardisation of their looping techniques, since this is a way of confirming tribal identity (1991: 103). But I would contend that this standardisation is not brought about, as MacKenzie claims, by conformity to rules. Indeed there appear to be no rules, beyond general exhortations of the kind delivered by the mother to her daughter in the case described above, or vague 'rules of thumb' that help prepare the practitioner for her impending activity but in no way determine its course (Suchman 1987: 52). Like most commonplace practical skills, such as tying shoelaces in Western society, looping resists codification in the form of generative rules or algorithms (Dreyfus and Dreyfus 1987). One becomes aware of this simply by looking at the elaborate diagrams, accompanied by written commentary, by means of which MacKenzie attempts to explain the step-by-step procedure for open-spaced looping (pp. 83–99, and for an example, see Figure 19.1). Though these diagrams are admirable for their intended purpose, of ethnographic description, any attempt by the untutored reader to follow them in practice would likely lead to the same kind of tangle that the inexperienced Telefol girl produces, on secretly attempting to carry on with her mother's work. It would be quite mistaken to suppose that anything remotely equivalent exists in the native mind. But if standardisation does not follow from the application of rules, how are we to account for the persistence of technique from one generation to the next?

Partly in an attempt to answer this question, a group of us in the Department of Social Anthropology at the University of Manchester resolved to experiment with different ways of making knots. One of our experiments was to try making a completely unfamiliar and rather complicated knot, guided only by a manual which provided detailed verbal instructions and step by step diagrams. It turned out to be an immensely difficult and frustrating task. The problem we all experienced lay in converting each instruction, whether verbal or graphic, into actual bodily movement. For while the instruction was supposed to tell you how to move, one could only make sense of it once the movement had been accomplished. We seemed, almost literally, to be caught in a double bind, from which the only escape was patient trial and error. Of course we had resort to the instructions, but far from directing our movements, what they provided was a set of landmarks along the way, a means of checking that we were still on track. If we were not – if the tangle of string in front of us did not match the corresponding graph (and that, in itself, was not easy to discern) – there was no alternative but to unravel the whole thing and start again!

Our experiments seemed to lend strong empirical support for the view that the practices of knotting – which are, after all, among the most common and widely distributed in human societies – cannot be understood as the output of any kind of programme. They cannot, then, be learned by taking any such programme 'on board', as part of an acquired tradition, as if all you needed to know to make knots could be handed down as a package of rules and representations, independently and in advance of their practical application. In our experiments, despite having a manual to consult, we had to develop the necessary know-how from scratch. Generally speaking, of course, this is not a problem that novices face in real life. They are shown what to do by more experienced hands, as we have already seen in the case of the acquisition of looping skills by Telefol *bilum*-makers. But in seeking to emulate the work of the tutor, the novice is guided by the latter's *movements*, not by formal instructions that have somehow been already copied into his or her head. As Merleau-Ponty put it, citing the pioneering work of Paul Guillaume on imitation in children, 'we do not at first imitate others but rather the actions of others, and . . . find others at the point of origin of these actions' (1964b: 117, see also Bourdieu 1977: 87). It follows that the reproduction of movement patterns is a function not of the fidelity with which information specifying these patterns is copied from one generation to the next, but of the co-ordination of perception and action that lies at the heart of practical mimesis.

Dissolving the distinction between innate and acquired skills

It is obvious that Telefol girls have to learn to make string bags. It is not a skill that they are, in any sense, 'born with'. As MacKenzie notes, 'talent in bilum making, that is, having hands which flow, is [defined as] a physically acquired attribute rather than an inherent pre-disposition in the sense that westerners think of ability and talent' (1991: 103). My concern now is to look more closely at what it means to say that a particular skill is acquired rather than innate. I shall do so by way of another example, this time taken from the animal kingdom. For while we are used to thinking of human skills as belonging to this or that cultural tradition, the skills of non-human animals are commonly regarded as properties of their genetically encoded, species-specific nature. What are we to make, then, of the male weaverbird, which carries out the most intricate knotting and looping with its beak in the construction of its nest? The nest building of weaverbirds has been investigated in a remarkable series of studies by ornithologists N. E. and E. C. Collias, and in what follows I draw on their report (Collias and Collias 1984).

The nest is made from long strips torn from the leaves of grasses, which are intertwined in a regular lattice formed by passing successive strips over and under, and in a direction orthogonal to, strips already laid. It is held together, and attached to the substrate, by a variety of stitches and fastenings, some of which are illustrated in Figure 19.2. The bird uses its beak rather like a needle in sewing or darning; in this the trickiest part lies in threading the strip it is holding under another, transverse one so that it can then be passed over the next. The strip has to be pushed under, and through, just far enough to enable the bird to let go with its beak in order to shift its hold and pull it up on the other side. If the free end is left too short, the strip may spring back; pushed too far, it could fall to the ground. Mastering this operation calls for a good deal of practice. From an early age, weaverbirds spend much of their time manipulating all kinds of objects with their beaks, and seem to have a particular interest in poking and pulling pieces of grass leaves and similar materials through holes. In females this interest declines after about the tenth week from hatching, whereas in males it continues to increase. Experiments showed that birds deprived of opportunities to practise and denied access to suitable materials are subsequently unable to build adequate nests, or even to build at all. Indeed, fiddling about with potential nest material appears to be just as essential for the bird, in preparing itself for future building, as are the first experiments of Telefolmin toddlers in roving and spinning shredded fibres for their future *bilum* making (Collias and Collias 1984: 201, 206–7, 212, 215–20).

It is evident from the Collias' account that all the five qualities of skill which, as I have shown, are exemplified in the making of string bags by people of central New Guinea, are also manifest in the nest building of weaverbirds. Though the needle of the *bilum*-maker is detachable from the body whereas the bird's beak is not, in use both are not so much moved as incorporated into a habitual pattern of movement. The abilities of the weaverbird, just like those of the human maker of string bags, are developed through an active exploration of the possibilities afforded by the environment, in the choice of materials and structural supports, and of bodily capacities of movement, posture, and prehension. Furthermore, the key to successful nest building lies not so much in the movements themselves as in the bird's ability to adjust its movements with exquisite precision in relation to the evolving form of its construction. As Collias and Collias report:

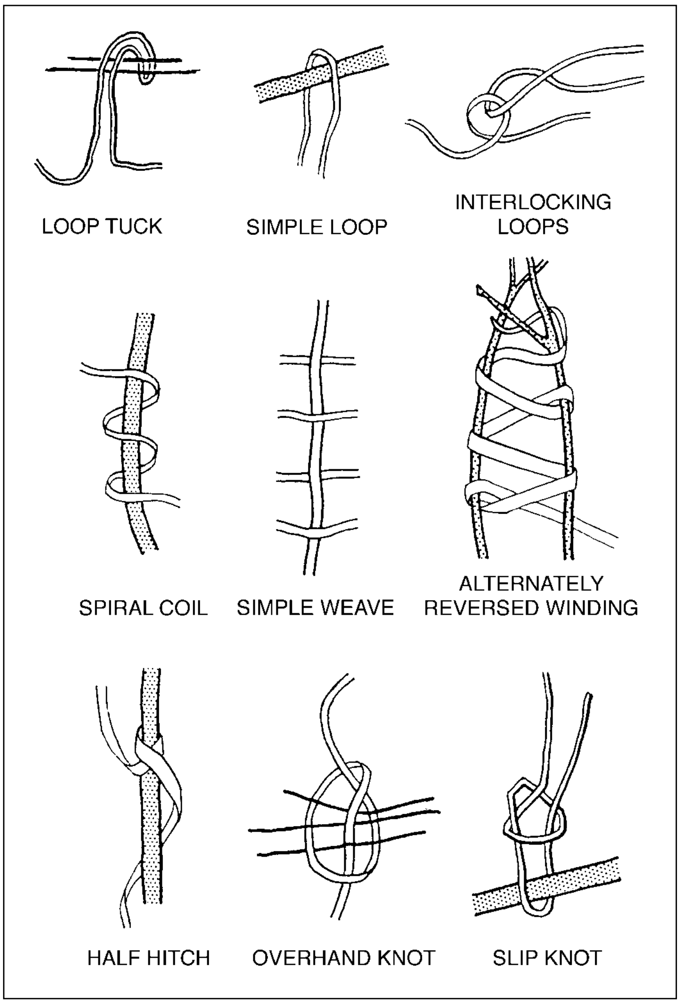

Figure 19.2 Various common stitches and fastenings used by male weaverbirds in constructing their nests.

From N. E. Collias and E. C. Collias, *Nest Building and Bird Behavior*, © 1984 by Princeton University Press, reprinted by permission of Princeton University Press.

> In watching the numerous attempts of young male weavers to fasten initial strips of nest materials and their gradual improvement in weaving ability, it seemed to us that what every young male weaver has to learn is what in subjective terminology one would call 'judgement'.
>
> (1984: 219)

One can sense the reluctance with which these hardnosed empirical observers find themselves having to resort to a notion of this kind. But the evidence leaves them with no alternative. It is clearly judgement, rather than a programme of instructions or a set of design specifications to be mechanically applied, that the bird acquires through mimetic practice. Finally, the form of the nest results from the iteration of a small number of basic movements, and from the fact that the bird stands throughout on the same spot while it weaves all around – above, below and in front – pushing out the developing shell of the main chamber as far as its beak will reach, and then tilting gradually backwards to complete the antechamber and entrance (1984: 193, 209–10).

Given that weaverbirds, in their nest building, exhibit the same properties of skill as are manifested in the looping techniques of the Telefolmin and their neighbours, wherein lies the difference? The conventional answer is to claim that the human *bilum*-maker follows the dictates of an acquired cultural tradition, while the bird works to a template that is genetically transmitted and thus innate. But if, as our experiments with knot-making suggested, there can be no programme for such tasks as knotting, looping, and weaving that is not immanent in the activity itself, then it makes no more sense to interpret the weaverbird's behaviour as the output of a genetic programme than it does to interpret the *bilum*-maker's as the output of a cultural one. In all likelihood the human maker of string bags has an idea in mind of the final form of the construction, whereas the weaverbird almost certainly does not. Yet in both cases it is the pattern of regular movement, not some prespecified design, that generates the form. And the fluency and dexterity of this movement is a function of skills that are developmentally incorporated into the *modus operandi* of the organism – whether avian or human – through practice and experience in an environment.

This last point is absolutely critical. Recall that Telefol girls develop their looping skills at a time of life when their bodies are also undergoing rapid growth. These skills, then, far from being added on to a preformed body, actually grow with it. In that regard they are fully part and parcel of the human organism, of its neurology, musculature, even anatomy, and so are as much biological as cultural. After all, a human being, with its particular aptitudes and dispositions, is a product of neither genes nor culture, nor of both together, but is rather formed within a lifelong process of ontogenetic development. To be sure, the skills of looping are acquired, in the sense that at whatever stage in the life-cycle they may be identified, a history of development already lies behind them. But the same would have to be said of the knotting and looping skills of the weaverbird, and indeed of *any* skill, human or non-human. Moreover one could just as well claim that such skills are innate, in the sense that so long as the necessary environmental conditions are in place (including the presence and activity of already skilled practitioners) they are more or less bound to develop. All Telefol girls learn to make string bags, just as they all learn to walk or to speak. All male weaverbirds learn to make nests, unless opportunities for practice are artificially removed. Conversely, Telefol boys and female weaverbirds never develop full-blown looping and weaving skills, since their respective activities and concerns take them too soon into other fields of practice. In short, whatever the difference between the two sets of skills, avian and human, it cannot be aligned on the axis of a distinction between the innate and the acquired.

This conclusion, however, leaves us with our earlier question unanswered. How, exactly, *do* human skills, such as those exemplified in the making of string bags, differ from those of animals such as the weaverbird? To be frank, I do not pretend to know. I remain perplexed by the question, and have yet to find an answer that is wholly convincing. Once again, however, MacKenzie's study of the Telefol offers a possible clue. It lies in the observation, to which I have already alluded, that Telefol people liken the dextrous manual movements of the fluent *bilum*-maker to running water (MacKenzie 1991: 136). For these inhabitants of intermontane valleys, the current of water in a river or stream is as familiar a part of experience as is the motion of the hands in looping. Now it seems reasonable to suppose, likewise, that the weaverbird has as much of a 'feel' for air currents, while on the wing, as it has for nest materials in building with its beak. However what the bird does not do, so far as we know, is to tie these different strands of perception and action together. If birds were human, they would say that the good weaver is one whose beak seems to 'fly', just as Telefol say that the skilled looper is one whose hands 'flow'. But they do not do this. Human beings, it seems, differ from other animals in that they are peculiarly able to treat the manifold threads of experience as material for further acts of weaving and looping, thereby creating intricate patterns of metaphorical connection. This interweaving of experience is generally conducted in the idioms of speech, as in storytelling, and the patterns to which it gives rise are equivalent to what anthropologists are accustomed to calling 'culture'.

However, culture thus conceived cannot be understood to comprise a system of intrinsic rules or schemata by means of which the mind constructs representations of the external world from the data of bodily sensation, nor can speech be regarded simply as a vehicle for the articulation of these mental representations. Speakers no more 'use' their voice, as Plato would have had it, as the mere instrument of a language-based intelligence, than they 'make' sense by superimposing their pre-existing designs upon the raw material of experience. Rather, in speech, the voice is incorporated into a current of sensuous activity – namely, narrative performance – from which, as it unfolds, form and meaning are continually generated. For speaking is itself a form of skilled practice, and as such, exhibits all the generic properties of skill to which I have already drawn attention. Like any other skill, speech develops along with the growth of the organism, is continually responsive to perturbations in the perceived environment, and is learned through repeated practical trials in socially scaffolded contexts. Above all, it cannot be reduced to the mechanical execution of a rule-governed system, or 'grammar'. Yet speech is no ordinary skill. Weaving together, in narrative, the multiple strands of action and perception specific to diverse tasks and situations, it serves, if you will, as the *Skill of skills*. And if one were to ask where culture lies, the answer would not be in some shadowy domain of symbolic meaning, hovering aloof from the 'hands on' business of practical life, but in the very texture and pattern of the weave itself.