CHAPTER 17

TECHNOLOGY

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1 Introduction

Popular conceptions of 'technology' tend to associate that term with activities governed by science and involving important 'hardware' content; i.e., tools, devices, machines. Conversely, 'technique' would pertain to more mundane activities; built upon non-reflexive routines and implying more direct forms of engagements with materials. This view has been severely challenged for the last three decades. As stressed by Haudricourt (1964) and Sigaut (1987), the 'technology' label should more appropriately designate the 'science of techniques', which is above all 'a science of human activities' (Haudricourt 1964: 28). In this chapter, I will accordingly use the term 'technique' and 'technical practice' in reference to any action upon matter, hereby conceived as a dynamic combination of both tangible (actors, actions, instruments, materials, energy . . .) and intangible (knowledge, representations) components.

That being said, associating techniques with concepts such as 'religion' and 'rituals' may sound a bit unsettling, especially for a Western audience. Granted, we may all think of one or several examples of such association. The Christian cross, for instance, is the main component of a Roman killing technique used together to materialize a religious affiliation and what believers deem to be the core of the Christ's message. Similarly, the design of the tyre-less tractor used in modern Amish communities has clearly been influenced by religious considerations (Morel 2002: 64–6). Apart from these obvious examples, however, a more general consensus is that techniques are essentially utilitarian in nature: they aim at fulfilling basic needs, in the most efficient and rational way possible. Such a 'standard view' (Pfaffenberger 1992) relegates social and symbolic preoccupations to the back of a 'technical core' supposedly governed by physical and functional constraints. Religious aspects, if any, would simply be adjunct to a set of practices and implements that develop essentially outside the cultural field.

This view is not only at odds with the way in which non-Western societies conceive and engage in technical practice (see below), but also the way in which, from antiquity to modern times, techniques and technical actors used to be considered in Western societies. As notably illustrated by Eliade (1962; but see also Gille 1980; Sigaut 1987), inventors and civilizing heroes—purveyors of techniques—have often been associated with magicians or portrayed as tricksters, who relied on ruse and artifices in the conduct of technical activities. In fact, up to the early seventeenth century, science, technique, and magic developed in

close association (Hansen 1986, cited in Sigaut 1987: 17). Things started to change dramatically with the scientific revolution of the seventeenth and eighteenth centuries. On the one hand, techniques were considered from a purely utilitarian and positivist point of view; on the other hand, scholars began to associate them with brainless routine, a segment of human practices less likely than others to give access to cultural values, knowledge, and identities (Sigaut 1987). Having started in Classical Greece, but clashed for centuries with the realities of technical practice (Svenbro 2006), the laicization of techniques was now complete, albeit in a way that subordinated them to a new scientific ideology and mainly provided an impoverished grid of interpretation.

Starting with Mauss (1979 [1934]), social scientists have since then attempted sporadically to break the ideological covering under which techniques were buried. It is only by the late 1970s, however, that a new conception has started to be imposed as a viable alternative, thanks to a multiplication of anthropological, archaeological, and sociological case studies. What follows is a short overview of the way in which social sciences reinvested the technical domain and renewed it with a more culturally oriented conception of techniques that included its religious and ritual dimensions.

2 Technological Style and *Chaîne Opératoire*

For archaeologists on both sides of the Atlantic, 1977 was the year two seminal papers on style came out, that would respectively mark the end and the beginning of an era. The first was by Martin Wobst. It envisioned style as residing in the parts of an artefact relating to its participation in processes of information exchange. In other words, only visible, non-functional, and non-technical parts of an artefact were deemed 'stylistic' and said to inform us about the deliberate marking of social boundaries. Although Wobst did not address the issue of technology, his definition of style may be seen as the epitome of a dualist conception of human practices that clearly separates technique from culture. Widely discussed and criticized during the following decade, it has since been largely abandoned (see David and Kramer 2001: 177–83; Martinelli 2005). The second publication was by Heather Lechtman, a scientist with experience in physics and anthropology, and training in metallography. She viewed style as liable to reside in any part of an artefact, since it corresponded to the material expression of cultural patterning, to which members of a cultural community remained largely oblivious. Style thus reflected pre-existing cultural values rather than the active signalling of identities. Lechtman's decisive contribution came with the concept of 'technological style', defined as a package of 'the many elements that make up technological activities—for example, by technical modes of operation, attitudes toward materials, some specific organization of labor, ritual observances—elements which are unified non randomly in a complex of formal relationships' (1977: 6; see also Lechtman 1984). In Lechtman's view, technology was thus not only intrinsically stylistic; it was also 'culture' in the full sense of the term—an idea quite at odds with the prevailing processualist conceptions of the time (see discussions in Dobres 2000; Childs 1991; Childs and Killick 1993).

Here, I will briefly evoke the historical and anthropological background of her study, for it illustrates how religious beliefs may combine with technical practices, and how we may

grasp this interrelation from material analysis. As with many other archaeologists interested in the development of Andean metallurgy, Lechtman was struck by the very late inception of the bronze technique in the area. During two millennia, Andean metallurgists produced artefacts made from metal alloys—copper with a small proportion of gold and silver—that all had a gilded or silvered appearance. Such colours could be obtained with pure gold or pure silver, but not copper. In that case, the most convenient technique would have been to plate golden or silver leaf on a copper core, a technique used in most parts of the world. Yet, Andean metallurgists relied on a more complex procedure, consisting of a surface depletion of metal alloys aiming at 'developing' gold or silver surfaces. According to Lechtman, such a technique only made sense if the importance of these two metals in Andean cosmologies is considered—gold being assimilated to the sweat of the sun and silver to the tears of the moon—and the fact that Andean people assimilated the outer appearance of things to their inner essence. Thus, using gold or silver plating would have been cheating with nature and the gods: to do things appropriately, gold and silver had to be *embodied* in the copper core, even if this led to their temporary disappearance. In later publications, Lechtman (1984, 1996) showed how such correlation between cosmological representations and technical practice did not only concern metallurgy but also weaving: clearly, Andean technologies shared a common 'technological style' insofar as their constituting elements were unified non-randomly, according to a similar cultural logic.

If not an instant hit, the concept of 'technological style' was definitely growing: by the early 1990s a whole generation of archaeologists were exploiting it outside the Andean and metallurgical domains. Such success may be explained by at last three reasons. First, the concept came at the right moment to rejuvenate a debate on style that was mainly concerned with artefact typologies and the marking of identities. Second, Lechtman demonstrated that there could be more in laboratory analyses than the seemingly useless—and definitely boring—columns of number that had plagued much of the archaeometrical literature so far. In that regard, her case study illustrated how careful laboratory analyses were actually the best way to explore such crucial aspects as the technical embodiment of cosmological representations. Third, and more importantly, Lechtman's work was in step with a growing body of studies developing nearly independently among English-speaking (Pfaffenberger 1992; Dobres 2000) and French anthropologists and emphasizing the cultural dimension of techniques.

The latter gravitated around the Musée de l'Homme and the team 'Techniques & Culture' at the CNRS, and included people such as Hélène Balfet, Bob Creswell, François Sigaut, Marie-Claude Mahias, Pierre Lemonnier, and Marie-Noël Chamoux—some of whom had been the students of André Leroi-Gourhan and André-Georges Haudricourt (themselves former students of Marcel Mauss). All these scholars did not approach techniques from the same angle: some focused on economy; others on history and cultural geography, or social and symbolic dimensions. Yet they all shared the belief that ethnography would benefit as much from an analysis of technical systems as it already did from that of social or matrimonial systems. They also shared a common analytical tool—the *chaîne opératoire* or operational sequence—initially developed by Leroi-Gourhan (1964), and corresponding to the analysis of the series of operations involved in any transformation of matter (Balfet 1991; Lemonnier 1992: 26; see also Creswell 1983).

English-speaking scholars tend sometimes to confuse this concept of *chaîne opératoire* with a theoretical or philosophical point of view; a way of stressing the cultural dimension of

technical actions. Actually, the *chaîne opératoire* is an *analytical tool* aiming at documenting activities in the field or in the archaeological record and, as importantly, for ordering the data in view of subsequent comparisons. What is actually compared, as well as how things are interpreted, depends largely on theoretical perspective (e.g., Marxism, structuralism) of scholars. *Chaîne opératoire* remains nevertheless a powerful analytical tool because it imposes systematization in data collection, as well as the acknowledgement of a variety of elements—location, actors, gestures, tools, raw materials, duration, organization, vocabulary, rituals, and taboos, etc.—that are invariably brought together in the conduct of technical activities. Such a collection of elements reminds us of the 'package' evoked by Lechtman (1977: 6) in her definition of 'technological style'. As an analytical framework, however, the *chaîne opératoire* allows for a more systematic and comprehensive exploration of the nature of, and relationships between, the constitutive elements of techniques.

Given the topic of this handbook, I will focus on studies that aim at exploring the social and symbolic dimensions of techniques. Pioneered by people such as Pierre Lemonnier (1986, 1992, 1993), they currently constitute an impressive body of work. Their basic assumption, rooted in structuralism, is that all techniques of a given society form a 'system', within which various categories of tools, devices, actions, materials, and knowledge are interrelated, both socially and historically (Gille 1978; Lemonnier 1992; for a similar conception among English-speaking historians, see especially Hughes 1983). These elements, as well as their combinations, are 'arbitrary', in the sense that they do not stem from technical or functional constraints, but are chosen, deliberately or not, among equally viable options. They are also 'conventional', in the sense that they are generally congruent with, and constitutive of a wider system of social conventions. (Petroski [1993: 220–5] provides a good example of the combined effect of arbitrariness and conventionality in retracing the changing packaging of McDonald hamburgers.) In order to approach the social logic that lies behind technical choices, data collected through *chaîne opératoire* analyses must be compared at three levels: (1) elements constituting a given technique; (2) set of techniques developed by a given society, whose interrelation constitute a 'technical system'; (3) relationships between a technical system and other elements of social organization (Lemonnier 1983). As stressed by Mahias (2002: 43–44), anthropologists have focused in particular on the first and third levels of comparison, perhaps because such analyses do not require exhaustive inventories of techniques. Her detailed comparison of several production techniques in India demonstrates, however, that one does not require exhaustiveness for reconstructing a technical system, especially if paying attention to elements such as vocabulary or body grammars.

The following section summarizes some of the post-1970 anthropological contributions to the study of techniques.

3 Great Expectations

Iron-smelting and blacksmithing have been especially explored in Africa, where these activities are not only surrounded by rituals and taboos, but also associated with human gestation, fertility, and rituals of power in a variety of ways. Such an association materializes, notably, in furnaces being conceived as a female belly/uterus and decorated accordingly with breasts, genitals, scarification, and necklaces; in bellows being conceived as male

genitals and bellowing noise as the sound of sexual intercourse; in songs praising the fertility of the furnace/bride; or in blacksmithing hammers being used both as symbols and makers of political power (see, among many others, Barndon 1996; Childs 1991; Childs and Killick 1993; David and Kramer 2001: 328–47; Haaland et al. 2002; Herbert 1993; Maret 1985; Schmidt 1997). According to Rowlands and Warnier, the analogy between smelting and the reproduction process may be less indicative of a representation of fertility as a metaphor of iron-working, than of a context in which 'smelters and smiths appear to have regarded themselves as facilitators in what we would call a *natural process* by which certain materials in nature transformed themselves into a substance which could be adapted to culturally useful ends' (1993: 541). Hence their possible intervention outside the field of iron-making (e.g., for curing presumably frigid or barren women), and the ambiguous social position of blacksmiths (Hoberg 2001; Maret 1980), that culminates throughout the African Sahel in blacksmithing being often practised by members of endogamous socio-professional sub-groups or 'castes', who act as main ritualists. Comparing data collected in Nepal and East Africa in view of assessing the technical grounding of the symbols people 'spin' around iron-working, Haaland et al. (2002) also point out that smelting and forging do not offer the same potential in that regard. The first centres on an invisible process of transformation in which objects and actions are strongly reminiscent of sexual intercourse and gender imagery. The second is a visible process through which the blacksmith gives shape to the bloom, an activity that 'can be made relevant to understanding domains related to the theme of giving shape and creating order' (2002: 53). In Africa, this would explain the frequent occurrence of blacksmiths' tools and mentions in kingship rituals (Maret 1985, Ch. 66, this volume; Reid and MacLean 1995).

Pottery-making is also an activity 'good to think' for those who practise it (Lévi-Strauss 1988). Following Lechtman, Sillar (1996) provides a fascinating illustration of a south-central Andean 'technical system' in which pottery techniques, food production, food processing, and mortuary practices are connected, both metaphorically and practically, through a series of transformation processes—digging, drying, soaking—that seem to structure both the technical and the social world (Figure 17.1). This symbolic emphasis on transformation in pottery making is a common phenomenon that has been commonly discussed in relation to African material (Berns 1993; Barley 1994; Gosselain 1999; McLeod 1984). Throughout the continent there exists what Barley calls a 'potting model' (Barley 1994: 138), associating pots and pottery techniques to transitory states, fertility, death, and bodily cavities, and placing them as efficient tools for explaining natural processes or shaping cultural ones. For example, pottery-making is metaphorically associated with human gestation—in much the same way as iron-smelting—with a pot/foetus thought to result from the mixing of female (clay) and male (water or temper) elements, hardened in a fire/uterus, and born with the help of a potter/midwife, who may subsequently strengthen it through similar treatments as those used for newborns (see examples in Gosselain 1999). Similarly, potters, pots, and pottery tools and techniques may appear in puberty rites, marriage ceremonies, or funerals. The breaking of a vessel, for instance, may materialize death; yet pots may also serve as receptacles for ancestors and media for communicating with them (Berns 2000; Sterner 1989).

As in the Andean example evoked above, David (1992: 193) observes that some north Cameroonian populations liken the grave to a pottery vessel, a granary and a uterus, 'all appropriate abodes for the process of ancestralization through germination, gestation, and

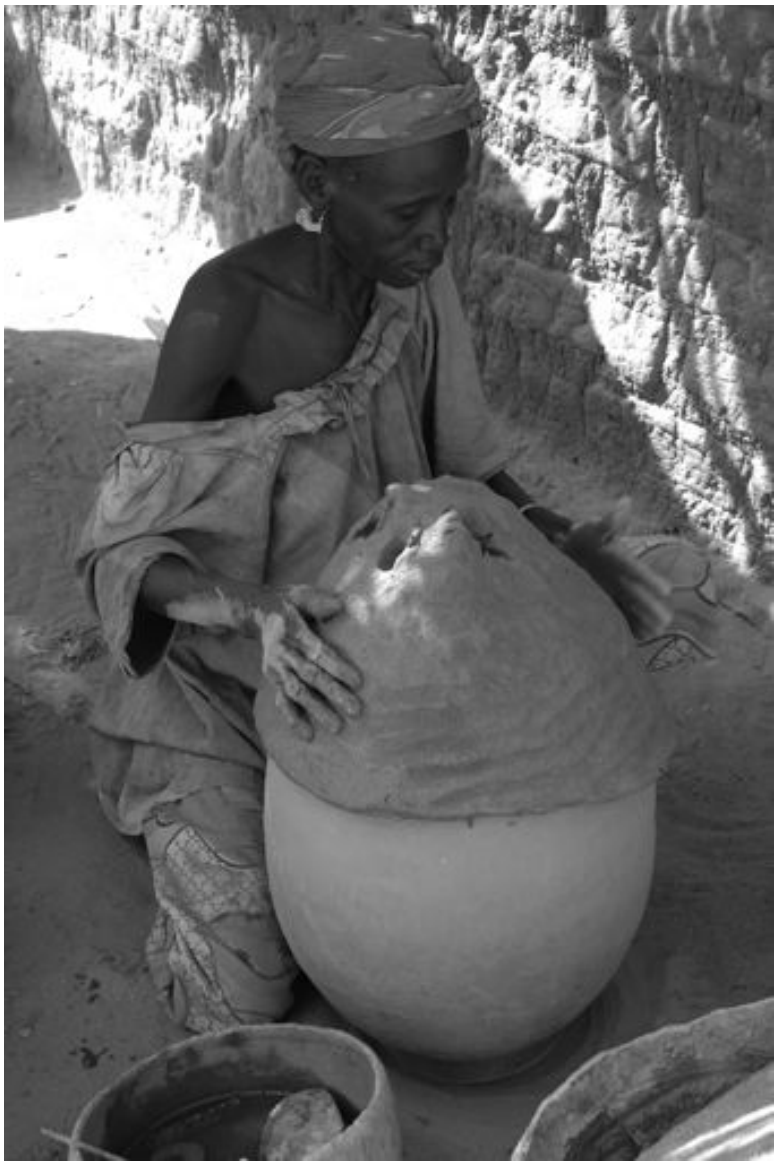

FIGURE **17.1** Initially soft, plastic, and moist, clay is durably transformed into a hard and resonant material through the action of fire. Such properties provide a series of technical metaphors that have been heavily exploited throughout the world.

possibly fermentation'. Pots are also frequently likened to human beings, in Africa as in other parts of the world, which translates into parallels between body and vessel ornamentation, with numerous occurrences of clay, clay firing, and fired products in creation myths and proverbs, or pottery parts being designated after body parts (David et al. 1988; Erikson 2002; Gosselain 1999, 2008; Mahias 1993; Ritz 1989). Combined with the fact that pottery-

making is usually practised within domestic contexts, this anthropomorphization of pots and potting processes is often viewed as the main reason why the craft is preponderantly in the hands of female potters across the world (e.g. Vincentelli 2003): as women give birth to human beings, so should they also 'give birth' to human-like objects. But controlling natural elements such as clay and fire also places them in an ambiguous position, both dangerous and powerful. As blacksmiths, they may consequently occupy a singular social position and act as prominent ritualists and/or providers of ritual tools and metaphors (Barley 1994; see Mahias [1993] and Saraswati [1978] for examples in India). The context in which potters enter the craft, as well as the way they practise it may also be surrounded by a series of taboos and rituals aiming at protecting individuals from the dangers of manipulating clays and fired products.

Of course, the symbolic prominence of fire and heat are not confined to pottery- or iron-making (see de Heusch 1972, 1982; Jacobson-Widding 1989). In the Irian Jaya region of New Guinea, for example, large circular fires are used for cooking meat and tubers (with the help of heated stones), for heating blocks of stone in order to obtain plates from which axes will be roughed out, and for making salt. The connection transcends technical actions and devices, since both stones and salt are considered as the body parts of mythical heroes, classed among 'hot things' (with pork grease), and cooked in highly socialized contexts. According to Pétrequin et al. (2000: 562–3), the underlying logic pertains to hot, dead organisms that must be cooked and distributed in a ritual anthropophagous context in order to reproduce the ideal functioning of society. And as for metal or pottery objects, the fact that production techniques are embedded in mythology and social practice transforms certain axes, salt-making tools or objects made with pork tusks into sacred objects, that are subsequently used for ensuring the fertility and power of lineages. Note that such a combination of technical, symbolic, and social concerns has also been splendidly illustrated by Lemonnier (1993) in his study of the Anga eel-trap or, more recently, drums used by Ankave people in ritual ceremonies (Lemonnier 2004).

In the Irian Jaya example, fire and heating were the nodes linking food preparation, salt-making, the shaping of stone axes, and social order. In India, Mahias (2002) documents a different linking process, centred on milk and especially the production of butter—one of the 'ramparts' of ritual purity—through churning. Besides the uses of lacteous products and the references made to the processes of milk transformation in ritual contexts, 'churning' stands as a prominent metaphor in mythological accounts and daily life. For example, the components and structuring principles of the universe are said to proceed from a churning of the 'sea of milk', accomplished by gods and demons with the help of a mountain serving as a rotating whipping tool and set in motion with a snake/rope. This rotating device, used throughout India for churning milk, is similar to that formerly used for producing fire, a technique strongly associated with the act of procreation. Interestingly, after the introduction and generalization of matchsticks, the technique has survived in ritual contexts, such as the lighting of sacrificial fires or funeral pyres. (Frazer [1984: 74–88] cites a similar example: on Easter day, Greek Orthodox priests lit a fire in front of the church with a flint and steel. The faithful took brands from this fire and re-lit their own kitchen fires.) As concluded by Mahias (2002: 58–9), similar gestures and modes of action 'reveal' the fire hidden in the wood or the butter hidden in the milk. In both cases, the aim is to overturn a primary state, chaotic or inert, in order to transform it into something both fertile and having the ability to create, be it the cosmological or the social order. The symbolic

FIGURE **17.2** The 'mystic mill' chapter, Cathedral of Vezelay (France). After its inception in the twelfth century, the mill became the main metaphor for explaining the incarnation of Christ and the Church. Here, Moise pours the grains (words of God) into a mill (the Christ) activated by Paul, who collected the flour.

representation is thus an integral part of the techniques, but it requires a material (technical) support to be *activated*. In other words, rituals are not simply 'nurtured' by technical metaphors, or technical mimicking: their ability to transform people and the world may be drawn from technical actions themselves.

Europe and the Mediterranean world provide another fascinating example of the symbolic dimension and ritual exploitation of food processing. As the main staple food for millennia, bread has become a metaphor for life. Since antiquity, it was associated with gestation and the human body, since yeast makes the dough bulge as the 'breath of life' makes the foetus grow in a woman's womb (Gélis 1984). Every tool and device used in the bread-making process is thus embedded in a similar web of significance (Macherel and Zeebroek 1994). For example, the oven is likened to a uterus and the wooden stick used for cleaning the oven to a penis. Also, the word 'placenta' is a scientific translation of the popular word 'cake' (Gélis 1984). Through centuries, the Christian Church manipulated these powerful symbols, adapting them to its own agenda and developing new metaphors, in close connection with technical innovations. After its inception in the twelfth century, for instance, the mill became the main metaphor used for explaining the incarnation of

Christ and the Church: the mill transformed the grains of the Christ's words into hosts (the body of Christ) that would subsequently be shared by the faithful, through a process that reified the role and position of the Virgin, the Apostles, the pope, the bishops, and the priests (Figure 17.2; Pierce 1966; for a further illustration, see the Host Mill altar piece [around 1470], Ulm, Ulmer Museum, Germany). As in the case of iron- or pottery-making, and with striking symbolic correspondences, bread-making techniques served thus as a convenient referent for explaining and teaching religion, for reifying a social (and religious) order, and for making sense of biological experiences.

4 Problems and Prospects

Cultural approaches to technology have of late clearly influenced anthropological and archaeological reasoning. Even if former techno-functional conceptions are currently being recycled into neo-Darwinian research programs (e.g. O'Brien and Lyman 2003), those remain fortunately marginal. As put by Küchler (2006: 325), '"technological determinism" gave way . . . to a large number of theoretical frameworks that have in common to largely accept as a premise that there are social influences in technology, having replaced the earlier impact-driven theory with a notion of a "seamless web" of social and technological dynamics'. We cannot ignore, however, that these theoretical frameworks have also brought their share of conceptual and methodological problems. What follows is a brief evocation of some questions generated by studies that seek to explore the symbolic dimensions of technical practices.

To start with the trivial, the quest for 'world views' and 'symbolic logics' should not make us forget that there is always more at play in technical processes than religious or ritual concerns. Doing things is not just enacting world views; it is also responding to economic, social, political, ecological, *and* functional concerns. The nature and characteristics of the action itself, the materials involved and the surrounding environment also play a crucial role, in channelling behaviour—or, more appropriately, creating the conditions of its actualization (Ingold 2000, 2007; Lemonnier 1992; van der Leeuw 1992). In their eagerness to denounce the fallacies of the materialistic approach to technology, some, for example, have gone as far as stating that 'pottery- and iron-making are social rather that material necessities' (Pinçon 1999: 4), a conception as misleading as the ones it seeks to oppose. Indeed, thinking about the relationship between procedures, goals, and meaning is not a question of calculating their respective weight, but, more simply, of acknowledging their simultaneous occurrence and complete tangling (Lemonnier 1991: 17).

This said, an ongoing question is by what actual 'means' are those symbolic representations embedded in, and generated by, technical practice. Here, I am considering the actors' point of view as well as that of those scientists interested in a better understanding of cultural practices. When considering the anthropological and ethnoarchaeological literature of the last decades, one gets the impression that the 'social representations' attached to technical procedures pertain largely to the religious and magical domains. To paraphrase Bourdieu (1980: 88), they also appear as big 'structured' and 'structuring' principles—or logics—that not only loom over individuals and societies, but also overflow the boundaries of individual techniques. What is, then, their capability to affect technical choices, beyond

rationalizing, at a representational level, a set of practices already acquired through socialization processes? And could it be that such systems exist *outside* history?

A related question is that most—if not all—the symbolic systems evoked above develop within a web of metaphors linked to transformation processes: natural/biological transformation, technical transformations, social transformations, ritual transformations. Of course, there are notable differences in the nature and association of these metaphorical referents, which allows for singling out sub-Saharan systems of thought from New Guinean ones, for instance, or Indian and European ones. But there are also similarities, as notably highlighted by Haaland et al. (2002). And even when considering discrete areas, the tendency is for symbolic systems to overlap social boundaries. What is therefore their cultural and historical significance?

In a cross-cultural comparison of taboos, rituals, and representations linked to pottery making in sub-Saharan Africa, for example, I identified a similar logic spreading throughout the continent and materializing in associations between pots and people, pots and uterus, potters and pregnant women, pottery-firing and birthing, or the breaking of a pot and death (Gosselain 1999). Those associations are shared by people living in distinct cultural contexts, with few—if any—historical ties. Hence they do not provide any clue in regard to social boundaries or culture dynamics. We have seen, moreover, that these metaphors are also widely attested outside the African continent. So, when the archaeologist Goce Naumov (2006) observes parallels between pots, ovens, houses, women, wombs, and burials, in Neolithic cultures of the Balkans, he rightly concludes that the symbolic system is built upon notions of transformation, regeneration, and female fertility. Does it follow, however, that since similar conceptions have been documented among modern Slavic populations, archaeological evidence 'reveal[s] the deep roots of several Slavic rites and practices from the [nineteenth] and [twentieth] centuries' (Naumov 2006: 84)? I would say no.

More prosaically, if people living in different contexts draw similar symbols from pottery-making, it is because these symbols are 'afforded' (in the sense developed by Gibson [1979]) by the physical characteristics of the activity; because the very materiality of the craft offers a set of representational possibilities and opportunities. To be sure, such 'affordances' are always numerous. Their recognition and exploitation may also vary according to the cultural background of individuals. But some affordances are so salient as to literally 'impose' themselves on us. Pottery-making, for example, necessarily involves the shaping of a moist, plastic material, and its transformation by fire into a different material. When related to other salient qualities, such as the biological functioning of the human body, it seems nearly unavoidable that similar symbolic representations will be generated. This is not new. In his *Psychoanalysis of Fire*, first published in 1938, Bachelard (1987) already documented these 'natural analogies', to which humans gain access by virtue of their own nature (see also Eliade 1962). As concluded by Lemonnier (2006) in his comparison of witchcraft in Papua-New Guinea and fifteenth- and sixteenth-century Europe, such categories of symbols may be likened to a sort of 'background noise', that hampers the exploration of cultural specificities and dynamics, in diverting our attention toward universal cognitive processes.

If, on the contrary, we consider these natural analogies as a baseline, a first level of potentialities offered to people by simply being and acting in the world, the next logical step is to explore how such potentialities are actually exploited in the course of history. This direction has notably been followed by Webb Keane (2005). Drawing on the 'logical-causal'

model of semiotics developed by Charles Sanders Peirce, he emphasizes the ongoing potential of objects to bring new realizations into new historical contexts, due to their material qualities. Such qualities form 'bundles', which are only partially exploited by semiotic ideologies, opening the way for new significations. As put by Keane (2005: 12), 'the work of selecting and stabilising the relevant bundles of iconicity and indexicality, the semiotic ideology this involves, is a project that can in principle never be completed, or fully consolidated. As such, semiotic ideology is necessarily historical.'

To come back to pottery-making, one sees that the potentialities offered by the craft do not necessarily relate to its pyrotechnological aspects. Socrates, for instance, compared a life conducted without thinking to the attempt of shaping a pot without following, or even knowing technical procedures (De Botton 2001: 21). The focus was thus put on the complexity of the craft (used here as a metaphor for existence) and on the subsequent impossibility of carrying it out by mere intuition. A similar metaphor is developed by Mintzberg, who urges modern corporate managers to 'craft' strategies with 'an intimate knowledge of the materials at hand' (1987: 67). But even if considering the metaphorical use of potting techniques in relationships with natural and cultural transformations, as I have done so far, one does not need to dig much to see the diversity of ways in which it may be stated from one population to the next (e.g. Barley 1994; Gosselain 1999). Rather than seeking to reconstruct coherent and widely shared structures of thought through comparison, we should thus focus on internal variations within such systems and, above all, look for the development of systems of opposition within sets of adjacent (or more remote) populations. This certainly requires a shift in the spatial scale of analysis, as well as the level of detail taken into consideration, but not necessarily a rejection of structuralism. On the contrary, exploring the processes that underlie regional systems of opposition is a way of concretizing its potentials as a historical method (de Heusch 1993).

Another question, related to the preceding, is what people actually know about, think about, and do with the symbolic and ritual aspects of technical processes (see especially Dobres and Hoffman 1994). Those 'underlying logics' reconstructed from observations and interviews often appear to exist beyond the grasp of the people we work with. As put by a Cameroonian informant, 'when ancestors leave you prescriptions they never take the trouble to explain the meaning' (Gosselain 1999: 206). Symbolic systems would thus loom over people and have a deep impact on practice, without people being necessarily aware of their existence or having the capacity to alter or adapt them to changing circumstances. This later conception has been strongly criticized by the historian Marcia Wright (2002). Reconstructing the life trajectory of a Tanzanian master smelter, she shows that the stability and importance of rituals in iron-smelting may have been overemphasized by ethnoarchaeologists. Indeed, post-1950 reconstructions were decontextualized performances achieved mainly by individuals whose role in the activity had formerly been peripheral. They consequently placed processes and rituals at the 'heart' of the event, for such components of the technique were those that they could more easily single out and analyse 'scientifically'. The biography of Mzee Stephano—the master smelter—reveals, on the contrary, that symbolic prescriptions were easily downplayed in the normal course of activities, for instance when faced with an economic challenge such as an increase in the regional demand for iron tools (e.g., the smelting took place within the village, it involved male and female individuals unrelated to the craft). Neither sticking to the 'tradition' nor

fully embracing colonial practice, Mzee Stephano was simply adapting to a changing context, without compromising his craft, identity, or social position.

Wright's observations are reminiscent of those made by Michael Rowlands and Jean-Pierre Warnier in regard to iron-smelting in the Cameroonian grassfields. First, they identify what they call a 'secularization' or 'disenchantment' of the symbolism of iron production in certain communities; second, and more importantly, the symbolic code is seen to allow 'the producers to have a fairly clear representation of what is going on, and how to cope with technical breakdowns' (Rowlands and Warnier 1997: 538). Such a representation, they add, constitutes 'an intellectual *bricolage*', 'functionally equivalent to the scientific and empirical knowledge of the metallurgical engineer'. Instead of viewing symbols and rituals as the passive (and mainly involuntary) testimonies of a wider system of thought—that mainly exists *outside* the field of technical activities—we should thus consider them as tools in their own right; that is, as components of any artisan's toolkit, liable to be used and adapted strategically in the course of activity.

This opens a series of possibilities that do not necessarily exclude one another, contrary to what Rowlands and Warnier seem to imply in their critic of van der Merwe and Avery's (1987) functional interpretation of magic in African iron-smelting. At a first, basic level, controlling or coaxing natural forces, ancestors, and deities would be a way of coping with the uncertainties surrounding most technical processes, even in overtly laicized contexts of production (Svenbro 2006: 33–5)—a required skill, thus, but not necessarily one that supersedes others. For example, I have often been struck by those artisans who, having vehemently stressed the importance of respecting taboos while carrying out an activity, would, if faced with unexpected failures, explain them in purely technical terms (e.g. 'the clay was not sufficiently dry', 'there has been a gust of wind during firing'). Clearly, resorting to symbols and rituals did not exonerate them from developing an accurate knowledge and mastery of technical actions. Should such symbols and rituals be conceived therefore as a sort of supplementary safeguard? Or is it, as suggested by Gell (1988: 7–8), that 'magical thought formalizes and codifies the structural features of technical activity, imposing on it a framework of organization which regulates each successive stage in a complex process'? This conception of magic as adjunct to technical practices and serving cognitive ends (just as the 'intellectual *bricolage*' highlighted by Rowlands and Warnier [1997]), seems to be corroborated by historical documents such as the written formula of Western medieval dyers or painters (Pastoureau 2006: 64–7). Two categories of texts are indeed uncovered by historians: short, practical ones, that may have been used in workshops on a daily basis, and long, philosophically oriented ones, whose actual purpose remains unclear.

Other kinds of relationships between techniques and magic should also be envisioned, as suggested by van der Merwe and Avery (1987). For instance, esoteric knowledge is a way of maintaining a monopoly on craft activities, but also of negotiating social status. Here again, practices and representations depend heavily on historical and cultural contexts. For instance, many Kanuri blacksmiths of eastern Niger, who had formerly occupied a low social position when practising the craft, have reinvented themselves as Muslim scholars. They explained to me that they owned their power and knowledge—widely recognized locally—from carrying a 'blacksmith's hammer' in one hand and the Koran in the other. In other words, it is the combined use of Muslim and non-Muslim esoteric knowledge that empowers them and provides an efficient way to redefine their social position. Yet, knowledge and skills do not necessarily need to be conceptualized as 'esoteric' for being

attributed magic-like qualities and exploited in social negotiations. Jeanjean (1999) provides a fascinating example of the way in which town sewer workers of Montpellier (France) tend to mask technical skills and knowledge when operating in public, presenting successful interventions as strokes of luck. Success is not associated to the rational linking of particular actions, but to an undetermined 'something else', from which sewer workers draw their power in the eyes of watchers. There is something akin to magic, concludes Jeanjean (1999: 81), when soiled waters spring again; an effect deliberately sought by workers for, as in the case of Kanuri *mallam*, it allows them to redefine their professional image.

Finally, the symbolic aspects of craft activities may also be exploited outside the technical domain, by a wider range of actors. This is the case in southern Togo, where blacksmithing has become one of the main expressions of social order for Ewe people (Mace 1998). Said to be the abode of Nyiglà, a powerful voodoo that protects the whole community, the smithy is regarded not only as the production place of necessary tools, but also as a shelter, a safeguard against the troubles and dangers having plagued the country since the re-election of G. Eyadéma in 1993 and the devaluation of money in 1994. Technical and symbolic values are thus used by a community to define and reinforce itself vis-à-vis others, through a process that, even if relying on ancient—so-called 'traditional'—world views, is plainly inscribed in modernity.

5 Conclusions

If anything, I hope to have made clear that techniques are not only cultural productions in their own right, but cultural productions that should be taken most seriously by social scientists. They correspond to 'ongoing and unfinished process[es] . . . through which people, society, and materials together weave and reweave the meaningful conditions of everyday life', as put by Dobres (2000: 4). They are thus 'ways' of acting upon the world, not only to fulfil economic or biological needs, but also to fulfil social, political, religious and symbolic ones. Besides illustrating the rich symbolic web that surrounds technical practices, recent anthropological and sociological studies have also documented their ability to create crucial aspects of the world inhabited by humans. And this goes far beyond the daily production of material culture or the modification of the physical environment. As we have seen, techniques are also used to transform people through the ages of life; to create, maintain, or abolish meaningful boundaries such as gender, age groups, and social entities; to generate social order and political power; to carry on ritual actions; and to cope with the uncertainties of daily life. In other words, techniques play a role in transformations that largely exceed action upon matter. Exploring these crucial issues requires first that we get rid of the positivist and utilitarian ideology that shaped our relations to techniques since the eighteenth century; second, we should develop more appropriate methods for exploring both the historical dimension of technical systems and processes of individual appropriation and transformation of practices. Some steps have already been made in that direction, as I showed above.

In closing this chapter, I would like to stress that the salutary turn taken by social scientists in regard to techniques and material culture could also benefit those interested in rituals and religion. Mitchell (2006) reminds us that performances taking place during feasts and

rituals have transformative potentialities that develop from an interaction between things, places, time, and the body. In this regard, rituals should be taken as seriously as techniques; that is, not simply considered as categories of actions that lack technical motivation (e.g. Whitehouse 2002). Indeed, if rites, myths, and actions upon matter are completely intricate in technical practice, why should ritual actions be analysed as a distinct category of cultural production, disconnected from other realms of human experience? As with Lemonnier (2006: 38–9), I suspect that *chaîne opératoire* analyses of rituals will open new avenues in the study of religion.

Suggested Reading

From the mid-1970s onward, hundreds of ethnographic studies aiming at documenting the cultural dimension of technical practices have emerged throughout the world, forming a field of investigation that, while incredibly heterogeneous in regard to the nature and purpose of individual contributions, has had a deep and lasting impact on anthropological and archaeological practice. Here are some references that may prove useful for archaeologists. Readers interested should look at issues of *Techniques & Culture, Technology and Culture*, *History of Technology*, or *Journal of Material Culture*, among others. They should also consult the recent compilation of ethnoarchaeological studies made by David and Kramer (2001) and publications such as Cohen and Pestre (1998), Dobres (2000), Dobres and Hoffman (1999), Küchler (2006), Lemonnier (1993, 2004), Mahias (2002), and Pfaffenberger (1992). Part 3 ('Skill') of Ingold (2000) is also of great interest, for it covers topics not addressed in other works. And, of course, readers would be well advised to check the works of Leroi-Gourhan, Haudricourt or Balfet, some of which are referenced in this chapter.

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