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From mechanics to embodiment.
Some theoretical considerations on techniques[1]

ABSTRACT: *Archaeological research often tends to consider ancient techniques as a mechanical process, which simply materializes mental representations. This Cartesian perspective draws the attention away from the human sensual involvement and reduces techniques and in general crafts to externalized knowledge or bare information of mechanical functioning and hence clearly distorts our ideas of ancient crafts. In this regard the paper surveys as a first step the different theoretical currents which have guided our approaches to techniques until very recently and finally proposes how we could further explore and integrate aspects of embodiment and "tacit knowledge" within our reflections about making to finally enrich our often distorted mechanical view on ancient techniques.*

KEYWORDS: CRAFT, TECHNIQUE, TECHNOLOGY, EMBODIED KNOWLEDGE, THEORY

> *In my own collaboration with painters, sculptors and craftsmen extending over four decades, I have learnt to admire their capacity to grasp essences of things through their hands and bodies, and through their non-conceptualised existential understanding rather than through intellectual and verbal analyses. They rely on the silent wisdom of the body and hand.*
> (Pallasmaa 2009, 117)

Introduction

Cultural approaches to crafts and the involved techniques have been a major issue in archaeological and anthropological research for a rather long time. This specific interest holds particularly true for the French tradition of anthropology, where different theoretical approaches have been discussed and developed to achieve a better understanding of the action leading to finished artefacts (Leroi-Gourhan, 1943; 1945; Creswell, 1972; Digard, 1979; Lemonnier, 1976; 1991; Gosselain, 1992). In contrast to this vibrant intellectual discussion circling around the topic of making, archaeological studies have long been restricted to finished artefacts and their typology and did rarely expand to the making itself. With single exceptions as for example the earlier studies of Tixier (1967), this particular perspective has been picked up to a larger scope only later, in the 1970s/80s, together with the concept of a *chaîne opératoire* (for a discussion see below) or behavioural approaches (Schiffer, 1976, p.46); the latter as an outgrowth of "new archaeology" (Schiffer, 2010, p.3), hand in hand with the rising popularity of experimental and ethno-archaeology (for the discussion see Gosselain, 1992, p.559). With the following years the examination of techniques as material renderings of representations gained more popularity, especially thanks to the works of Pierre Lemonnier (1992).

Only recently, embodiment, and hence its specific perspective on skill, became a focal point in archaeology and anthropology (Ingold, 2011a; 2013; Marchand, 2007; 2010; Marchand and Kresse, 2009). Indeed, some of its notions have been key issues since Mauss' discussion of body techniques in the first half of the 20th century (Mauss, 1973) or also played a major role in Bourdieu's habitus and hexis concept (Bourdieu, 1982). But it is argued here that the recently renewed and more intensive discussion about these aspects of embodiment and the centrality of the craftsperson's sensual involvement allows us to gain a new and more in-depth insight on how we can understand crafts beyond simple categorizations, mechanical processes, or as materialization of mental representation. But before trying to grasp this perspective it is of importance to retrace the development of these different approaches to technique and their underlying theoretical concepts and zeitgeist.

The chaîne opératoire – from mechanical to cognitive approaches[2]

Even today we mostly reference André Leroi-Gourhan, a student of Marcel Mauss (Soressi and Geneste, 2011, p.336), when we use the *chaîne opératoire* in archaeology and anthropology of techniques as a method of recon-

structing the work flow of manufacture through the remains of raw materials, working traces, tools, and archaeometric data. His approach always emphasized the process of techniques as comprising motion and tool (Leroi-Gourhan, 1964, p.323), and that the tool only exists as part of the gesture of its technical efficacy within the "operation cycle" (Leroi-Gourhan, 1988, p.196).

Beyond this more general methodological approach, his aim was to understand the development of the human mental abilities in accordance with rhythm, movement and technique. The human subject was therefore always at the center of Leroi-Gourhan's considerations, but maybe surprisingly one can nonetheless trace a certain neglect of the human's sensual involvement in his description of technical processes. In his book "Le geste et la parole" of 1964 he described the "progress" of techniques from an evolutionist perspective: techniques conducted by the human body, techniques with tools moved by a human "motor", and the externalization of technologies to machines. Certainly driven by a fascination for technologies and machines, he draws parallels between machines and humans, culminating in a description of habitualized human operations as "automatic" or "machine-like" (Leroi-Gourhan, 1988, pp.289-293). Such a labelling of these often highly complex technical practices puts them closer to mechanics and technological functioning, and draws them away from the human sensual involvement in techniques. Whether intentionally or not, his choice of words reduces the motion within these techniques to a mechanical one, marginalizes the specific human character of the sensually guided body movement, and therefore dehumanizes techniques (von Rüden, 2015, pp.36-37).

During the same period, a similar attitude can be observed in other anthropological fields. In an essay on distinguishing forms of human behavior in 1966 for example, Edmund Leach tried to grasp human practices with "observable results in a strictly mechanical way" as "rational technical" (Leach, 1966, p.403, also cited and discussed by Ingold, 2011c, p.317 f.). For us today it is rather obvious that a description of human practices as strictly mechanical or "rational technical" cannot be supported any longer. But these verbal choices are the result of the zeitgeist of large periods of the 20th century, which have driven the authors to use metaphors taken from the world of machines and industrialization. But deliberately or not, these metaphors also resulted in a specific perspective, and hence theoretical approach, to techniques not as sensually guided practices, but as externalized technologies (von Rüden, 2015, pp.38-41), and this still has an immense impact on many archaeological studies of techniques and craft until today.[3]

In the following period, the concept of the *chaîne opératoire* has been mainly pursued by the French tradition in the anthropology of technique, especially by Leroi-Gourhan's student Robert Cresswell. In 1972, he even released the revue „Techniques et Culture", in which this specific approach has been extensively discussed (Djindjan, 2013, pp.94-95). It seems that some of Leroi-Gourhan's ideas have been detached from the general method of the *chaîne opératoire,* which then has been used in a much broader sense. The common denominator of its use can possibly be described best by the later definition given by Bensa and Cresswell:

> *"Une chaîne opératoire est une séquence de gestes techniques qui transforment une matière première en produit utilisable. Naturellement peu de processus techniques sont faits d'une seule chaîne. La manière dont sont imbriquées les chaînes est culturellement définie, ou plus exactement définit une culture particulière"*
>
> (Bensa and Cresswell, 1996, quote also by Djindjan, 2013, p.95)

Only since the 1980s, the expression *chaîne opératoire* has been picked up more and more by archaeologists, even though similar processual concepts were already in use before in the study of lithic tools (cf. Djindjan, 2013, pp.95-96). But of course we have to keep in mind that at about the same time, comparable analytical methods were also adopted in Europe, the Near East, and the United States, of which the works by Schiffer might be the best-known (Schiffer, 1975; 2010, for a more detailed enumeration see Bar-Yosef and Van Peer, 2009, p.105). This more reluctant adaption of the *chaîne opératoire* in archaeological studies might be also due to the fact that Leroi-Gourhain himself hesitated to use the term in regard to archaeological remains. In the volume *La Préhistoire*, published in 1968, he remarked that the uncertainty in identifying the function of objects does not permit a study of a cultural technology, (Leroi-Gourhan, 1968, p.241) and also in his prehistoric study with Brézillon in 1972 he used the term "procédé fabrication" instead of *chaîne opératoire* (Leroi-Gourhan and Brézillon, 1972, p.36, for a more detailed discussion see Djindjan, 2013, p.94).

Later, the term's use was very much promoted by Pierre Lemonnier (e.g. Lemonnier, 1983), a student of Robert Cresswell, and successively gained more and more popularity in archaeological studies, in particular in the field of palaeolithic research (e.g., Boëda, 1988, 1995; Boëda, Geneste and Meignen, 1990; Pelegrin, 1990; Pigeot, 1990, 1991; Schlanger, 1996; Inizan, et al., 1999). This boom was also related to a wide-spread dissatisfaction with the systematic typological classification of stone tools and the simple construction of cultural taxonomies, often resulting in descriptive culture histories in this field (Tixier, 1978, 1979, Tixier, et al., 1980; Bar-Yosef and Van Peer, 2009, p.103). In the course of this development, concepts as for example technical system, production processes, and technical intention, previously formulated by the French ethnographers, have been introduced in archaeological research, too (Soressi and Geneste, 2011, p.336). Apart from this, the idea that a technique is evidence of the society and has a "social intelligence" has now been shared by prehistoric archaeology, cultural anthropology and history of science (e. g. Latour and Lemonnier, 1994).

With the adoption of the *chaîne opératoire* in lithic studies, two different main approaches have been developed: an economic perspective on the work flow and a technopsychological or cognitive approach. The latter was especially concerned with the reconstruction of the past concept of artefact manufacture (Bar-Yosef and Van Peer, 2009, p.105). In many regards, these classical cognitive approaches have focused on the revealing of mental aspects, of concepts and planning, and hence have a certain relationship to the above mentioned ideas of Leroi-Gourhan in detecting the evolution of human mental abilities (for a more detailed discussion see for example Schlanger, 1996; Mahaney, 2014). It was obviously very suitable for the evolutionist or biological approach inherent to many of the research questions in the field of palaeolithic stone tools, while it played a minor role in other fields of archaeology.

These classical cognitive approaches of the 1990s considered technical procedures mainly as a sequence first managed by a cognitive project, which was then translated into a conceptual scheme and finally concretized in the operational scheme (Inizan, et al., 1995, p.15). This three layered heuristic has been introduced by Thomas Wynn. It describes a problem-solving/cognitive control layer that guides and selects sequentially-structured actions and deploys them flexibly and intelligently into problems, while a biomechanical layer guides "simply" behaviours like reaching and grasping (Wynn, 1993, p.390; Mahany, 2014, p.176, fig. 3). By this, Wynn hypothesizes that tool behaviour and language have similar structures and therefore that the lower layers and their elements are "subordinated to and organized by the higher layers" (Wynn, 1993, p.390). Even though his description of the "biomechanical" layer includes the affordance of the anatomy of the stoneknapper and emphasizes the importance of the "sensori-motor intelligence", he also considers this as a very simple cognitive task controlled by the hierarchical higher problem-solving layer (Wynn 1993, pp.390-395) which blurs the impact of the biomechanical on more abstract aspects and their mutual relation in general. Therefore, despite his careful analysis a certain Cartesian separation of his layers is still maintained as well as the idea of a primacy of higher mental processes. This can also be observed in other contemporaneous studies which for example separate the "technique" as the physical means of transfer of energy in the removal of the flakes (Pelegrin, 1995, p.24) from the "method" which refers to the intellectual steps followed throughout the knapping process (Pelegrin, 2000; 2005, referenced already by Soressi and Geneste, 2011, p.347, fn. 10).

The concept of technical representations and its limits

In the course of this development within French anthropology and archaeology, Pierre Lemonnier can surely be considered as a major actor in bringing the relationship between technologies and social systems into the foreground. In an article in 1976 already, he focused on this interrelation by extensively discussing two interrelated hypotheses: firstly, that technical practices are objects of a complex social control, but that in return, certain technical practices also have a direct impact on the social system; secondly, which is indeed a consequence of the first one, he assumes a possible structural analogy between the technical and the social systems (Lemonnier, 1976, p.102). This rather early article was an initial point to discuss in more detailed manner that techniques are not only "functional technical", but also depend largely on representations of a wider symbolic system. His perspective is particularly evident in his definition of technique in 1992 as *"physical renderings of mental schemas learned through tradition and concerned with how things work, are to be made, and to be used"* (1992, pp.3-4).

The works of Lemonnier and their specific representational perspective has permitted us to better understand how so-called "social logics", which seem to be at first unrelated to our understanding of pure technological functioning, often have a strong impact on the development.[4] This insight became particularly evident thanks to many anthropological studies in which techniques often were even contradictory to our modern understanding of efficiency or technological progress (see the examples given by Lemonnier, 1992, pp.1-2, p.4; Spicer, 1952).[5] They help us to critically reflect on our own, somehow teleological view on techniques and technologies as "naturally" seeking towards so-called "objective functional", more efficient and hence "progressive" solutions.

But nonetheless, his structuralist way of describing these two sides, or maybe better two levels, of techniques did not allow him to go beyond this, and indeed integrate the social and symbolic into the human practice of technique. On the one hand, Lemonnier describes the dimension of how all the following aspects, the *"human actor, a source of energy, tools, raw materials, gestures and mental procedures are involved in an action that aims at obtaining some material result which generally fits together physically"*, and on the other hand he emphasizes that *"some of these elements […] also cohere and play a role in some symbolic aspect of social life"* (Lemonnier, 1992, p.4). Bruno Latour calls this, after Whitehead, a bifurcated way of dealing with technology: on the one side the action with the material world, the "efficient technical", on the other side the symbolic action and everything that is non-technical "above", the excessive, superfluous, non-functional (Latour, 2014, p.507).[6]

Lemonnier's term 'representation' can be understood in the tradition of Durkheim (1912) as collective representations of ideas, beliefs and values and their possible role in a symbolic system. And it is exactly this idea of representations which restrains him and obscures how material functioning and its "representation" might have been interwoven. His understanding becomes very clear in the way he has described techniques above, as "physical renderings of mental schemas" (Lemonnier,

1992, pp.3-4). As it is the case with the cognitive control layer of techniques of Wynn discussed above the concept which seems to be behind Lemonnier's statement is a somehow Aristotelian perspective which conceives the mental schema as the primacy which is then physically rendered or executed in a bodily or material practice. Hence, despite his wish to integrate the material and the mental world, he carries forward a Cartesian division and marginalizes the integrative aspect of the bodily gesture and embodiment. This problem is certainly approached in his book "Mundane objects: Materiality and non-verbal communication", in which he refers to Ingold (2011a (2000) and Warnier (2000; 2007) in this specific regard, but also makes clear that still much has to be done in this field (Lemonnier, 2012, p.19).

The cartesian trap of the term technology[7]

Above, Leroi-Gourhan's rather mechanical approach to techniques has been critically discussed and embedded in the zeitgeist of the 20th century. In this regard, Tim Ingold's analyses of the terms technology and technique, and how they are used in archaeological and anthropological research, are of interest. He hints at the fact that while in historical and sociological research the term *technology* is only used for scientific principles and discoveries since the beginning of 'Western' science and mechanical industry, archaeologists and anthropologists tend to use the term through all periods (Ingold, 2011b, referring to Burns, 1964, p.714). He considers the emergence of the term 'technology' in a Western context of the last centuries "hand in hand with what could be called a 'machine-theoretical' cosmology" as a conflation of the technical with the mechanical of the machines (Ingold, 2011b, pp.314-315), as in a Cartesian way separate from the human bodily experience. This zeitgeist and its 'machine-theoretical cosmology' can be considered as a reflection of the disappearance of the dexterity of the individual machine-worker that had been so clearly described by Karl Marx in the 19th century:

> *„Das Detailgeschick des individuellen, entleerten Maschinenarbeiters verschwindet als winziges Nebending vor der Wissenschaft, den ungeheuren Naturkräften und der gesellschaftlichen Massenarbeit, die im Maschinensystem verkörpert sind und mit ihm die Macht des ›Meisters‹ (master) bilden."*
> (Marx, 2013, reprint of 1890, p.446).

If we follow this argument, we can state that the term 'technology' is strongly connected to the externalized mechanics of machines, and it seems as if this implication and its accompanied zeitgeist had a certain power over how crafts have often been reduced to rules of mechanical functioning in anthropological and archaeological research (von Rüden, 2015). And it is not only in Leroi-Gourhan's very early approach in which such a mechanical perspective is traceable. It had not been dissolved yet in Lemonnier's structuralist description of techniques in 1992. Deliberately or not, by his description of the two different sides of techniques he divides them into a symbolic, non-functional dimension of crafts and a rather efficient, functionalist, mechanical way of action that simply aims at obtaining some material result (Lemonnier, 1992, p.4). Also here, the term 'technology', the mechanical ways of executing, has left clear traces on how he characterizes at least one of the dimensions. The same holds true for the cognitive discourse of the 1990s discussed above which was still coined by expression like "biomechanics" or "sensori-motor intelligence".

This raises the question which perspective would permit the term 'technique' instead? In a first step, Mitcham and Ingold contrast it with the modern concept of technology. Both authors have a very similar definition of technology as either something which is "more tightly associated with the conscious articulation of rules and principles" (Mitcham, 1979, p.252) or as knowledge of the objective principles of mechanical functioning (Ingold, 2011b, p.315). Therefore, both authors closely follow what we consider today the subject of technological sciences, as the discursive rules and principles of technologies, of mechanical functioning. These rules and principles can greatly be separated from the human actor and largely distributed without direct human contact, as for example written down as rules in modern manuals, in plans, or in pattern books, as they are proposed for the transmission of motifs in Roman mosaics (Donderer, 2005, pp.59-68). Technology hence addresses completely externalized knowledge which is indifferent to the human subject, and is therefore surely not appropriate to approach traditional crafts, in which the dexterity of the craftsperson is one of the very central aspects.

In contrast, technique is for Ingold inseparable from the experience of the particular human subject (Ingold, 2011b, p.314-315), while for Mitcham it "relies a lot on intuition" (Mitcham, 1979, p.252). By their descriptions it becomes obvious that the term is less clearly confined and therefore far more difficult to grasp than technology. The term is not restricted to a mechanical function, but includes the bodily experiences, and hence intuition, of the craftsperson. Both aspects are an integral part of what Michael Polanyi calls "tacit knowledge" in the 1960s (Polanyi, 2009, p.4), an idea which might help us to bridge the Cartesian way of analyzing technique in anthropological and archaeological research.

The Tacit Dimension of Techniques

In fact, Michael Polanyi acts from the assumption that "tacit thought forms an indispensable part of knowledge" and therefore "eliminating all personal elements of knowledge would, in effect, aim at the destruction of all knowledge" (Polanyi, 2009, p.20). This would in fact re-

duce knowledge to bare information. Therefore, it is this personal knowledge which deserves special attention in anthropological and archaeological research, and an integration of its specific character, possibilities, and restrictions may permit a better understanding of how technical knowledge evolves, is maintained, or can be spatially and temporally spread.

The term 'tacit knowledge' refers to the knowledge suggested by Polanyi's dictum, "we can know more than we can tell" (Polanyi, 2009, p.4). In contrast to technological, discursive knowledge, tacit knowledge cannot be verbally specified by the human subject and therefore cannot be captured in rules and formulas.[8] Lampros Malafouris gathered several hypothetical questions to illustrate the tacit dimension of wheel throwing in pottery production. He assumed that even to the very general question of how do you do it, a potter would usually prefer to reply by showing and not by articulating and similar reactions can be expected for the questions how one decides the force of the grip, the appropriate speed of the wheel, or how much water to add on the clay. All aspects are very well-known to a potter, he or she can execute them in perfect manner, but they are difficult to be expressed by words (Malafouris, 2008, pp.19-20). And this even goes beyond the performance one can visually attend. Willeke Wendrich points out that if a master says "let me show you how to do this," he in fact says "let me make you feel how to do this" (Wendrich, 2012a, p.13).

All these aspects of a skill that cannot be captured in rules or formulas or be explicitly defined by the potter can be described as "tacit knowledge". As an initial point, this criterion of exclusion is indeed very helpful, but bears the danger of becoming a simple label or black box for not-articulable aspects of techniques, while displacing its inner complexity (von Rüden, 2015, p.41). What we need to better understand is its role and characteristics in technical practices.

From a more intimate look it becomes evident that for our engagement with technical skills, a central facet of what Polanyi considers a tacit knowledge surely is embodied knowledge. But how can we characterize and understand embodied knowledge within the context of a skill? We have already seen that because of its specific nature we cannot define it verbally, but we might encircle it descriptively, as a first step to approach its role within technical practices.

In his book "The Tacit Dimension", Polanyi tries to familiarize us with the term's implications by describing the setting that allows us to learn the skill of riding a bike (Polanyi, 1958, p.50). Evidently one cannot learn this task only by verbal communication or any kind of manual, plan, or drawing. For learning this skill, a demonstration by a skilled practitioner is needed, which must be observed and then be imitated by the apprentice. Its crucial point is that by repeatedly attempts to imitate the movement, the learner makes his or her own sensual experiences with the bicycle and the surrounding environment, which successively allows his or her knowledge to grow (von Rüden, 2015, p.42). No matter if the novice is observing the movement or practicing it him or herself mirror neurons are active and create a "motor resonance" circuit providing scaffolding for imitation (Mahaney, 2014, p.184).

Polanyi's description emphasizes the general setting, the necessary circumstances, and structure for bodily learning. But one of its crucial points, namely the apprentice's very individual sensual experience with the movement and the bicycle, still remains rather abstract. This is described much better in Stölzle's elaborate account of bodily learning at Johannes Itten's class, where she excellently depicts the complexity of her internal perception and her very individual reality of the rhythm and movements while learning the craft of drawing: *"First, one has to train one's hand, make the fingers flexible; we do finger exercises just as pianists do. We begin to feel what makes rhythm come into being, endless circular motions, starting with the tips of the fingers, the movement flows into the wrist, the elbows, the shoulders, up to the heart"* (Ince, 2012, p.51).

Despite the different perspectives, Polanyi and Stölzle approach the same important aspect of a craft from only slightly different angles. Stölzle depicts the complexity of her internal perception and her very individual reality of the rhythm and movements, while Polanyi emphasizes the external settings. But both descriptions have in common that they can hardly be used as a guide to learn the art of drawing or biking. Without observing and exploring the movements of a master and trying to imitate them in person, without personal sensual experience, an apprentice would hardly accomplish the task. Pallasmaa also emphasizes that learning a skill is not primarily founded on verbal teaching, and beautifully expresses the act of sensory perception and bodily mimesis as the core of "artistic learning" that is necessary for the transmission of skill as *"from the muscles of the teacher directly to the muscles of the apprentice"* (Pallasmaa, 2009, p.15).

Embodiment – the sensual involvement of the craftsperson

To approach the importance of embodiment for crafts it is very helpful to understand the way a specialized skill is learned, to trace the efforts and necessary endurance of completing such a task in the context of an apprenticeship. These insights help us understand the frequent problems of the often immense simplification underlying the functional mechanical approaches, and might point to how we can try to overcome our often very Cartesian descriptions in technical studies.

Apart from the fact that in many traditional settings the apprentice is trained towards learning the properties of the raw material, the use of tools, and the type of products that are supposed to be the end result, Willeke Wendrich also hinted to the fact that there often is a strong relationship between the different stages of learning and the *chaîne opératoire:* At the beginning, one often has to

clean up and prepare, then the learner is involved in the often time consuming preparation of the raw material, and is indeed allowed only afterwards to learn the production itself. Within this multiyear process of learning, the apprentice first assists or handles the raw material and, with rising dexterity, he or she is permitted to conduct more difficult tasks. Only at the very end the apprentice is finally allowed to execute the full *chaîne opératoire* (Wendrich, 2012a, pp.9-10). Within all these stages, but especially during the actual manufacture of the product, the apprentices are usually requested to watch and imitate their masters the best they can. Students are then completely occupied with adjusting their own position and movements to what they visually perceive as their teacher's performance. From time to time, the body positions of the novices might be corrected by the teacher's tactile adjustment or by short verbal remarks that draw the student's attention to the specific mistake (von Rüden, 2015, pp.41-45).

And as Polanyi described, they gain their own bodily experiences during this process. But in fact, this seemingly little detail is a very challenging task. The perception of the apprentice is only eclectic, the muscles not specifically trained, or the own awareness of the body is not yet cultivated, in the way needed for the movement (von Rüden, 2015, pp.43-45). Only by the help of uncountable repetitions these movements are finally incorporated and become part of a person's repertory. Learning any specialized skill calls for repetition ad absurdum (Pallasmaa, 2009, p.82), and indeed, this is the most important aspect of this process, as it enhances kinesthetic skills and ingrains the movement, actions, and work order in the body which can be described as body knowledge (Wendrich, 2006, 2012, p.13). In the course of these uncountable repetitions the complex sequence of movements and spatial and temporal relationships of the task are internalized and embodied, rather than intellectually understood and remembered (Pallasmaa, 2009, p.22).

Of course, bodily learning in a self-contained "community of practice" (Wenger, 1998) might tend to result in a certain degree of homogeneity, but even in these settings there are many moments of creative potential inherent to the learning process itself that can result in the emergence of diversity. Creativity might be evoked by the individual's body configuration, as, for example, different size or muscular characteristics, and the consequent adjustment of the techniques by the practitioner (von Rüden, 2015, pp.44-45). Maybe even more crucial are those body techniques persons have already incorporated in the course of their lives. It is difficult to "overwrite" these body techniques (Loney, 2007), and almost inevitably it leads to a certain amalgamation of the newly learned movement with the previously incorporated one (von Rüden, 2015, p.45). But of course the degree of deviation from the so-called prototype depends very much on the social setting and what this setting permits. It is the group culture which in the end considers a change either positive or negative, if new forms can become a standard or not (Warnier, 2007; Wendrich, 2012a, p.16).

Another possible trigger for technical change is, of course, the intentional and conscious modification of a technique on a more abstract level. This can be stimulated for example while one is teaching a technique to an apprentice and is thus forced to reflect, and hence to articulate, certain movements (von Rüden, 2015, pp.44-45). Richard Sennett describes this interplay as being in general an important aspect of craft. Even if he emphasizes that all skill begins as bodily practice, through knowledge which is gained through touch and movement, the technical understanding develops through the power of imagination, by exploring language that attempts to direct and guide bodily skills. He argues that it is this specific relationship a craftsperson needs to develop, between thought and making, idea and execution, action and matter, learning and performance, self-identity and work, pride and humility, (Sennett, 2008, p.35). If we followed the argument of theory of embodiment, we might argue that the craftsperson needs not to develop this relationship, but to allow it, as it is always inherent in our existence (Clark and Chalmers, 1998; Clark, 2008).

Moreover, a craftsperson is also engaged in other people, tools, and raw materials, and needs to adjust to these aspects. The kind and quality of material has an immense impact on the creation process and Tim Ingold has tirelessly emphasized that making cannot be understood as the craftsperson simply subduing the raw material by mechanical forces (Ingold, 2011d, p.347, p.353). Moreover, the person has to sensually respond to the qualities of the material. The flexibility of the clay, the density of the wood, or the hardness of the stone to be worked has an immense impact on the making of the artefact, and presents an affordance for specific shapes in the sense of Gibson (Gibson, 1977; 1979). This is radically different to the representational approaches of Lemonnier discussed above, who considers techniques as "physical renderings of mental schemas" (Lemonnier, 1992, pp.3-4) what certainly marginalizes the affordance of the material. Consequently, the craftsperson needs to gain certain experience with the specific material so that his or her techniques can become precise, and during this process, material and human actor develop a kind of sensual entity we can describe as extended mind, too (Clark and Chalmers, 1998; Clark, 2008). This sensual entity of making dramatically changes when the craftsperson needs to rely on new material with different characteristics, for instance if the potter is confronted with a different temper.

This tactile interplay might be even more intensive in tool use. A tool can be considered as an extension of the body. Polanyi describes how a blind man learns to extend his tactile senses to the tip of the stick (Polanyi, 2009, p.12, p.16). The same holds true for the craftsperson: he or she incorporates the tool until it becomes a tactile extension with which the human subject can feel the raw material, and the artefact coming into existence (von Rüden, 2015, p.46). But tools are also expanding our actions in specific ways, and in this regard, Pallasmaa

points out that it is not exchangeable to choose either charcoal, a pencil, an ink pen, or a computer mouse for the purposes of drawing an architectural project (Pallasmaa, 2009, p.50).

All the aspects mentioned are involved in the way Tim Ingold defines skill: the human subject, the tools, and the different raw materials within their social and environmental setting (Ingold, 2011d, p.347). So, for him, skill is not restricted to a human and his or her abilities in a very narrow sense of Cartesian separation. All these elements are tightly interwoven within the process of making, and if one of these elements changes it has an impact on the skill as a whole. So, approaching the skill of a craft and the way it might change when being transmitted to another person, into a new social or environmental context, suddenly becomes a much more complex undertaking.

Conclusion

Even though scholars have always been aware of the importance of body techniques, the sensual involvement within crafts has gained more attention only recently. This might be related to the fact that these aspects of craft are difficult to approach with the help of so-called rational and objective methods of archaeological research, the way we are categorizing our archaeological evidences, and our still very Cartesian way of thinking, no matter if we contrast mental processes or representations with bodily experiences and the material world. Furthermore, to articulate all these largely nonverbal, embodied experiences in a theoretical, and therefore necessarily a verbal, discursive paper seems to be a paradox in itself (von Rüden, 2015). One can even postulate that a theoretical, and therefore necessarily a verbal, discursive paper about embodied knowledge and skill is not an appropriate way of approaching these aspects. In this regard Lise Bender Jørgensen, emphasizes that when academics write about crafts, the language falls short (Jorgensen, 2012), and Willeke Wendrich observes that when we as academics are trying to describe aural, visual, or tactile aspects of craft production, we often revert to quite clumsy, often numerical ways to describe the rhythm of working or specific properties of the material (Wendrich, 2006, 2012, p.14). This might be the reason why Sennet, Pallasmaa, and Ingold often make use of rather poetic language, and this might indeed meet the specific needs for an immersion into the sensual world of crafts, but unluckily this is often condemned in research.

But nonetheless, the significance of embodiment and the senses for our understanding of the process in techniques and crafts is tremendous. Therefore, it is really necessary to foreground at least some aspects of embodied learning to approach the techniques and the skill of ancient craftspeople. Consequently, our greatest challenge as archaeologists is to allow a change of perspective in our interpretation of work flows: to switch from the objectifying, Cartesian perspective to the sensual lifeworld of the craftsperson, from technology to technique, from objects to things, from a traditional natural science perspective of clear categorization to a phenomenological one of sensual involvement. Of course, we cannot and should not avoid trying to reconstruct the *chaîne opératoire* with the help of objectifying research of our archaeological evidence, but we should keep in mind that this will always remain a highly reductive and distorted construction if we neglect the sensual involvement of the craftsperson. I would therefore encourage an attempt to identify and emphasize those moments of the work flow which obviously needed to be guided by a sensual intelligence, or something we might call an extended mind, and to tightly integrate them with our narrative of crafts.

Notes

1 Parts of this article are based on some extracts out of my article “Approaching Ancient Techniques. From Technology to Bodily Learning and Skill”, published in 2015 in: W. Gauss, G. Klebinder-Gauss, C. von Rueden, eds. 2015. The Distribution of Technical Knowledge in the Production of Ancient Mediterranean Pottery. Vienna: Akademie Verlag.

2 This paragraph is partially based on an article published in 2016.

3 See therefore also the discussion of the term technology vs. techniques by Ingold (2011b).

4 Lemonnier uses the expression “in part only, these social representations of technologies concern material phenomena stricto senso” (1992, p.3).

5 See therefore also the volume “Human Problems in Technological Change” , edited by Spicer in 1952, referred to also by Pierre Lemonnier, 1992, p.4, fn. 5.

6 This problem has also been discussed in a volume edited by Latour and Lemonnier together in 1994.

7 The following two paragraphs are greatly based on von Rüden, 2015, pp.38-41.

8 Here it should be emphasized that both tacit and discursive knowledge are usually tightly interwoven and only separated in form of analytical categories.

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