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New perspectives for microwear analysis

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Microwear analysis developed within a typical processual approach in the 1970s, addressing questions about form and function and site typology. Recent theoretical developments in material culture studies, centred on the role of materiality in cultural encounters, offer new perspectives to which microwear studies can contribute significantly. It is argued that microwear analysis can play a key role in the study of the interconnectivity of crafts combined with a biographical approach towards transformations of materials in cultural encounters. This approach would be perfectly positioned to shed new light on the neolithization process in the Lower Rhine Basin.

1 Introduction

Materials, and more specifically objects, play a vital role in human interaction and form of old the centre of archaeological research. However, for the most part, interest has focused on typology and the possibilities for relative dating. Much less research was invested in the technological process involved in the making and using of objects. It was not until the term *chaîne opératoire* became influential that an interest developed in the technological aspects of artefacts, and how form developed. It also became increasingly clear that objects went through different stages. Schiffer distinguished between procurement, manufacture, use, maintenance and discard, an approach that allowed a dynamic study of material culture in which there was also room for recycling and re-use (Schiffer 1972). In a famous and often cited article, Kopytoff proposed that objects had a biography analogous to that of human beings (Kopytoff 1986). Of great importance was the increased anthropological interest in technology and material culture in the last decades. Lemonnier argued that people, from the plethora of possible technological alternatives, made specific choices which were in accordance with their socio-cultural system (Lemonnier 1986).

Nowadays many researchers are taking materials more and more seriously (Ingold 2007; Boivin 2008; Conneller 2011). The focus on the finished product as a static entity (tool type) is shifting towards an approach that takes material properties into account and that looks into the varied human-material interactions, as reflected in the life trajectory of an object. At the same time a range of scientific methodologies was developed with which to study the biography of objects (Sillar and Tite 2000; Jones 2002; 2004). One of those is microwear analysis, which forms the focus of this paper.

Microwear analysis as initially developed by Semenov constituted a holistic approach encompassing a microscopic analysis of objects made of different raw materials (Semenov 1964). When introduced in the West most research in this field concentrated on flint and chert (a.o. Keeley 1980; Odell 1980; Beyries 1988; Van Gijn 1990). Only later did researchers turn to the study of bone, antler (a.o. Maigrot 1997; Van Gijn 2007), shell (Lammers 2007; Cuenca Solana *et al*. 2011), coral (Kelly and Van Gijn 2008) and ceramic tools (Van Gijn and Lammers-Keijsers 2010). Unfortunately, archaeology has a tradition of specialists in different material culture categories: a person is a lithic specialist or a ceramic technologist and will rarely be involved in the study of both. This attitude also pervaded microwear analysis: studies concentrated on one material category only, usually flint or chert, which overlooked the fact that flint constitutes only a limited part of complex technological systems. Admittedly, the focus on one material category can to some extent be justified by the fact that microwear studies rely on the presence of relevant experimental reference collections. Each new material requires experimental exploration.

I too started with the microscopic study of flint tools, but turned to 'other' materials with the find of large numbers of bone and antler objects in the Late Mesolithic sites of Hardinxveld Polderweg and De Bruin (Louwe Kooijmans 2001a; 2001b), excavated in the late 1990s by Archol and the Leiden Faculty of Archaeology. Not only were the flint implements studied microscopically, but also a sample of the bone and antler tools. The results made me acutely aware of the interconnectivity of different activities and the need for a more holistic approach towards microwear analysis. Such an approach was applied to the Middle Neolithic site of Schipluiden (Louwe Kooijmans and Jongste 2006) where I explicitly searched for tool kits: "set of tools used in the same *chaîne opératoire*" (Van Gijn 2008b, 219; see also Van Gijn and Lammers-Keijsers 2010). In Schipluiden a range of different tool kits could be distinguished, each consisting of objects made of different raw materials. However, even

though the concept tool kit allows for a holistic microwear study of different material categories, it remains a somewhat static concept that does not convey the complexity of past technology and the interconnectivity of the different *chaînes opératoires*.

In this paper I therefore want to explore briefly the possibilities of applying some concepts and ideas, recently developed in especially Late Bronze Age studies in the Eastern Mediterranean, to the Late Mesolithic and Neolithic wetland sites of the Lower Rhine Basin. In recent publications Brysbaert and others have proposed the term "cross-craft interactions" to examine the various relationships between different crafts, both within settlements but also as seen from a regional and even supra-regional perspective (Brysbaert 2007; 2011; Brysbaert and Vetters 2010; Tsoraki 2011). Other researchers have addressed the role of material culture in cultural encounters (Hahn 2012; Knapp 2012; Stockhammer 2012). These authors argue that we should study in detail the context of consumption of imported objects and how this differed from the context from which they originated. This could shed light on the role of material culture in the construction of new "hybridised" (Knapp 2012, 34) identities in contact situations. Such an approach can potentially be very fruitful in studying the neolithization process, the long period during which hunting-fishing-gathering societies transformed as a result of contact with the farmers of the Linear Bandkeramik and later periods.

Microwear and residue analysis is perfectly suited to study the interconnectivity of different craft activities and the transformations objects may undergo when moving from one cultural context to another (Van Gijn 2008a; 2010; Wentink 2008). Although in egalitarian societies, such as we assume for the Late Mesolithic and most of the Neolithic, crafts are likely to have been organized at the local level, studying the interrelatedness of different crafts can potentially reveal much about specific technological choices made by people through time and across space. Such a study would require a biographical approach, first of all including determining the provenience of raw materials, or the context exotic objects originate from. Long-distance mobility of stones has repeatedly been demonstrated for the Mesolithic and earlier Neolithic (a.o. Verhart 2000; Vanmontfoort 2008). Moreover, it is in the Mesolithic that we see the appearance of composite tools. Such composite tools always involve different raw materials: the flint, bone, antler, wood, binding materials, and bark for producing tar have to be procured at different places, to be brought together in one tool. All these materials require specific ways of processing, treatment, times of harvesting and so forth. The second step in a biographical approach would involve a technological study: what is the production sequence, how much skill and knowledge are necessary, which kinds of tools and equipment are needed to carry out the task and how do different materials 'react'. It is here that we can explore the interconnectivity of different craft activities by means of experimentation (fig. 1). Next, use wear and residue analysis could shed light on the actual life of the object, the transformations it underwent through time and possibly also what happened to it upon deposition, loss or discard. And lastly, the context in which an object ends up will tell us much about the possible meaning and role the object had in its lifetime.

Figure 1 Experimental hide working tool kit, including implements made of different raw materials (Photo Laboratory for Artefact Studies, Leiden).

2 The interconnectivity of craft activities at the Late Mesolithic sites of Hardinxveld Polderweg and De Bruin

In the 1990s rescue excavations took place in the Late Mesolithic wetland sites of Hardinxveld Polderweg and De Bruin, situated in the Lower Rhine Basin of the present-day Netherlands, close to the city of Rotterdam (Louwe Kooijmans 2001a; 2001b). Habitation layers at the two sites date from c. 5500-4500 BC. In addition to a techno-morphological study, samples of both the flint and the bone/antler tool assemblage were studied for traces of use (Van Gijn *et al*. 2001a; 2001b; Louwe Kooijmans *et al*. 2001a; 2001b). Unfortunately, at that time large, non-flint, stones could only be studied by stereomicroscope due to the absence of appropriate equipment at the Leiden laboratory. Still, the technological and microwear research of the flint and bone and antler tools showed that craft activities included plant processing, hide working, wood working and the manufacture of bone and antler tools.

Traces from contact with siliceous plants predominated in both sites and were always found on regular, unretouched blades. It concerns a smooth polish with a clear transverse

directionality, indicating that the blades were used in a transverse motion (Van Gijn *et al*. 2001a) (fig. 2). Despite extensive experimentation, we still do not know which kinds of plants were worked with these blades. The closest match was produced by scraping *Phragmites* stems in order to make them supple for weaving. Producing garments and blankets of plant fibres requires skills and a considerable input of time (Barber 1994; Turner 2007) and the amount of plant stems that needs to be processed is enormous. The fact that so many blades display this type of wear can be seen in this context. Other tools involved in plant processing are the bone awls, most likely used for basket making or textile production. These awls were made by means of the metapodium technique, a production technique in which flint tools are instrumental (Maarleveld 1985; Van Gijn 1990). In terms of its biography the bone awl is thus linked to flint, both in its production stage and during its life. Both flint blades and bone awls form part of a tool kit directed at collecting, preparing and processing plant fibres and incorporating them into craft items.

Another type of bone tool involved in plant-based crafts is the bone needle, two of which were found at the site of Hardinxveld De Bruin (fig. 3b). They were made from the ulna of a swan and experiments have shown that they are easily made with a simple flint flake. Both needles displayed a strongly developed polish from contact with siliceous plants. An experiment with a replica used for making a carrying bag from twined nettle rope (*Urtica*) produced traces that were very similar. To make this bag the technique of knotless netting was used and, interestingly enough, rope fragments made of plant fibres found at the site of Hardinxveld Polderweg display this technique (Louwe Kooijmans *et al*. 2001c, 401-405) (fig. 3a).

Especially at the site of Polderweg were traces of hide working seen on only very few flint tools (Van Gijn *et al*. 2001a). Surprisingly, it was on bone and antler tools that such traces were present most frequently: they were used both for scraping and piercing hides. Again, flint tools form part of the *chaîne opératoire* of these bone and antler tools

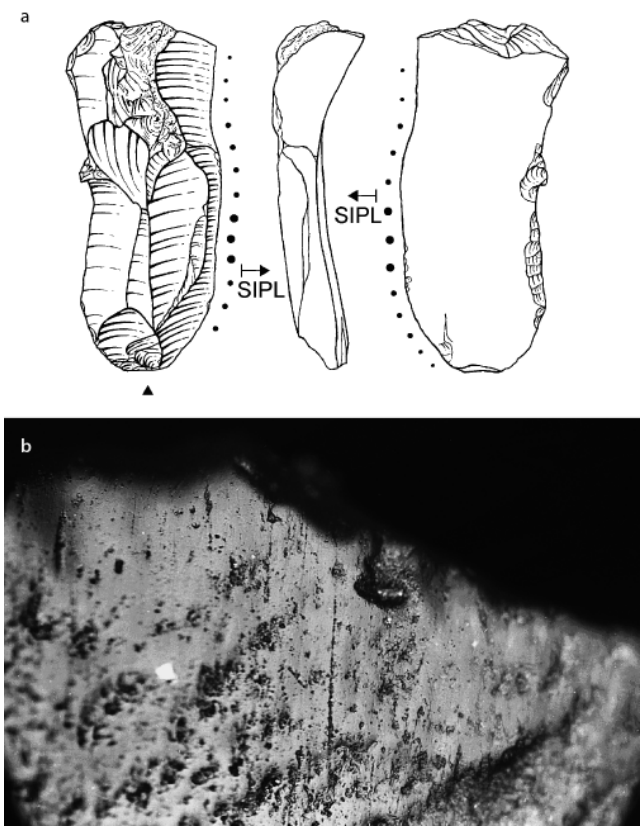

Figure 2 a) Flint blade from Hardinxveld Polderweg phase 1 (nr. 13.354) displaying traces of scraping or planing siliceous plants (scale 1:1). b) Polish from contact with siliceous plant seen on flint blade Polderweg 4000 (original magnification 200x) (from Van Gijn *et al*. 2001a).

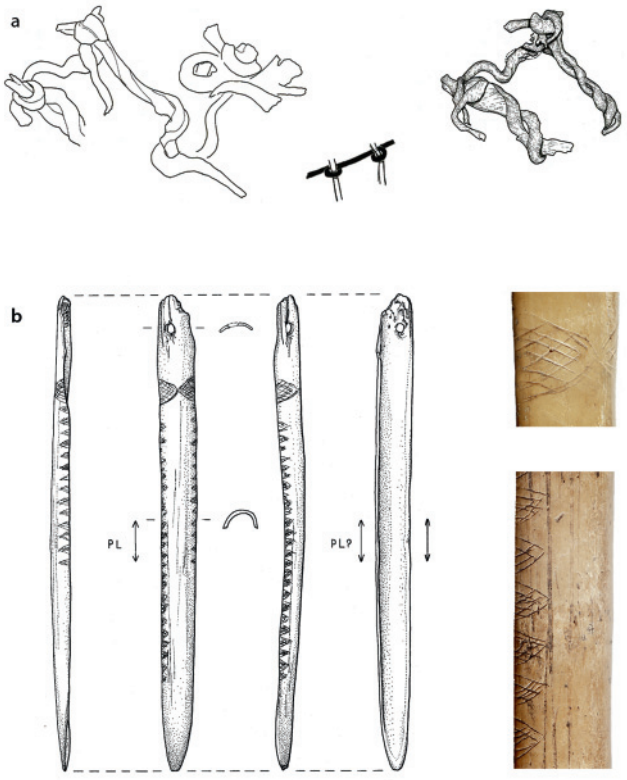

Figure 3 a) Fragment of a piece of a net made in 'knotless netting' technique from Hardinxveld Polderweg phase 1 (from Louwe Kooijmans *et al.* 2001c, fig. 13.18).
b) 'Needle' made of an *ulna* of a swan, probably used for net making from Hardinxveld De Bruin phase 2 (findnr. 6990) (from Louwe Kooijmans *et al.* 2001b, fig. 10.15).

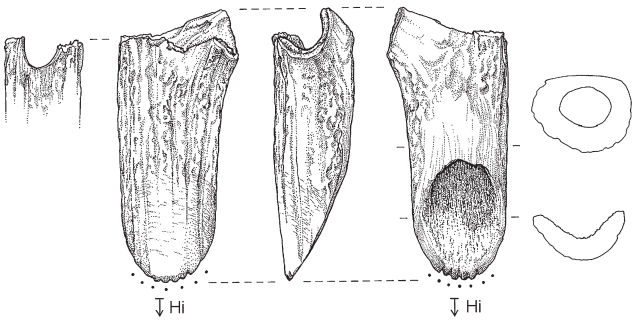

Figure 4 Recycled broken T-axe of red deer antler, modified into a toothed scraper used for cleaning hide, found at Hardinxveld De Bruin (from Louwe Kooijmans *et al.* 2001b, fig. 10.7).

as we have evidence for the use of flint in their production in the form of cut marks. It is also interesting to note that many of the hide working tools made of bone or antler actually are recycled implements, which were most likely first used for other purposes, like chopping wood. A good example is formed by the antler T-axes which tend to break at the perforation, especially if they are dry: the half with the cutting edge was not thrown away but used as hide scraper. The cutting edge was made more effective for cleaning hides by serrating the edge with a flint tool (fig. 4).

Another craft activity demonstrated at the Hardinxveld sites is wood working. Wood working was done both by means of flint implements and bone and antler tools, as evidenced by the use wear traces. We can assume that some of the wood working involved the preparation of hafts for flint and bone/antler tools, as some such tools were found both in Polderweg and De Bruin (Louwe Kooijmans *et al.* 2001c). Interestingly, even though the excavations yielded abundant evidence for the production of bone and antler tools in the form of waste, rejects and cut marks, very few flint implements with traces from contact with bone and antler were found. Admittedly, only a small percentage of flint implements were studied, so it is possible that none were included in the sample, but it remains strange considering the enormous amount of bone and antler working that must have taken place on the sites. Further research can hopefully make clear whether this absence is reflective of a specific technological choice (*sensu* Lemonnier 1986), like seems to be the case with the preference for bone and antler tools for hide working, or whether it is due to sampling.

Despite the limited amount of microwear study carried out so far, the results nevertheless show that the Hardinxveld settlements formed the nodes where different materials came together to be modified and joined. Many of the crafts are related and intertwined, with numerous technological and functional links between flint, bone, antler, wood, skin and various plants. This is something that can be explored in much more detail in the future. Additional material is currently being studied by Aimée Little (Marie Curie fellowship) and RMA student Sara Graziano, and with new equipment available and other technical possibilities, it is likely that further evidence for the interconnectivity of the various craft activities will appear. Instrumental will also be a different theoretical perspective, aimed more at materials and their properties, and less at standard classification issues.

3 Materiality and cultural encounters: the case of the Middle Neolithic Hazendonk sites of Schipluiden and Ypenburg

The sites of Schipluiden and Ypenburg are dated to c. 3750-3400 BC and are attributed to the Middle Neolithic Hazendonk group (Louwe Kooijmans and Jongste 2006; Koot *et al.* 2008). The sites are located just to the east of the present-day town of The Hague in a micro-region where quite an abundance of sites and finds from this specific period and cultural group have been found. Microwear analysis was done on samples of the flint tools, the ground stone assemblage, implements of bone, antler and tooth, as well as the ornaments of amber, jet and bone (Van Gijn 2006a; 2006b; Van Gijn and Boon 2006; Van Gijn and Houkes 2006; Van Gijn and Verbaas 2008; Van Gijn *et al.* 2006). As already mentioned above, the reconstruction of tool kits used in different *chaînes opératoires* formed a key objective of these studies. Schipluiden and Ypenburg were, like the Hardinxveld sites, contract excavations with only relatively limited money available for detailed research. Therefore, although a range of different tool kits could be distinguished (Van Gijn 2008b; Van Gijn and Verbaas 2008), there is still much to gain from a detailed examination of cross-craft interaction, searching for specific interconnections between *chaînes opératoires* within both sites. In addition, there are prospects for a more regional, inter-site perspective on cross-craft interaction. Ypenburg and Schipluiden display some curious differences in terms of their material culture which would merit further examination. For example, the large grinding stones, associated with the production and maintenance of stone axes, form a major artefact category in Schipluiden, but are completely lacking in Ypenburg. 'Mapping out' cross-craft interaction in detail within this micro-region may provide some explanations for this remarkable inter-site variation in find composition.

Both Schipluiden and Ypenburg also offer good prospects to study the role of materiality in cultural encounters. They form key – that is, transitional – sites in the study of the neolithization process of the wetlands of the Lower Rhine Basin, a region which had an (extended) broad-spectrum economy long after farming had been introduced in the southern part of the present-day Netherlands around 5300 BC

(see Louwe Kooijmans 2007 for details). The two sites have not only provided the earliest solid evidence for local cropping of cereals within the Lower Rhine Basin, at the same time the biography of the bone and antler objects displays a remarkable technological continuity with the Mesolithic (Van Gijn 2006a). It is also clear that there must have been interaction with communities further south, as evidenced by the presence of 'exotic' flint implements imported from the farming communities in the south. Most of the flint was, however, of more local origin, although the exact provenience is still unknown. The exotic implements were imported as finished objects but were given a 'special place' in the local technological system. Microwear analysis showed that the inhabitants of Ypenburg and Schipluiden selected this exotic flint for specific tasks: cereal harvesting, fire making and ornament production (fig. 5). It was argued that these three tasks carried a special significance for the local community (Van Gijn 2008a; 2010). Cereal harvesting was special because it was new, precarious and must have run to some extent counter to the ancient lifestyle, as it required the destruction of the life-giving forest. The long period of tending the fields and waiting for the crops to grow must have been perceived as unpredictable and precarious. The, probably intentional, destruction of the flint sickles by means of fragmentation and burning is interpreted as an act to return the harvesting tools back to nature (Van Gijn 2008a; 2010, fig. 7.3). Fire making was seen as a special activity because the burial of a man within the settlement of Schipluiden contained flint strike-a-lights. They were held in the hand of the deceased, along with a piece of pyrite, in front of the mouth, as if blowing a spark (Van Gijn 2010, fig. 6.6). Lastly, ornament making was argued to be of special significance as ornaments were given along to the dead as evidenced by the cemetery of Ypenburg (Koot *et al.* 2008). The life history of these exotic tools was thus very different from that of locally made flint implements. Clearly, the consumption of these import goods in the local wetland context seems to have been surrounded by special circumscriptions, ensuring their use in specific tasks, but nevertheless embedded in the recipient technological system. The use of the exotic implements by farmers for special tasks in the wetlands can be interpreted as a way of negotiating the transition to a new Neolithic way of life (for details see Van Gijn 2008a; 2010).

Stone may have played a special role in cultural encounters. It has specific material properties in terms of colour, weight, translucency, texture, workability and so forth. It is thus usually very clear to the knowledgeable observer whether a stone was available locally or not. Stone is also very durable, outlasting human generations, and people must have been well aware of this. Lastly, it is also portable and can be exchanged or traded in small quantities. The variability,

Figure 5 Exotic flint tools used in the production of ornaments of jet and artefacts of jet (from Van Gijn 2006b, fig. 9.2).

portability, and durability of stone make it an ideal carrier of symbolic meaning to be moved from one cultural context to another. Such a transition would inevitably leave evidence in terms of technological features, traces of use and treatment, and indications for the context and associations with other types of objects. As the wetlands are largely devoid of stone sources, most of the stone material in the Lower Rhine Basin must have been brought in from elsewhere. The stone artefacts of Schipluiden and Ypenburg, but also of the Hardinxveld sites, thus provide ideal study material to look in detail for evidence of material transformations that can be linked to cultural contacts with the farmers in the south.

4 Concluding remarks

Microwear analysis developed within a typical processual approach in the 1970s. Questions about the relationship between form and function, the detection of possible activity areas and site typology predominated and are still important, especially in site-oriented contract excavations. With the increased interest in the relationship between people and their material surroundings, microwear analysis became more integrated in the *chaîne opératoire* approach (a.o. Plisson and Beugnier 2007). There was also a growing interest in the biographical study of artefacts, to which microwear analysis could make key contributions (a.o. Wentink 2008; Van Gijn 2010). The research of artefacts from the Hardinxveld sites, Schipluiden and Ypenburg has shown that it is profitable to incorporate as many categories of material culture as possible in order to shed light on otherwise invisible craft activities

and the tool kits involved in these. However, despite the fact that microwear analysis has clearly been contributing to larger research questions, the approach remains somewhat static. Looking at cross-craft interaction, both from an intra- and inter-site perspective, could potentially give much information about craft organization in the past and about cross-cultural interaction. This would require the detailed study of the interconnectivity of various crafts, a task which will involve an extensive amount of experimentation. Each technological choice will require experimental exploration in order to assess the associated macro- and microscopic traces of manufacture, use, treatment and discard. Although this may seem a formidable task, it can be done within the context of public archaeology, making experimental research a twin-edged sword. Experimental archaeology forms a perfect bridge between scientific material analysis and public engagement and as such is not only a research tool, but has merits in and by itself.

The study of the interconnectivity of crafts combined with a biographical approach towards transformations of materials in cultural encounters is perfectly positioned to shed light on the neolithization process. Distribution studies of Late Mesolithic and Neolithic Rijckholt flint, stone adzes and flint axes have shown them to be widely distributed across the wetlands (a.o. Verhart 2000; Vanmontfort 2008). However, these imported stone tools were seen as finished objects, not as objects in transition, having a specific biography. Moreover, their presence in the wetlands was examined from a presence/absence perspective. Little attention was paid to the possible transformations in form, function or role the objects may have undergone in moving from one cultural context to another, transformations that may be linked with the construction of a new identity in the encounters with the farmers to the south. By carefully studying the materiality and biography of these southern exotics, how they were treated in the recipient communities, we may obtain a better understanding of the gradual incorporation of a new Neolithic lifestyle and identity by the inhabitants of the wetlands (Van Gijn 2008a). Microwear research, embedded in a biographical study of materials, is perfectly placed to study such transformations and shed light on cross-craft interaction. It just needs a shift in theoretical perspective, a sensitivity to materials and a closer look.

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