The haft and its tool: Investigating hafting wear traces on flint scrapers from the Vlaardingen group (3400-2500BC) in the Netherlands.

Fiona Vernon

Cover Image: Photo of Experiment 3732, photo taken by the author, Fiona Vernon.

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Masters Thesis

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MSc Material Culture Studies

University of Leiden, Faculty of Archaeology

Den Haag, 1st July 2018

Final version

Contents

Acknowledgements

I would like to take this opportunity to thank all those who made this thesis possible.

I am eternally grateful for the supervision of Prof. Dr. Annelou van Gijn, the teaching of Annemieke Verbaas, the assistance and cheerful companionship of Eric Mulder and Loe Jacobs in the Material Culture Studies Laboratory, and the guidance of Dr. Morgan Roussel and Drs. Martina Revello Lami.

Additional thanks must go to the experimental archaeologists/craftsmen, Diederik Pomstra, who made my hafted experimental tools, and Jaap Hogendoorn, who assisted with stretching the hide into its frame, without whom my experiments simply would not have happened!

Thank you to my fellow Material Culture Studies students and friends in Leiden, who listened to all the drama and kept me sane – I do not think I am a piece of flint, yet!

Finally, I would like to thank my parents and sister for their unfailing support throughout this Master's degree. I dedicate this thesis to my grandparents, who themselves may never have dreamed of such an academic achievement, but who have always been my guiding inspiration.

Chapter One: Introduction

Some features of the past demand our notice. Stonehenge, for example, may amaze archaeologists and the general public alike with its size and complexity. At the other end of the scale, a tiny, flint scraper, only 2cm in size, may easily be overlooked. However, once you hold it your hand the questions start bubbling to the surface. How did they make it? What did they use it for? And how did they use something *so* small? What makes the investigation of these small, perhaps unimpressive, artefacts exciting is that they represent the everyday interactions and behaviour of individuals in a dynamic, past society. Ubiquitous and mundane as scrapers may appear in prehistoric flint assemblages, they are ideal candidates for investigation, because they were the tools with which people were most regularly interacting.

1.1. The assumption: small tools need hafts

Whilst size may not be everything, it remains the starting point for this thesis. Overviews of the Middle Neolithic period in the Netherlands (Van Gijn and Bakker 2005; Van Gijn 2010), as well as previous use-wear studies (Van Gijn 1990, 119) have noted the presence of a quantity of tiny scrapers (<3cm), some known as 'thumb-nail' scrapers, from archaeological sites known collectively as the Vlaardingen Group (3400-2900 BC) (Fig. 1).

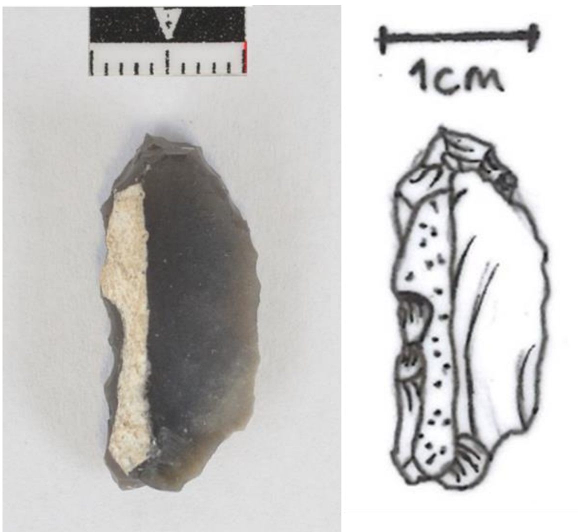


Figure 1: A tiny scraper from the site of Vlaardingen, which is the type-site of the so-called Vlaardingen Group.

What these scrapers share in common with discussions of microliths from earlier periods is the assumption, or assertion, that these tiny tools would almost certainly have been hafted in order to be used (Unrath 1987; Julien *et al*. 1987, 288). Despite human, fine motor skills, small flint tools are discussed as simply too small to have been used efficiently, or even at all, without a haft (Straus 2002, 71). It is also argued that very small scrapers must have been hafted in order to practically allow resharpening. Evidence for which is apparent in fragmented use-wear polish and the presence of extreme edge angles (Van Gijn 1990, 119). These morphological attributes have been the basis for the widespread assumption that tiny tools require hafts.

However, as the development of the use-wear analysis methodology since the 1960s has proved, tool morphology is not necessarily a reliable indicator of actual tool function. So, it may be expected that the interpretation of hafting on the basis of morphology would also be questioned and interrogated by the results of microwear analysis. As will be explained later, this was not the case until relatively recently.

Bearing in mind the advances that have been made within the study of hafting traces (Rots 2002; 2003; 2010) and the wider use-wear methodology, I want to test the hypothesis that my sample of small, flint scrapers were hafted, by looking at the microscopic level for traces of hafting on the tool.

1.2. Out of the spotlight

Despite being recognised as important for interpretation of lithic assemblages (Keeley 1982), only sporadic and often rather unsystematic investigation of hafting traces took place until relatively recently (Rots 2010, 2). For the early pioneers of the use-wear methodology the investigation of prehension and hafting was not a priority. The methodological problems of interpreting use-wear traces were complicated enough and, as it was suggested that hafting traces were unlikely to consistently form, analysts focussed on getting to grips with the nature of use-wear first. Nevertheless, a few analysts did attempt to characterise hafting traces using both low power (Odell and Odell-Vereecken 1980; Odell 1980) and high power magnification analysis (Plisson 1982; Moss and Newcomer 1982; Juel Jensen 1994). Papers from the first major conference addressing the issue of hafting organised by Stordeur in 1984, demonstrate a bewildering range of microscopic (Moss 1987) and macroscopic attributes as evidence of hafting, such as: tool standardisation (Caspar and Cahen 1987); morphology (Cauvin and

Stordeur 1987) and fractures (Keeley 1987). Elsewhere, when traces did not conform to the expected pattern for use, they were often vaguely attributed to hafting, but not sufficiently investigated further (Rots 2010, 2). Nevertheless, analysts were noticing something.

1.3. A systematic study

Analysts did not know how to interpret hafting traces, because they did not know what to look for, and which microwear attributes were significant for hafting. Only a systematic programme of experiments with hafted tools could provide the necessary analogies required to suggest what attributes were related to hafting. It was into this niche that Rots (2002) placed her doctoral research. Through extensive experimentation with hafted tools, her research elucidated some of the characteristics of hafting traces, and the variables which influence their formation. In the conclusion of her thesis, Rots expressed confidence in her ability to interpret not only the presence or absence of a haft, but also, in favourable conditions, the more detailed specifics of the hafting arrangement and haft material.

1.4. Statement of aims, objectives and research questions

Rots (2010) has demonstrated using extensive experimental evidence that characteristic hafting traces do form and analysts now have a clearer idea of which microwear attributes might be significant for an interpretation of hafting. For these experiments to be worthwhile, however, they should aid us in our interpretations of archaeological material. In this research, I want to personally test whether Rots findings aid my interpretation of hafting traces on a sample of archaeological artefacts. This sample is particularly interesting to study, because it allows us to test the assumption that these small, 'thumb-nail' scrapers must have been used hafted, because of their small size.

Whilst this is very much about testing out a methodology against a seemingly common-sense assumption, the wider implications of the evidence of hafting will not be forgotten.

This focus of this research could be illustrated with the following questions:

- Were these scrapers hafted?

- What traces of hafting are preserved on these scrapers? Have they possibly been obscured?

- In what hafting arrangements were the scrapers used?

- Is there a consistent pattern of hafting amongst the scrapers? Were they hafted to be used in a certain way on a certain material?

- How might evidence of hafting contribute to the discussion of the Vlaardingen group?

1.5. The importance of studying hafting

Here, it is important to briefly outline why investigating hafting traces is important and worthwhile. Evidence of hafting is not only significant, because it tells us about the biography of an individual stone tool, but also, because the overall process of hafting has an effect on the wider archaeological record.

But first, it is essential to highlight that an investigation of hafting traces encourages us to think about the interactions of materials in prehistory. Hafting traces provide indirect evidence of an organic, haft material, which was integral to the functioning of the stone tool, but which often does not survive, and therefore is often underrepresented in the archaeological record. Within the field of material culture studies, the realisation that this lithic depended upon another material to operate as a functional tool, helps to break down barriers between materials specialists. It encourages archaeologists to consider the wide reaching entanglements and cross-craft interaction of which this lithic was a part.

Hafting can have a significant impact on all aspects of the life cycle of a tool (Fig. 2) and hence strongly influences the archaeological record and our interpretations thereof. This even extends to the behaviour and technological strategies we attribute to prehistoric communities.

Firstly, hafting requires planning the procurement of an increased number of varied raw materials compared to the use of hand-held tools. So that hafting forms evidence of the planned manufacture of tools in advance of use (Odell 1996, 55). In Palaeolithic Archaeology, this then feeds into discussions of identifying human behavioural complexity.

Crucially, the manufacture of the haft demands a large time and energy investment compared with the knapped tool (Pétrequin and Pétrequin 1993). So, the fact that prehistoric people nevertheless made this investment gives us insights into what choices they were able to make in terms of availability of resources, and what they thought was worthwhile, even if it resulted in higher production costs. Rots (2003, 807) argues that given this investment, a hafted tool can hardly be seen as expedient, but that hafting is more characteristic of a curated tool technology, or even of personal rather than ad-hoc, situational tools. This says something about these people's technological strategy.

Furthermore, the intention to haft may also have led to the adaptation of tool morphology during production, so that it would fit a particular haft. A high level of investment in the haft, as well as ethnographic evidence, for example from Ethiopia, indicates the importance of the haft in contrast to the replaceable stone tool (Rots and Williamson 2004). This suggests interpretations of morphological standardisation or variability within lithic assemblages should take into consideration whether the tools were made to be hafted.

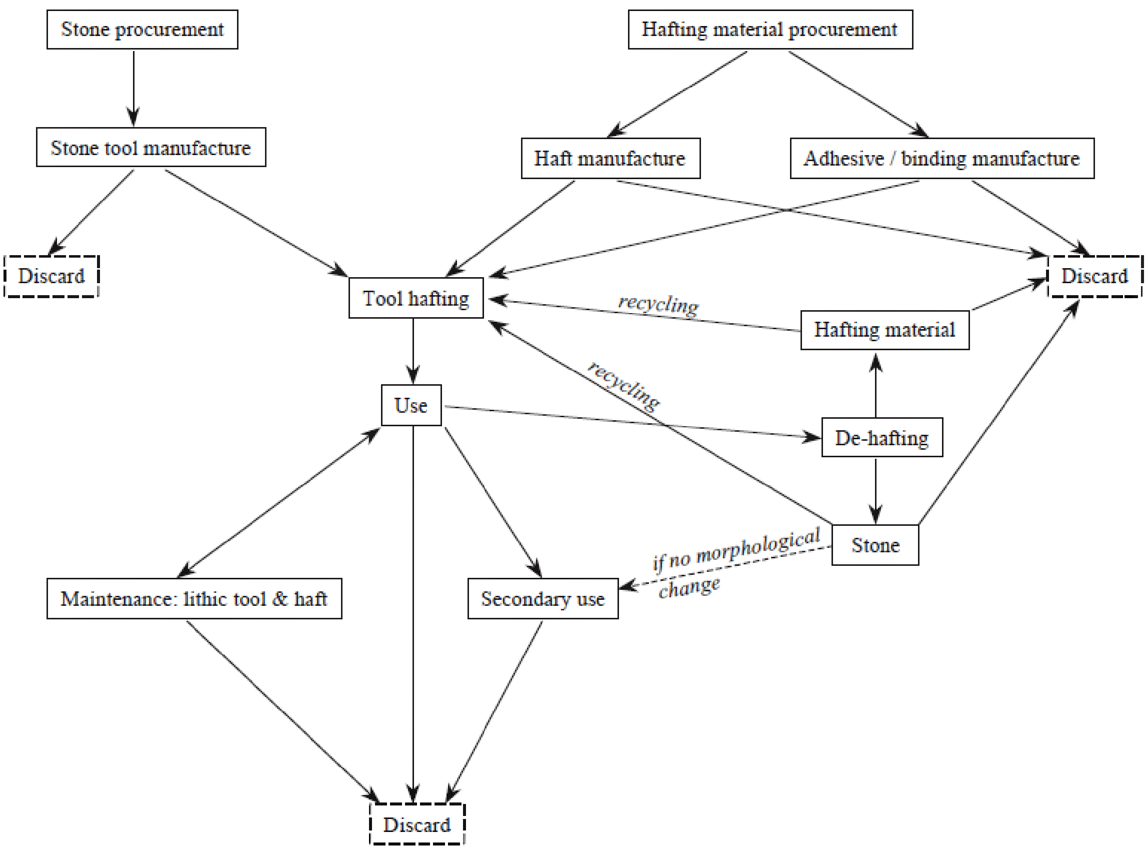


Figure 2: Flow chart for hafted stone tools (Rots 2010, 4).

Finally, the presence of hafting traces is important for the interpretation of the site function or specialisation, and even for the wider, functional relationships between sites in the same region. The practice of hafting usually involves the activity of retooling, where a new stone tool is inserted into an existing haft, after the previous stone insert has reached the end of its use-life. This may have taken place only where and when it was convenient to do so, therefore influencing the discard of stone tools. Sites where retooling took place may not have been the same places these tools were actually used. Therefore, an interpretation of a site's function based on the use-wear traces of these artefacts may, in fact, be misleading.

1.6. Organisation of the thesis

Now that the scene has been set in this first introductory chapter, we can move on to the background and previous archaeological investigations of Vlaardingen sites in chapter two. This will be followed by a critical evaluation and explanation of the methodology employed for this research in chapter three. However, the programme of experimental archaeology undertaken as part of this thesis will be discussed separately in chapter four. In chapter five the results of the microwear analysis will be presented, explaining why scrapers were interpreted as hafted, and looking at them in the wider context of the scraper assemblage. Discussion of the issues and insights that these results have raised will continue in chapter six. Finally, in chapter seven, we will return to some of the research questions raised here in the introduction and sum up this research, also offering some suggestions for future research.

Chapter Two: The Vlaardingen group

The term Vlaardingen Group, or Vlaardingen Culture, is used to refer to sites dating between 3400 and 2500 cal BC and located within the Rhine-Meuse delta (Fig. 3). This distribution of sites is situated between the Funnelbeaker Culture to the north-east and the Seine-Oise-Marne Culture to the south, whilst its relationship to, or equivalence with, the nearby Stein group is still debated (Van Gijn and Bakker 2005, 281).

The settlement system of the so-called Vlaardingen Group is often interpreted in relation to four geographical regions with their own characteristic site types (Raemaekers 2003; Van Gijn and Bakker 2005). Sites are located on dunes on the coast; on creek banks in the freshwater tidal zone; on river dunes in the peat zone and on fluvial levees.

The sites located on the coastal dunes are characterized by unambiguous plans of significant house structures (e.g. Haamstede-Brabers), the domination of domestic animals in the faunal assemblage (Voorschoten and Leidschendam) and some evidence for crop cultivation in the form of ardmarks and palynological data (Zandwerven and Hellevoetsluis-Ossenhoek (Goossens 2010)). This has led to the suggestion that these sites were probably inhabited year-round by family groups focusing on cereal cultivation and animal husbandry (Raemaekers 2003, 744-745).

In contrast, the sites in the freshwater tidal zone, including Vlaardingen and Hekelingen III, are considered less suitable for year-round occupation due to their natural environment setting (Raemaekers 2003, 744) and generally present a faunal assemblage dominated by wild species. Faunal remains suggest hunting and fishing took place throughout the year, but evidence of small, lightweight shelters at Hekelingen suggests occupation at a different degree of permanence than the coastal dune sites. Instead, they may have been inhabited by seasonal task forces involved in fishing, fowling and hunting.

River dune sites in the peat region include sites such as the Hazendonk. Here a peculiar, wild faunal assemblage (predominately otter and beaver) has suggested this was a subsidiary, special activity site, which was associated with permanent settlements elsewhere (Amkreutz 2013, 396), although it seems considerable investment was made here in building a wooden trackway and palisade (Louwe Kooijmans 1985).

Finally, sites on fluvial levees further inland, such as Ewijk, are also characterised by the presence of significant numbers of domesticates, much like those sites in the coastal zone. Other wetland (Wijchen) and upland sites (Hulst, Toterfout) have produced Vlaardingen material, and although poor preservation precludes a confident attribution of function, an agricultural function has been assumed (Amkreutz 2013, 398). The southern location of these sites has also triggered discussions of whether these sites belong to the neighbouring Stein group or whether they are all one Vlaardingen-Stein complex (Van Gijn and Bakker 2005, 281).

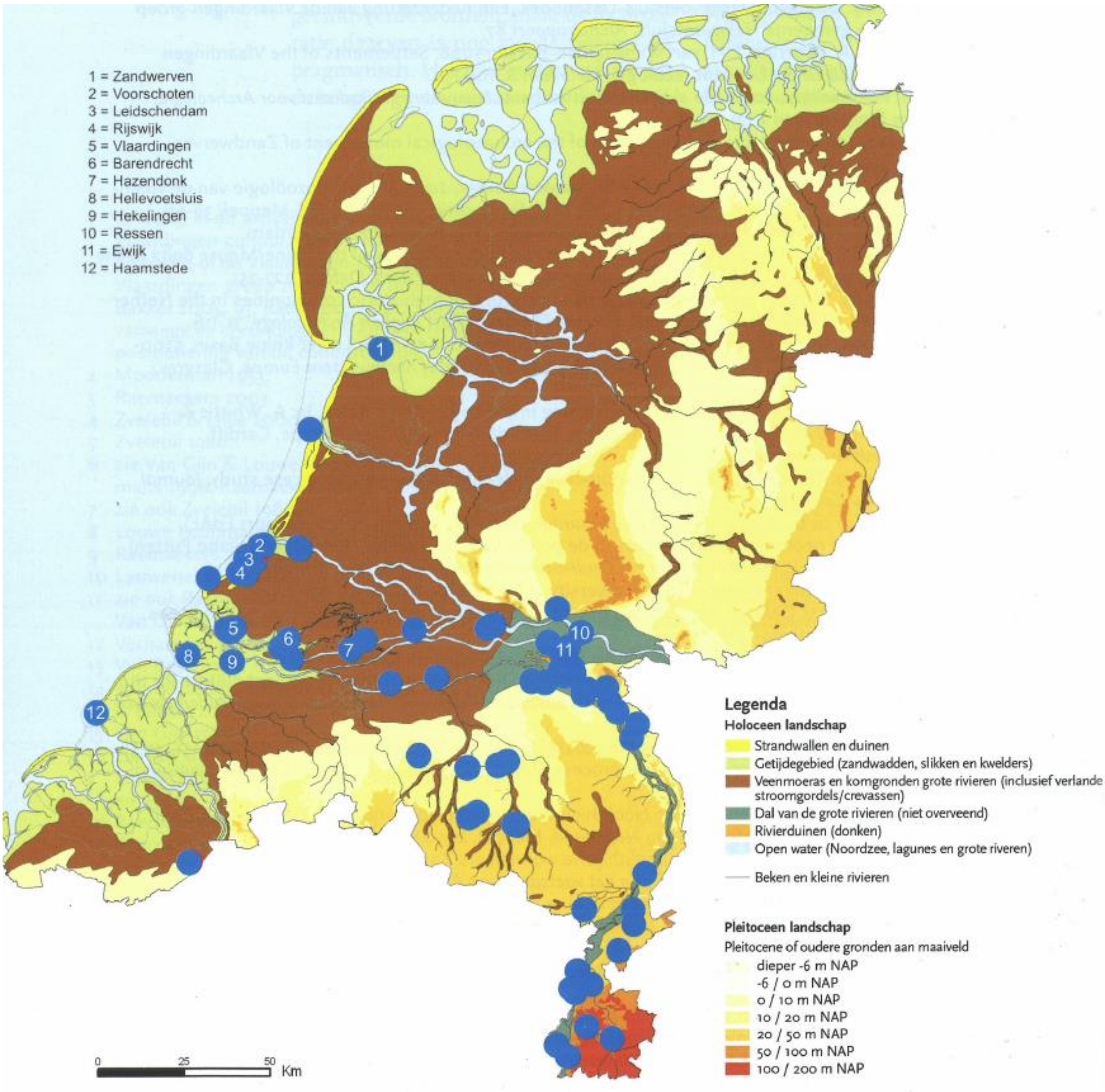


Figure 3: Distribution of possible settlements of the Vlaardingen group and the Stein group in the Netherlands (Brinkkemper *et al.* 2010, 26). The material studied as part of this thesis come from sites numbered 2, 3 and 5.

2.1. The flint technology

A significant characteristic of Vlaardingen sites is the heterogeneous sources of flint between, and sometimes within, assemblages (Fig. 4). Based on a literature review, Amkreutz (2010) suggested the following significant differences in the types of flint being used at different sites. At coastal sites, such as Haamstede, Leidschendam and Voorschoten, artefacts were made on local, rolled flint nodules, which resulted in smaller sized tools (Van Gijn and Bakker 2005, 295). However, flint with a more northern source was also used at Leidschendam and Voorschoten as well as at Zandwerven. At the Hazendonk, regionally available terrace flint was primarily used, but with evidence of southern, import products from the Rijkcholt and Hesbaye area. In contrast, Vlaardingen and Hekelingen display a strong 'exotic' component, as almost all of the flint came from southern sources, mainly from Spiennes or northern France, and probably from the Boulogne coastal area. Amkreutz (2013, 402) argues that these differences represent site-specific resource networks and suggests a greater level of independency for sites than is commonly suggested.

Given the complex networks necessary for 'exotic' flint to appear in the Rhine-Meuse delta, it seems curious that at some Vlaardingen sites like Hekelingen III, the reduction of cores was rather inefficient (Van Gijn and Bakker 2005, 295; Van Gijn 1990). The lack of platform preparations led to a large number of hinge fractures, which prevented further reduction (Van Gijn 1990, 103). Although these cores could have been made usable again, Van Gijn suggests the people at Hekelingen III decided not to work them further and whether this was due to a lack of skill, or an abundance of available flint is unclear. At Hekelingen III, Verhart (1983) and Van Gijn (1990) recognise cores made on nodules which were to some extent pre-prepared offsite, or on broken polished axes. On other sites, such as Leidschendam, people made thrifty use of small, local flint pebbles using a bipolar reduction technique (Van Gijn 2010, 82).

In fact, the variation in the proportion of cortical flakes at Vlaardingen sites suggests that onsite production took place at some sites more than others (Garcia-Diaz 2017, 257). However, this picture is occasionally obscured by excavation practices, which did not collect the smaller fraction of debitage (Van Gijn 1990, 134). Nevertheless, waste by-products and unmodified flakes dominate most Vlaardingen assemblages with a relatively low variability in retouched tool types (Garcia-Diaz 2017, 258) (Fig. 5).

	Voorschoten-Boschgest	Voorschoten-De Donk	Leideschendam	Vlaardingen	Hekelingen III	Hellevoetsluis-Ossenhoek	Wateringe-**Binnentuinen**	Barendrecht-Carnisselande	Habraken te Veldhoven	Hadriani / Arentsburg	Hazendonk	Total
Unmodified Flakes	134	1520	-	4809	-	206	1125	3	310	219	2	8328
Unmodified Blades	-	62	4	104	-	7	41	-	23	6	-	247
Retouched Flake	-	-	-	-	-	49	-	-	12	29	31	121
Retouched Blades	-	-	-	-	-	3	-	-	3	-	6	12
Retouched general	2	-	-	-	64*	-	307	4	-	5		380
Core and core fragments	38	121	131	80	49	6	52	-	-	15	1	493
Scrapers	-	-	116	628	119	91	619	-	8	50	5	1636
Borers	-	-	6	89	23	5	7	-	-	-	-	130
Hammerstone	-	-	-	-	-	-	4	-	5	-	-	9
Arrowheads	-	-	7	44	11	4	8	-	3	6	1	84
Sickle	-	-	-	-	-	-	4	-	-	-	-	4
Strike-a-lights	-	-	-	-	1	1	-	-	-	4	-	6
Burins	-	-	-	-	-	-	-	-	-	2	-	2
Chisel	-	-	-	-	-	-	-	-	3	-	-	3
Axe	-	-	-	341	3	14	-	-	-	-	-	358
Axe flakes and fragments	24	24	51	-	-	23	-	-	31	22	13	188
Block	-	-	-	-	-	-	23	1	-	-	1	25
Waste	-	152	-	-	-	167	346	-	-	110	-	775
Others	-	-	-	619	-	-	848	6	296	1001	-	2770
Flint general	258	2022	1773	6.714	1.011	847	3384	14	694	1469	196	1.485.913

Figure 5: Flint tool types and number of implements found at selected Vlaardingen settlements (Garcia-Diaz 2017, 258).

	gerold (lokaal)	Maasgrind/terras	Rijckholt	Haspengouw	Spiennes	Belgium	Lousberg	Boulogne	noordelijk	op bijl	Buren bijlen	bijlen	lokaal [%]	exotisch' [%]	literatuur
Haamstede-Brabers	+					+				+		+	90.6	9.4	Verhart 1992
Leidschendam	+								+	+	+	+			Van Gijn 1989
Voorschoten-De Donk	+					+				+					Van Veen 1989
Voorschoten-Boschgeest	+								+	+					Verhart 1992
Zandwerven									+	+					Van Regteren-Altena/Bakker 1961
Hekelingen-3	+				+?		+	+?					0	100	Verhart 1983
Hekelingen-1				+		+?				+			0	100?	Modderman 1953
Hellevoetsluis	+	+	+	+			+?	+?		+				+8?	Goossens 2009
Vlaardingen	+					+		+?		+		+			Pers. comm. L. Verhart
Hazendonk		+	+	+									70-80	20-30	Raemaekers 1999
Ewijk				+						+			20.3	79.7	Asmussen/Moree 1987

Figure 4: The different sources of flint found on Vlaardingen sites and, where possible, their proportions (Amkreutz 2010, 21). + indicates unquantified presence of that type of flint.

Predominantly made on flakes, rather than blades, assemblages from Vlaardingen sites are characterised by a prevalence of transverse arrowheads, tanged points and a few leaf points, as well as borers, numerous scrapers (including small 'thumb nail scrapers') and polished axes with oval cross-sections (Van Gijn 1990; Van Gijn and Bakker 2005, 295)(Fig. 6).

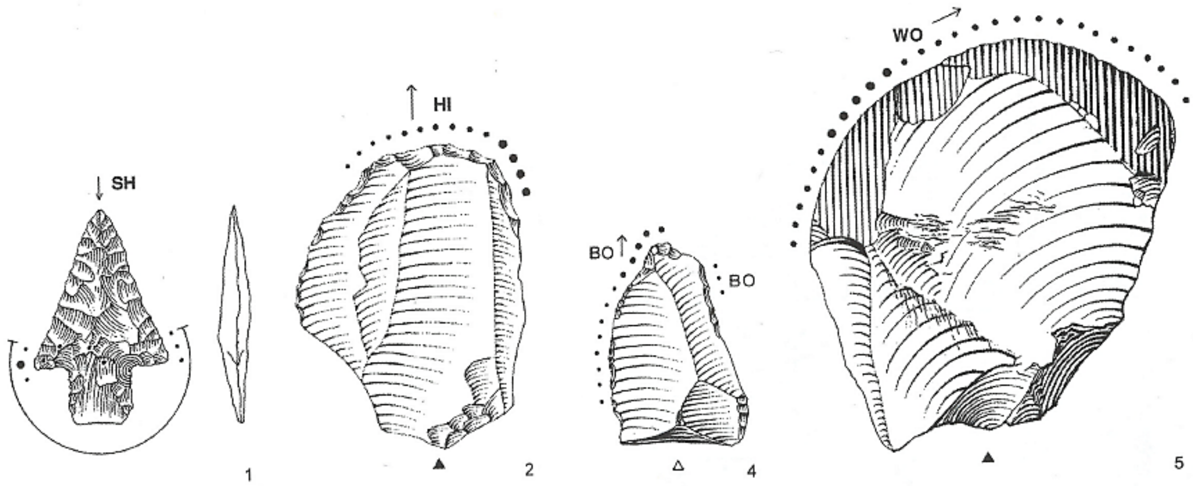


Figure 6: Flint tools characteristic of Vlaardingen sites (Van Gijn and Bakker 2005, 294). Annotations indicate presence of microwear traces – SH=shooting; HI=Hide; BO=Bone; WO=Wood. Arrow indicates polish directionality. Curved line indicates suggested haft limit.

2.2. Vlaardingen pottery

Traditionally, the Vlaardingen culture as an archaeological culture has been defined through a shared type of pottery, which was thick-walled, coarsely tempered and predominantly S-shaped (Van Gijn and Bakker 2005, 299) (Fig. 7). Typically, pottery from Vlaardingen sites is decorated with impressions and perforations in rows under the rim and on the wall, as well as knobs (Beckerman 2015, 110). However, variation between the pottery assemblages of different sites has also been noticed (Van Gijn and Bakker 2005, 294).

More recently, Beckerman and Raemaekers (2009) have proposed a new classification system for Vlaardingen ceramics based on morphometrical analysis and have thus suggested a new, three part chronological subdivision of the Vlaardingen period. However, building on this study and research into Corded Ware ceramics, Beckerman (2015, 135) argues that there are significant similarities in the development of ceramics within what is known as the Vlaardingen Culture in the south and the Corded Ware Culture in the north of the Netherlands. Moreover, ceramics which are traditionally termed Corded Ware are also found in the late Vlaardingen phase of a number of Vlaardingen sites (Beckerman 2015, 110). This study demonstrates the issues with using a type of pottery as a defining feature, and even raises doubt about the validity of the conception of Vlaardingen and Corded Ware Cultures as different cultural entities in the prehistoric Netherlands.

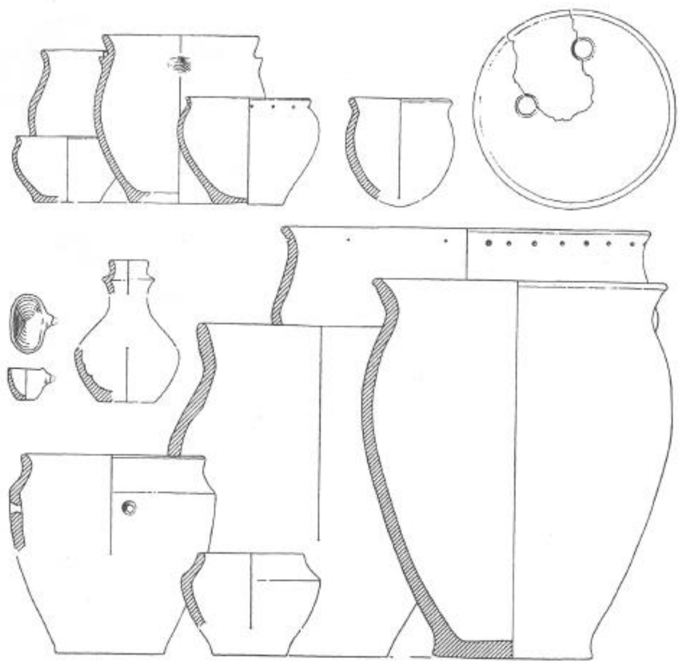


Figure 7: A representative selection of pottery from Vlaardingen, datable to the middle phase of the Vlaardingen group. Scale 1:6 (Van Gijn and Bakker 2005, 293).

2.3. Organic materials

The preservation of bone, antler and other organic materials on Vlaardingen sites is very good due to the relatively wet environment. Some of the highlights include antler hammers and fragments of fishing net (Vlaardingen), an almost complete ash paddle (Hekelingen III) and an axe haft and part of an oak dugout canoe (Hazendonk) (Van Gijn and Bakker 2005, 295-6).

Bone awls and chisels, as well as the waste from their production, are often found on Vlaardingen sites. Maarleveld's (1985) study of bone tools from Hekelingen III suggested they were mostly made on the metapodia of red and roe deer and a manufacturing sequence was suggested. The sequence involved deepening the natural grooves in the metapodia and sawing around the circumference of the distal end, in order to allow the bone to be snapped apart into a suitably shaped blank. This technique was later corroborated by Van Gijn's (1990, 109) use-wear analysis of flint tools from Hekelingen III and those used in Van den Broeke's (1982) bone carving and sawing experiments. The microwear traces observed on these experimental flint tools were very similar to observed archaeological traces and this led Van Gijn (1990, 109) to put forward this awl-making technique as the activity taking place at Hekelingen III. Similar bone working tools were also present amongst the material from Leidschendam (Van Gijn 1990, 137).

Both archaeological finds and indirect evidence from use-wear interpretations give us a more detailed impression of the organic materials employed on site, than can usually be achieved on archaeological sites.

2.4. Summarising the Vlaardingen Culture

There is significant inter-site variability amongst the sites known as the Vlaardingen Culture. The differences in site location, flint sources, bone assemblages, evidence of houses, and even to some extent pottery, suggest dynamic and varied ways of life. This seems to suggest people had a fairly flexible, expedient mode of existence, which was enabled by the heterogeneous landscape in which they lived (Van Gijn and Bakker 2005, 299). Evidence for domesticates and agriculture sits alongside a continuing tradition of a broad spectrum subsistence base (Raemaekers 2003). However, the degree to which the different sites relate and/or take precedence over the others is still debated, as is these groups' relationship with other archaeological cultures (Amkreutz, 2013). As a result, questions are increasingly being asked about whether these inter-site differences and wider cultural connections indicate that there is no such coherent entity as a Vlaardingen Culture.

2.5. Microwear analysis and Vlaardingen sites

Vlaardingen sites are amongst the most studied archaeological sites in terms of use-wear analysis in the Netherlands. Information derived from microwear analysis is available for sites such as: Hekelingen III and Leidschendam (Van Gijn 1990); Vlaardingen and Voorschoten (Van Gijn 1984; Van Gijn in Van Beek 1990); Hellevoetsluis-Ossenhoek (Metaxas 2010; Van Hoof and Metaxas 2009); Wateringse-Binnentuinen (Houkes *et al.* 2017); Hadriani/Arentsburg (Houkes and Verbaas 2014) and Habraken te Veldhoven (Van Gijn and Siebelink 2013).

One of the most significant, early discussions of microwear traces on Vlaardingen assemblages was Van Gijn's (1990) doctoral thesis. As part of this research, assemblages from Hekelingen III and Leidschendam (Trench 4) were analysed for traces of use-wear.

A number of activities were interpreted as taking place at Hekelingen III including: significant production of bone and antler objects; soft plant processing (possibly for basketry); wood working (cutting or whittling) and commonly, the scraping fresh hides of fur bearing mammals (Van Gijn 1990, 140). A similar range of activities was interpreted from the Leidschendam material, but the interpretation was hampered by significant post depositional surface modification (PDSM) of the flint. Nevertheless, evidence of hide, bone and wood working was found at Leidschendam.

Van Gijn (1990, 138) argued the heavy edge rounding of tools at Leidschendam suggested time intensive, dry hide working, possibly part of the softening stage of hide processing, which she suggests would have taken place at a more permanent base camp. This, along with the presence of two sickle blades, is behind Van Gijn's suggestion that Leidschendam represents a permanently settled agricultural community. In contrast, Van Gijn (1990, 140) suggests the less intensive use of flint tools at Hekelingen III, is evidence for a site only seasonally used to exploit wild resources.

Finally, in a review of site differentiation within the Vlaardingen Group, Van Gijn (1990, 140) also mentions a preliminary use-wear study carried out on material from the site of Vlaardingen. The material from Trench 11 is said to indicate the same range of performed activities as at Hekelingen III and Leidschendam with a predominance of hide working, whilst the lithic raw materials and size of artefacts is also similar to the Hekelingen material (Van Gijn 1990, 140).

In the decades that followed Van Gijn's thesis, further Vlaardingen sites were excavated and other microwear analysts studied samples of these assemblages. This enabled a more subtle understanding of the similarities and differences in activities taking place at Vlaardingen settlements. For example, Garcia-Diaz (2017, 261) highlights that use-wear traces related to soft plant processing turned out to be proportionally more important at the sites of Hellevoetsluis-Ossenhoek (Metaxas 2010; Van Hoof and Metaxas 2009) and Hadriani/Arentsburg (Houkes and Verbaas 2014) than at Leidschendam or Hekelingen III (Van Gijn 1990), although the latter sites did also have a large number of tool edges with such traces. On the other hand, evidence of cereal harvesting near the settlements, in the form of sickles, has remained limited to Leidschendam (Van Gijn 1990) and Hellevoetsluis-Ossenhoek (Metaxas 2010).

These more recent microwear studies have generally reported similar types of use-wear traces as those first identified by Van Gijn (1990) at Hekelingen III and Leidschendam. Bone and hide working are two of the most frequently inferred activities at Vlaardingen sites, such as: Hekelingen III, Leidschendam, Vlaardingen, Hellevoetsluis-Ossenhoek and Hadriani/Arentsburg (Garcia-Diaz 2017, 263). However, rare evidence of another activity was found at Wateringe-Binnentuinen, where, for the first time, analysts were able to interpret use-wear traces as suggestive of fish processing (Houkes *et al.* 2017). This had long been considered an important activity for Vlaardingen settlements near the coast and rivers, but had been rather invisible in the use-wear record.

2.6. Hafting traces on Vlaardingen assemblages

One of the most significant discussions of hafting traces on Vlaardingen material also relates to Van Gijn's (1990) analysis of material from Hekelingen III. Although use-wear, rather than hafting wear, was the focus of Van Gijn's investigation, and despite expressed misgivings about the formation and survival of hafting traces, Van Gijn recorded some attributes which could be interpreted as evidence of hafting.

The scarcity of microscopic traces of hafting on the material from Hekelingen III was attributed by Van Gijn (1990, 118) to the relatively coarse nature of the lithic raw material and post-depositional surface modifications, which limited the formation and later obscured traces. Only 7 out of 337 tools examined from Hekelingen III appeared to show microscopic traces of hafting, such as a smooth 'plant-like' polish suggestive of vegetal bindings, or 'hide polish' on dorsal ridges and lateral edges (Van Gijn 1990, 118). However, Van Gijn noted that many of these hafting traces involved an 'uncertain' interpretation, a view shared by many analysts at the time. Instead, Van Gijn (1990, 119) suggested morphological attributes such as notches, a retouched concave edge or the presence of bitumen as features that had potential as hypotheses for hafting.

In Van Gijn's (1990) discussion of material from Leidschendam there was no mention of hafting traces, but then this assemblage was adversely affected by post depositional surface modifications.

Over the decades, as the discipline of microwear analysis has matured and developed, analysts have been able to turn their attention to a wider variety of microwear traces. Subsequent studies of Vlaardingen sites have also occasionally reported evidence of some implements having been hafted.

For example, despite problems with PDSM, four scrapers from the site of Wateringse-Binnentuinen are reported to have obvious traces of hafting (Houkes *et al.* 2017, 186). Three different hafting materials were suggested (wood, hide and an unknown material) and from Houkes *et al.*'s published photographs it seems the interpreted hafting traces were concentrations of polish away from the edge, visually similar to what Rots (2010) calls bright spots. No specific scraper type or working edge angle was indentified for the hafted scrapers (Houkes *et al.* 2017, 188).

2.7. How could hafting traces make a contribution to the study of Vlaardingen sites?

Evidence of hafting could be important for our interpretations of the technological strategies used by people inhabiting Vlaardingen sites, particularly in terms of the level of tool curation. Although it is clear that not all curated implements are necessarily hafted, it is assumed that because of the extra effort involved in hafting, a hafted, stone tool will commonly be used more ex/intensively than other tools. In this case, the stone tool would qualify as a more curated tool under Shott's (1996, 267) evaluation of curation as the degree of use or utility extracted before discard. Whilst the effects of curation and hafting are not identical, they may sometimes be correlated (Keeley 1982, 799) and may give further indication of how people were using their flint. Indeed Keeley (1982, 808) goes on to argue that hafting is a strategy to manage the exploitation of lithic materials.

Furthermore, evidence of hafting could be important for our interpretations of Vlaardingen sites, because the hafting process affects the composition of the archaeological record. Even before the formation and interpretability of hafting microwear had been widely accepted, Keeley (1982) argued that the practice of hafting would significantly affect archaeologists' interpretations of the spatial patterning of activities within a site, and the variation in assemblages between sites (Keeley 1982, 798). For a group of sites which display such inter-site variability as the Vlaardingen Culture, evidence of hafting might offer some explanation for variable assemblages at different sites.

Keeley (1982, 802-803) makes two important suppositions about hafted tools which would affect their preferential deposition at certain sites.

Firstly, that previously hafted stone tools tend to accumulate where they were replaced, in other words where the haft was retooled, and this is not necessarily where the tool was last used. This means we should be cautious about interpreting specialised use zones within sites. If the tools also show hafting traces, the real activity taking place may be retooling rather than the activity suggested by the use-wear.

Secondly, that hafts would be retooled when convenient rather than waiting until it was absolutely necessary. Keeley (1982, 803) suggests this decision of when and where to retool would likely be influenced by factors such as the availability of suitable hafting materials and the length and season of occupation at a site. Therefore, hafted tools may only be found at sites considered suitable for retooling. This could offer archaeologists useful information, as we are also interested in those factors affecting the retooling decision. For example, it could be argued that evidence of hafting can contribute to a discussion of the type of occupation at different Vlaardingen sites, which is still somewhat unclear.

Chapter Three: Methodology

3.1. Introduction

An investigation of hafting wear traces has been made possible by the groundwork laid by analysts who pioneered the use-wear methodology. Therefore, it is important to mention its contribution, and how hafting wear analysis developed from this research. After this, the approach which the author has followed will be outlined and the procedural details described. Details of the experimental archaeology carried out in order to aid the interpretation of hafting wear will be discussed in Chapter Four.

Commonly referred to as use-wear analysis, functional analysis, or even traceology, I will use the term microwear analysis, as an indication that the range of macroscopic and microscopic traces under investigation, such as edge damage or polish, are key not only to interpretations of use *sensu stricto*, but to interpretations of prehension and hafting as well.

3.2. Microwear Analysis

In its simplest form, this methodology is based on the principle that the use of an object leaves traces of wear, and that these traces survive, more or less unobscured by post depositional processes, until the present day in which an analyst views the object. Furthermore, these traces are considered to vary according to the object's use, so that it is usually considered possible for analysts to distinguish between traces. Analysts are also able to suggest explanations for traces found on archaeological objects by analogy with traces created under known conditions, on experimentally made and used replicas, or occasionally on ethno-archaeological artefacts. As a result, traces are often discussed as the product of different contact materials and/or use motions, although this represents an interpretation, rather than positive identification.

3.2.1. Development of use-wear analysis

Use-wear analysis took off in the early 1970s, after the publication of Semenov's (1964) seminal work *Prehistoric Technology* in English. Semenov pioneered the use of systematic experimentation and microscopy to understand wear traces on lithic and bone tools (Marreiros *et al.* 2015, 5). Semenov's work was developed in two main directions which came to be known as the low power and high power approaches. Researchers, such as Tringham (Tringham *et al.* 1974) and Odell (Odell and Odell-Vereecken 1980), continued Semenov's use of stereomicroscopes (magnifications of less than 100x) to investigate mainly whether aspects of edge damage or diagnostic fractures were formed in relation to different worked materials. Meanwhile, Keeley (1980) developed the use of higher magnification (100-400x) microscopy and focussed on investigating microscopic polishes. Many experimental programmes, for example (Keeley and Newcomer 1977), were directed towards investigating the potential for specific materials to cause distinct polishes. This, however, was thrown in to doubt after a number of influential and disappointing blind tests (Newcomer *et al.* 1986; Unrath *et al.* 1986). It began to be acknowledged that polish on its own was not conclusive enough, and that all available clues should be considered for an interpretation of use. So by the early 1990s, the use of low and high power techniques came to be considered complementary rather than competing (Van Gijn 1990). An emphasis was now made on using all sources of information to support a functional interpretation, including all varieties of microwear traces (edge damage, polish, striations, and residues), the overall tool morphology, and its archaeological context (Bamforth *et al.* 1990, 415).

3.2.2. A self-aware modern methodology

The narrative of use-wear studies is of a methodology which after initial optimism, trials and disappointments has reached a certain level of maturity (Grace 1996). Van Gijn (2014) argues it has become a lot more realistic and explicit about its limitations and possibilities. Key to this has also been the realisation that through careful analysis of various types of traces, archaeologists may arrive at an interpretation of wear traces, rather than identification (Van Gijn 1990, 21; 2014). This is because there is a certain amount of overlap in attributes of wear traces between all worked materials (Van den Dries and Van Gijn 1997, 499).

Furthermore, some traces are simply not distinctive enough for a positive identification. This can be due to: weak trace formation from a short, or less intensive, use duration; post depositional surface modification masking traces, or the effect of the complex and idiosyncratic nature of human actions.

Nevertheless, in the case of well-preserved assemblages and with appropriate analogies from experimental tools, analysts can often be confident in their interpretations of worked material or use-motion. It is now acknowledged that use-wear traces do not always enable a suggestion of the exact activity taking place, for that, wider archaeological context needs to be taken into account. For example, Van Gijn (1990) was only able to suggest that some flint tools had been used in bone awl or chisel production, after collaborative evidence from traces on the bone awls and experimental work.

The foundation laid by analysts studying use-wear *sensu stricto* has enabled the next generation of analysts to focus on some of the finer subtleties of microwear, including hafting traces.

3.3. Hafting wear

3.3.1. Initial scepticism and first attempts

Influenced by Keeley's (1982) influential assessment, many early pioneers of the use-wear method did not prioritise the investigation of prehension and hafting, because traces were considered unlikely to form consistently and, if they did form to some minimal extent, they were judged difficult to interpret, especially as they could be obscured by post-depositional wear (Van Gijn 1990, 119). It must also be admitted that microwear analysts, who were limited in number at this stage, were already fully preoccupied with the methodological problems involved in interpreting the more obvious use-wear traces, to have much time for hafting traces.

Despite recognising hafting as important for the interpretation of technological strategies, spatial patterning of activities and inter-assemblage variability, Keeley (1982) was rather pessimistic about finding microwear evidence suggestive of prehension or hafting. Keeley (1982, 801) suggested several morphological features, such as size, thickness and steep edge angles, might distinguish hafted from non-hafted versions of tools, however, he claimed to have encountered microwear traces of prehension only very rarely on experimental or archaeological implements. He argued that they rarely formed, because the amount of pressure needed to create wear would be uncomfortable for the fingers of the user. Whilst he admitted to noticing traces from hafting a little more frequently, Keeley maintained that they too were rare, because in a well-made hafted tool, no movement or friction occurred between the tool and the haft, and so no traces were formed (Keeley 1982, 807). It seems on this basis, Keeley and others did not see it as worthwhile to try and interpret these kinds of traces further.

Similarly Moss (1987, 99) suggested only when tools moved in the haft were they capable of accruing any hafting polish, which she called Polish G. Even then, she argued the micro-polishes observed were often not as characteristic as use-wear polishes and could not always be reliably distinguished from traces from trampling (Moss 1987, 99). Furthermore, Moss and Newcomer (1982, 929) highlighted the presence of an adhesive in a hafting arrangement, such as resin, beeswax or sinew, as important in preventing movement within the haft. They argued this either precluded the formation of traces altogether, or resulted in "miniscule bits of unidentifiable polish on the ridges or high points of the microtopography" (Moss and Newcomer 1982, 292). Moss and Newcomer (1982) also dismissed edge damage on their sample from Pincevent as so minimal, that it could not be attributed to hafting. Despite their initially pessimistic tone, they go on to report the presence of antler polish on the proximal, dorsal ridges of an experimentally used endscraper as evidence of contact with the haft (Moss and Newcomer 1982, 310). Hereby implying that in certain circumstances they can recognise some traces related to hafting.

The influential multi-analyst blind test carried out by Unrath *et al.* (1986) also reported limited success with interpreting hafting or prehension, although some contradictory and conciliatory statements complicate the picture. Some particularly vague comments about "strange streaks of polish" are given as reasons for suggestions of hafting. However, it is argued that analysts' comments suggest they generally believe hafting traces do exist, but are undiagnostic, infrequent and too problematical to analyse within the context of blind test (Unrath *et al.* 1986, 172). In the article, however, the misinterpretation of traces of prehension and manufacture, for those of use-wear is mentioned a number of times (Unrath *et al.* 1986, 117; 152), which would seem to indicate that hafting traces can be distinguished as a category, because the authors argue they have identified the mistake. In concluding, Unrath *et al.* (1986) bemoan the lack of experimental hafting research, and indicate that this is why the recognition of hafting in this blind test, and in the archaeological record, was poor. It seems the formation of hafting traces is not so much doubted, as by Keeley, but the interpretation of what constitutes hafting traces still seems to be problematic for the analysts.

A more positive view of the interpretation of prehension and hafting traces was put forward by Odell (Odell & Odell-Vereecken, 1980; Odell 1980; 1981) who was the main proponent of a low-power approach to use-wear analysis. In terms of prehension traces, Odell suggested unifacial, edge removals would form in patches due to pressure along the edge from a relatively broad, fleshy fingertip (Odell & Odell-Vereecken 1980). Furthermore, it was argued that the tool's edge angle, and angle of force applied to the edge by the user (Fig. 8), are major factors in determining the form of the resulting removals (Odell and Odell-Vereecken 1980, 103). So the Odells argued that the form of these patches of scars, whether hinged or feather terminating, would indicate how the tool was held.

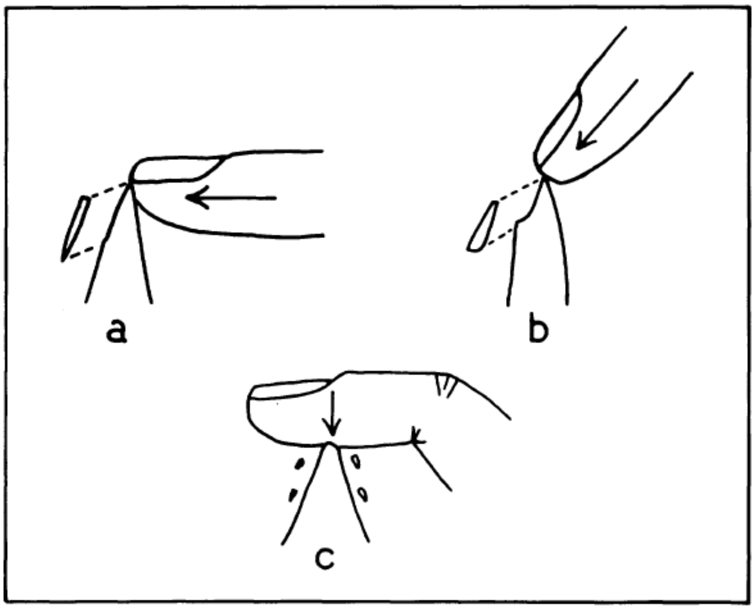


Figure 8: The effect of differing contact angles between applied force and lateral tool margin: a) oblique or perpendicular, b) acute and c) direct (Odell and Odell-Vereecken 1980, 103).

Odell and Odell-Vereecken (1980, 108) briefly mention that a wooden haft produces different characteristics to those of manual gripping, although when discussed in another article (Odell 1980, 410) it seems the main difference put forward is a greater "intensity" (?) to hafting traces compared to prehensile damage. Furthermore, Odell's principle argument for the presence of a haft on artefacts from the Burgumermeer assemblage is that the location and intensity of traces (such as polish, scratches and edge scarring) apparently cannot be attributed to any other factor such as use, manufacture or post depositional factors. Despite some positive remarks, the differentiation made by Odell between prehension and hafting traces seems unclear and confusing.

A picture emerges of occasional discussions of hafting wear on the side lines of larger use-wear related discussions. Analysts were noticing unexpected traces away from the active edge, but they were often simply filed away under a category of 'hafting traces' without any further attempt to interpret them. Reviewing early discussions of hafting, it becomes increasingly obvious that the issue was not with the formation of hafting traces, but on the level of analysts' interpretation. Practically no hafting experiments had ever been undertaken on a systematic basis, and analysts did not know how to interpret hafting traces, because they did not know what to look for and which microwear attributes were significant for hafting (Rots 2003, 805).

3.3.2. Recent advances

It was into this niche that Rots (2003, 2010, 2015) placed her doctoral research. This aimed to design a methodology to enable the interpretation of prehension and hafting traces on archaeological assemblages, through extensive and systematic experimentation with hafted tools. From traces found on experimental tools, Rots was able to elucidate some characteristics of hafting traces and the variables which influence their formation. In other words, analysts now have a better idea of what distributions and associations of traces indicate the presence of a haft, or hand-held use (prehension). This time consuming experimental ground work has given analysts a more solid basis from which to argue for hafting traces.

3.3.3. Issues when interpreting hafting wear

Many of the issues affecting an interpretation of use-wear will also affect analysis of hafting wear. Both involve analysing similar types of traces caused, in one way or another, by friction between two materials. However, in the following discussion any issues which particularly affect hafting wear will be highlighted. The issues can be discussed in terms of those affecting the formation of hafting traces and those affecting the analysts' ability to distinguish and interpret the traces.

It is now accepted that a number of factors affect the development of microwear, not only the nature of the contact material and the motion used.

Lerner *et al.* (2007) explain how the material properties of the lithic raw material have implications for rates of use-wear accrual. Lerner *et al.* (2007, 720) caution that differences in material hardness and micro-topography between different sources of flint can significantly affect wear development, so that the extent of wear alone may not be reliably used to determine tool function. Furthermore, none of the lithics tested by Lerner *et al.* proved to be perfectly homogeneous, so that a tool may not accrue wear evenly across its entire surface. Although for the purpose of this thesis, differences in hardness between flint sources cannot be measured or accounted for, it is important to consider this when making archaeological interpretations, as my sample comprises material from different lithic sources.

Rots (2010, 40) is quite clear that the amount and development stage of hafting wear polish depends on the hafting arrangement and ultimately the level of contact between the tool and haft. In favourable conditions, this variation in polish enables the distinction between different types of haft such as male or juxtaposed. However, for some hafting arrangements, where there is little contact, polish related to the haft material will not be formed. This may lead to the relative invisibility, or conversely, overrepresentation of certain hafting arrangements in the archaeological record. The level of contact the tool has with the haft material may be affected by aspects of the tools morphology, or by the use of another material in the hafting arrangement, such as resin or wrapping.

Depending on the relative hardness of the haft material, the longitudinal- and transversal surface curvature of the tool may limit the contact with the hafting material to a small area. First explored by Tringham *et al.* (1974, 180), in Rots' (2010, 27) research she describes longitudinal surface curvature as relating to the curvature of the ventral surface in relation to a flat plane (Fig. 9), which supposedly represents the hard and straight haft material. Transversal surface curvature, on the other hand, relates to the shape formed by the dorsal ridges, which, depending on the hafting arrangement, would also potentially come into contact with the haft material (Fig. 9).

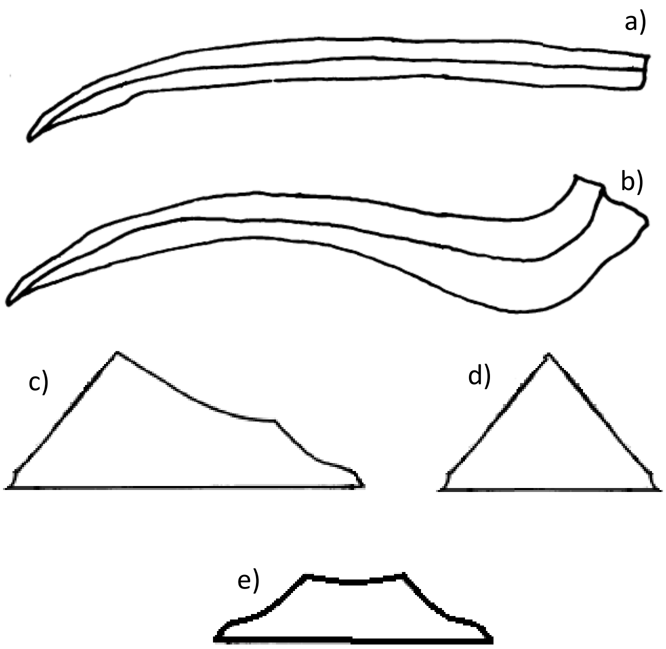


Figure 9. Examples of longitudinal surface curvature (LC) and transversal surface curvature (TC) (after Tringham *et al.* 1974, 178-179). a) straight LC; b) curved LC; c) sub-triangular TC; d) triangular TC; e) trapezoidal TC.

A further reason why contact and therefore hafting traces may be limited is due to the use of resin. Resin reduces the movement and friction between tool and haft material whilst it is being used and ensures that polishes from the haft material are rare to non-existent (Rots 2010, 162). Whilst resin usually prevents an interpretation of the haft material, the presence of resin is considered by Rots to be reliably interpreted through a very distinctive resin polish (Rots 2010, 162). Friction from resin particles, particularly occurring during the dehafting process, also leaves very characteristic bright spots (Rots and Williamson 2004, 1292). So the presence of resin seems clear to establish, even if this obscures a lot of other traces.

As with use-wear analysis, the survival of hafting traces into the archaeological record and their interpretability depends on the extent of post-depositional and post-excavational surface modification on the implements (Van Gijn 1990). As experimental studies have reinforced, these processes may obscure or even mimic use-wear traces (Levi Sala, 1986). Also for hafting traces, concerns were raised that traces would only form slowly, due to potentially limited contact between tool and haft, and so they would be more difficult to interpret and easily mistaken for post-depositional wear (Marreiros *et al.* 2015, 16). However, Rots (2010, 47) argues that hafting traces can be distinguished from post-depositional wear, because they are limited to one area of the tool and do not have the unorganised, random distribution across the tool which is caused by trampling or post exavation processing.

Each archaeological site will have a different history of mechanical and chemical processes affecting the burial environment and so each assemblage will have its own specific alterations. Therefore, analysts switching between assemblages from different sites need to become accustomed to the modifications which form the background, environmental wear traces of each site.

3.4. My analytical procedure

My investigation of traces of hafting on the Vlaardingen material will be highly influenced by the practical procedure advocated by Rots (2010, 198). As is common practise in modern use-wear analysis, both low and high power microscopic analysis will be employed, as they are suited to investigating different microwear traces. The investigation of a range of microwear traces is critical for hafting wear analysis, because it is often the presence of traces in association with other traces, for example edge scars and polish bright spots, which suggests these are specifically hafting traces (Rots 2003, 809). The traces which Rots (2010) particularly pays attention to recording are macro and microscopic scarring (damage to the edge and dorsal ridges) and polish, particularly the presence of intense concentrations of polish known as bright spots (Fig. 10), while striations and edge rounding do not feature so much.

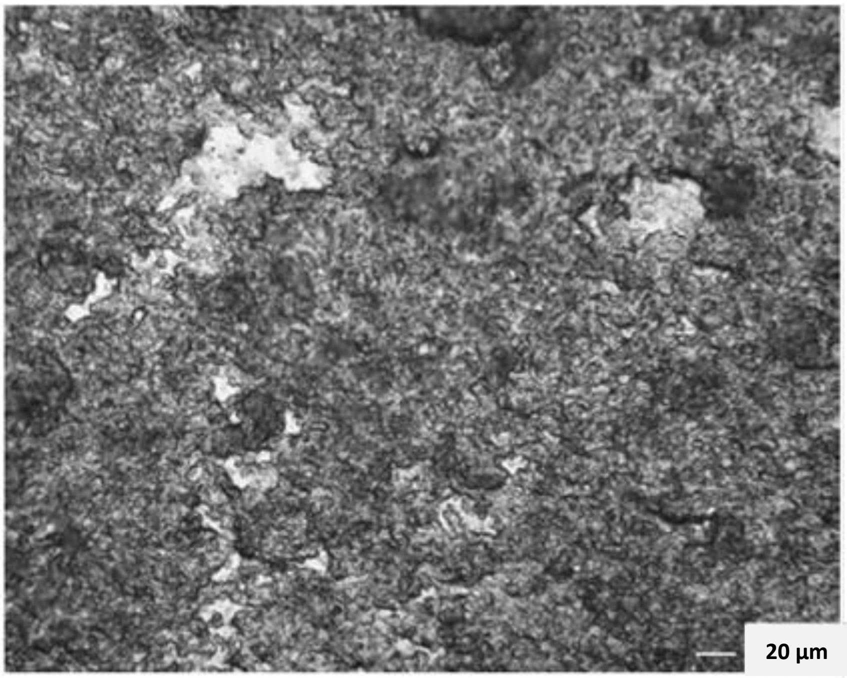


Figure 10: Hafting bright spots on the dorsal proximal surface of experiment 10/26 (200x) (Rots 2010, 246).

Aiming to achieve the highest level of detailed interpretation possible within the time constraints of this project, I will progress up the scale of magnification, starting with a basic morphological assessment of the scrapers and using both low and high power analysis to establish the presence or absence of hafting traces, before attempting to consider whether the traces indicate more detailed specifics of the hafting arrangement and haft materials.

3.4.1. Step 1: Morphology

Artefact morphology may influence the formation and distribution of hafting wear traces and needs to be taken into account when formulating expectations of if and where hafting traces might form (Rots 2010, 27). In this study, this will involve recording the size, presence of retouch, edge angles and curvature of the scrapers.

Measurements of both spline-plane angle and edge angle (Fig. 11) were taken. The spine-plane angle, measured 2mm away from the edge (see Van Gijn 1990, 17), enables an approximation of the original angle of the edge before use or resharpening occurred. Additionally the edge angle created by the retouch was measured, in order to establish the nature of the edges which were inserted into the haft. A steep edge angle created by retouch may reduce the chance of scars forming from the haft, or affect their visibility (Rots 2010, 26), therefore it is important to measure. Following the descriptions and figures of Inizan, *et al.* (1992) the position, distribution, delineation, extent, angle, morphology and maximum length of retouch was recorded.

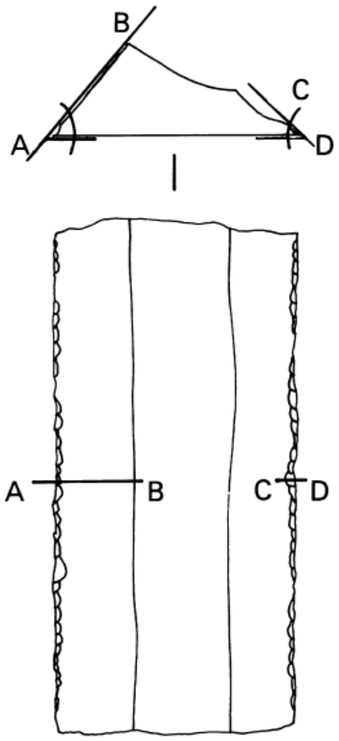


Figure 11. Measurement of the spine-plane and edge angles. A-B spine-plane angle. C-D edge angle. (Tringham *et al.* 1974, 178)

The longitudinal- and transversal surface curvature of the scrapers was also recorded as one of four categories: straight (whole ventral surface in contact with haft), twisted, light curve or curve (only extremities would be in contact with haft) and triangular, sub-triangular, trapezoidal or semi-circular cross-section (Fig. 9).

3.4.2. Step 2: Low power, edge damage

Due to time constraints and reduced chance of retouched edges accruing hafting-related scarring, the presence of edge damage or scarring was recorded on any unretouched edges on the scrapers using magnifications of up to 100x. The attributes of edge damage which were recorded, such as scar morphology, distribution and patterning, were selected on the basis of Rots (2010, 30) recommendation that these attributes had potential diagnostic value for hafting.

3.4.3. Step 3: High power, use-wear

Tool use has been shown to be a dominant variable in the formation of hafting traces (Rots 2010). Whilst use motion determined the overall pattern of hafting traces, the worked material had more of an influence on the intensity of the traces (Rots 2010, 121). Therefore, it is useful at the higher power stage of analysis to first make an interpretation of the use-wear visible on the tool. This involved detailed analysis of the tool's edges, in order make an interpretation of the used edge(s) and, where possible, the worked material and use-motion. Identification of the used part of the tool allows us to suggest where a potential haft was located; theoretically, it should be opposed to the used edge.

3.4.4. Step 4: High power, hafted or not?

An interpretation of whether a scraper was hafted or not relies upon an evaluation of all the evidence of different microwear traces. No one scar morphology or type of polish is sufficient evidence, but the most important argument for a tool having been hafted is the presence of some kind of limit in the trace pattern (Rots 2010, 199). The sudden start of a different type of scarring or polish (different to that of use), or the presence of traces which are restricted to one area of the tool, may suggest a haft covered that part of the tool (Rots 2010, 56).

3.4.5. Step 5: Which hafting arrangement?

If there is clear microscopic evidence of hafting traces, these may be used to make an interpretation of the more specific hafting arrangement, such as the haft type, haft material and presence or absence of bindings. Based on experimental tools, Rots (2010, 156) proposes a number of distinctive traits as useful for such making interpretations (Appendix C), but again it is only through a consideration of all microwear traces and a comparison between traces on different areas of the tool that it can be suggested which hafting arrangement is more likely. For example, in order to distinguish a juxtaposed, male or male-split arrangement a comparison should be made between traces on the dorsal versus ventral surface, and the edges versus the centre of the tool.

3.4.6. Selecting the sample and sampling

The 47 flint scrapers examined as part of this thesis came from three different Vlaardingen sites: Leidschendam (n=26), Vlaardingen (n=11) and Voorschoten (n=10). They were selected from material which was available to study at Material Culture Studies Laboratory at the University of Leiden. This material was originally part of a preliminary use-wear analysis undertaken in 1984 by Van Gijn. The material originated from trenches which were investigated by Van Beek's (1990) Ph.D. thesis. The material from the Leidschendam trench 4 also went on to be analysed for use-wear traces as part of Van Gijn's (1990) Ph.D. thesis.

My sample of scrapers from Leidschendam was selected from all the retouched tools recovered from Trench 4 of this site. For my Voorschoten sample, I selected from an assemblage of all the retouched tools, blades and flakes with a straight edge of a certain length from Trench 17. Finally, for my Vlaardingen sample, I selected from Van Gijn's 1984 sample of material from Trench 11, which consisted of 26.5% of the retouched tools found in the trench, plus 13 blades (Van Gijn 1984).

The scrapers were chosen on the basis of their size (less than 30mm) and a morphological tendency towards a circular circumference, which has been termed 'thumbnail scraper'.

Van Gijn (1990, 10) has highlighted that analysts sample individual artefacts by choosing to look at certain edges informed by preconceived ideas of tool use. This also applies when investigating hafting as we may already have ideas about the hafted part of the tool and where on the tool hafting traces should have formed. Whilst it is not feasible to look at every surface of the tool, the author attempted to look at as many different areas of the tool as possible, including ventral and dorsal surfaces and particularly dorsal ridges.

3.4.7. Cleaning

All scrapers were first cleaned with warm water and detergent, and thereafter wiped with alcohol to remove finger grease during analysis. Occasionally if scrapers still looked very dirty under the microscope they received additional cleaning in an ultrasonic tank or chemical cleaning. The scraper was placed in a ultrasonic tank for 60 minutes, or was submersed in a 10% solution of HCl for 15 minutes followed by 15 minutes in a 10% solution of KOH.

3.4.8. Observing

Low power microscopic analysis was carried out on a Nixon SMZ800 stereomicroscope, using magnifications of between 60 and 100x.

High power analysis was carried out mainly using a Leica DM 1750 metallographic microscope (magnifications of 50 to 200x) coupled with a Leica MC120HD camera to take photographs or traces. However, some scrapers were also analysed under the Nikon Optiphot-2 metallographic microscope using magnifications of 50 to 200x and occasionally 500x. For full specification of these microscopes see Appendix D.

3.4.9. Recording sheets

Basic morphological attributes were recorded in a form created by the author influenced by Rots (2010, 26) discussion of morphological attributes which may affect the formation of hafting traces (see Appendix E).

The edge damage or edge scarring analysed under a stereomicroscope was recorded on a form (Appendix A) created by the author based on Rots (2010, Annex I: trace attribute) form for recording hafting attributes. The location of the edge damage was also recorded diagrammatically on the back of the microwear analysis form.

The use-wear analysis and analysis of microscopic hafting traces under high magnification was recorded using recording forms provided by the Material Culture Studies Laboratory at the University of Leiden (Appendix B).

Chapter Four: Experiments

4.1. Experimental Archaeology and what makes a good experiment?

Experimental archaeology means different things to different people. For some, images of re-enactment groups may come to mind, but this is often rejected as experimental research by others who view them as having only 'experiential' or public engagement value (Outram 2008, 3). Instead, archaeologists have argued for experimental archaeology to be recognised as a scientific research method and part of the 'hypothetico-deductive' process (Outram 2008, 1). In this case, only experiments carried out to test specific hypotheses and based on archaeological data can produce results that are useful to archaeological interpretation (Lammers-Keijsers 2005, 19).

However, a key distinction between different types of experiments is acknowledged even within experimental archaeology. Whilst laboratory-based experiments offer the opportunity to control variables, and conform to more 'positivist' ideals of the scientific methodology, they do not normally bear any relation to how such processes were achieved in the past (Outram 2008, 2). This is obviously problematic, because what archaeologists want is to reconstruct the dynamic processes that took place in the past, which produced our static archaeological data (artefacts and features). The solution Outram (2008) believes is to also undertake more 'actualistic' experiments, taking place outdoors, in potentially more authentic conditions. Although it is harder to maintain the same level of scientific rigour, this ensures the quality of the analogy that experimental archaeology provides (Lammers-Keijsers 2005, 19).

Ultimately, it will depend on the specific research question, whether a laboratory-based or more 'actualistic' experiment is appropriate.

4.2. Importance of experiments to microwear analysis

The importance of experimental archaeology to microwear analysis lies in the observational standards it can provide from which we can differentiate wear traces (Bamforth 2010, 95). Experimental tools might display traces that elucidate the function of an archaeological artefact, whilst unexpected traces on archaeological artefacts might prompt a rethinking of tool use within experimental work. Therefore, a reciprocal relationship exists between experimental archaeology and microwear analysis. If traces are visually similar, it is possible to suggest that the archaeological tool was used or hafted in a similar way to the experimental tool. However, this comparison does not provide a definitive answer, as it is always possible that another, unknown use produces the same traces as a known use (Bamforth 2010, 102).

Experiments in microwear analysis could aim to train novice analysts, replicate conditions of prehistoric tool use or analyse the formation of specific traces (Bamforth 2010, 101). Many experiments are designed to control as many extraneous factors as possible, so that the effect of just one factor can be investigated. Whilst in the context of a scientific experiment controlling variables makes sense, Van Gijn (2014, 167) highlights that this is not how our archaeological tools will have been used. The artificial nature of the experiment reduces the validity of the comparison with archaeological examples (Rots 2010, 7). For experimentally created traces to be useful, tools should be used with a realistic task in mind.

The usefulness of experimentally created traces is also affected by the relative experience of the tool-user, as gesture and motion will also influence the microscopic trace pattern (Rots 2010, 7). An inexperienced, 21st century user may create different traces from the experienced, prehistoric user.

Nevertheless, experiments remain critically important, because the underlying mechanics and uniformitarian principles suggest that wear traces will form today in the same way as they did in the past. Therefore, we can produce an experimental tool with traces, which will help evaluate our inferences about traces found on archaeological tools.

4.3. My Experimental Programme

4.3.1. Rationale for an experiment

The Material Culture Studies Laboratory at Leiden University provides an extensive experimental, use-wear reference collection, which enables the interpretation of many microwear traces. However, relatively few of these experiments involved hafted tools, especially not hafted scrapers, so there were not sufficient example scrapers to aid my interpretation. Furthermore, as the formation and distribution of hafting traces is influenced by the morphology of the stone tool, it is important that the experimental tools have a similar morphology to the archaeological scrapers. Therefore, the author felt it necessary to conduct a small programme of experiments with hafted scrapers similar to those of the Vlaardingen group. This was intended to create an appropriate, mini reference collection, which would aid the interpretation of hafting traces, or even indicate where hafting might result in an absence of traces. It was considered important to have a range of different hafting arrangements in an attempt to characterise the variety of hafting traces which might occur. Also, it was not clear how such small, often awkwardly shaped, implements could be hafted.

4.3.2. Rationale behind the hafting arrangements

Direct evidence of hafts within the Vlaardingen group is limited to an axe haft from Hazendonk (Van Gijn and Bakker 2005, 296). Therefore, the choice of hafting arrangement was opened up to influence from wider archaeological (Stordeur 1987b) and ethnographic (Beyries and Rots 2008) evidence of hafting practices, as well as practical considerations and personal experience. For example, only certain materials were available to Diederik Pomstra, the experimental archaeologist/craftsman who made and fitted the flint tools into the hafts. Furthermore, the hafting process was influenced by his level of skill and experience, which although far surpassing anything the author could manage, does not necessarily match that of prehistoric people, or guarantee that the hafting arrangements used here reflect those used by the Vlaardingen group.

Even if the material and exact construction of the haft can vary almost indefinitely, there are only so many ways the haft can be in contact with stone tool. The experimental hafting arrangements were based on one of the three, fundamental ways of hafting, or haft types, referred to as male and based upon inserting the stone tool into a handle (Stordeur 1987a, 11-34; Rots 2010, 9). This seems to be a common haft type for smaller lithic tools in the Mesolithic and Neolithic examples (Stordeur 1987b). In contrast, female hafts, which involve inserting a handle into the stone tool, are normally only possible with large stone axes and do not apply to the small Vlaardingen scrapers. Juxtaposed hafts, where the tool is placed next to the handle (Fig. 12), were not included in the experiment, because of the limited scope of a Masters-level investigation, and the assumed difficulties of hafting a tool with such a small surface area in a juxtaposed manner. Whether this assumption is fair or not, the fact remains that only a limited number of hafting variables could be tested within the time frame of this research. Therefore, I chose to focus on slight variations on the male haft (male and male-split (Fig. 12), which provided different kinds of contact between haft and tool.

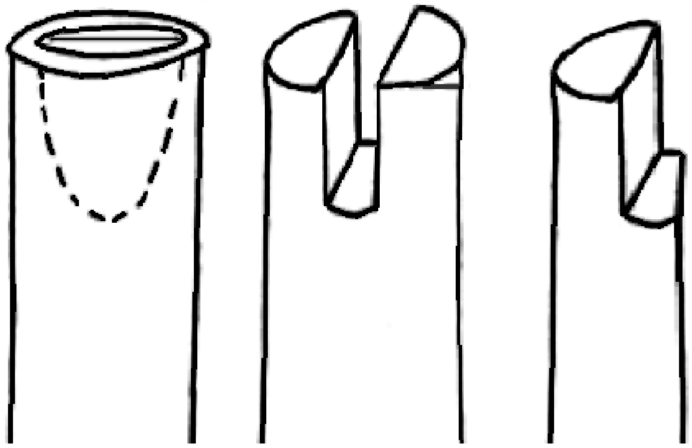


Figure 12: (Left to right) Male, Male-split and juxtaposed haft types (after Rots 2010, 22).

The choice of wood and antler as the haft materials is reasonable, as evidence of antler and wood working can be found on Vlaardingen group sites (Van Gijn and Bakker 2005; Van Gijn 1990). Bone is also recognised as an ideal hafting material (Rots 2010, 14), but the limited nature of this experimental programme precluded its use. The decision to use maple wood was mainly a pragmatic decision based on the availability of materials. However, maple is recognised amongst many other tree species as suitable for hafts, particularly those likely to be subject to flexion and compression during use (Rots 2010, 14), as is the case with scraping.

As well as the hafting arrangement and haft material, the use motion is considered by Rots to influence the traces created, particularly the pattern of traces. Although it is possible that the implements we call scrapers were also used in other motions, it is reasonable to assume that they were mainly used for scraping, rather than cutting. However, there is also more than one way to scrape, as research on ethnographic hide-working methods and gestures shows (Beyries and Rots 2008). Therefore, it was suggested that two different scraping motions be employed, to see if and how that had an effect on the hafting traces. These were: a motion pushing away from the user, and a chopping motion (see Fig. 13, Fig. 14 and Fig. 24).

The choice of each, specific arrangement will be discussed separately below.

Figure 13: Pushing motion (Photographer: Annelou van Gijn)

Figure 14: Chopping motion (Photographer: Annelou van Gijn)

4.3.2.1. Experiment 1: Push

Experiment Numbers:	3708 (Fig. 15) and 3709 (Fig. 16)
Brief description:	wooden, male-split haft with vegetal bindings not in contact with the stone tool
Haft material:	wood (maple)
Haft type:	male-split
Hafting method:	direct (no wrapping between tool and haft)
Bindings:	present (vegetal, but not in contact with tool)
Stone tool placement:	terminal (at the end of a straight handle)
Stone tool direction:	axial (parallel to axis of the haft)
Stone tool orientation:	perpendicular (orientation of active part of the tool relative to axis of the haft)
Dimensions (haft length; haft weight; combined weight of haft and tool)	3708: L 24cm; W 64g; Combined 72g. 3709: L 20cm, W 54g, Combined 58g.
Use motion:	held, often two-handed, and pushed away from the user, often upwards

Reasoning: This hafting arrangement was intended to provide an example of the traces that would form when the main contact areas between the haft and tool were the ventral and dorsal faces, without the influence of binding materials on the lateral edges of the tool. Vegetal bindings were present to help the haft keep its shape, but were not in contact with the tool. This experiment was to be compared with the same hafting arrangement under a different scraping motion in experiment 2, and the same scraping motion, but in a different haft material in experiment 4.

Figure 15: Experiment number 3708. Seen from the side.

Figure 16: Experiment number 3709. Seen from the side.

4.3.2.2. Experiment 2: Chop

Experiment Numbers:	3710 (Fig. 17) and 3711 (Fig. 18)
Brief description:	wooden, male-split haft with vegetal bindings not in contact with the stone tool
Haft material:	wood (maple)
Haft type:	male-split
Hafting method:	direct (no wrapping between tool and haft)
Bindings:	present (vegetal, but not in contact with tool)
Stone tool placement:	terminal (at the end of a straight handle)
Stone tool direction:	axial (parallel to axis of the haft)
Stone tool orientation:	perpendicular (orientation of active part of the tool relative to axis of the haft)
Dimensions (haft length; haft weight; combined weight of haft and tool)	3710: L 54cm; W 196g; Combined 202g 3711: L 53cm; W 210g; Combined 211g

Use motion: a chopping (almost stabbing) motion. The hafted tool was mostly held in the right hand, whilst the left hand was placed on the hide or frame. Depending on which area of the hide was being worked the action resembled a downward curving strike, or a vertical chopping motion.

Reasoning : The same hafting arrangement as experiment 1 was used in a different motion to see if this would create noticeably different traces. The main contact areas between the haft and tool were still the ventral and dorsal faces, without the influence of binding materials on the lateral edges of the tool. Vegetal bindings were present to help the haft keep its shape, but were not in contact with the tool. This experiment was to be compared with the same hafting arrangement under a different scraping motion in experiment 1, and the same scraping motion, but with bindings touching the tool in experiment 3.

Figure 17: Experiment 3710 (left) and 3711 (right)

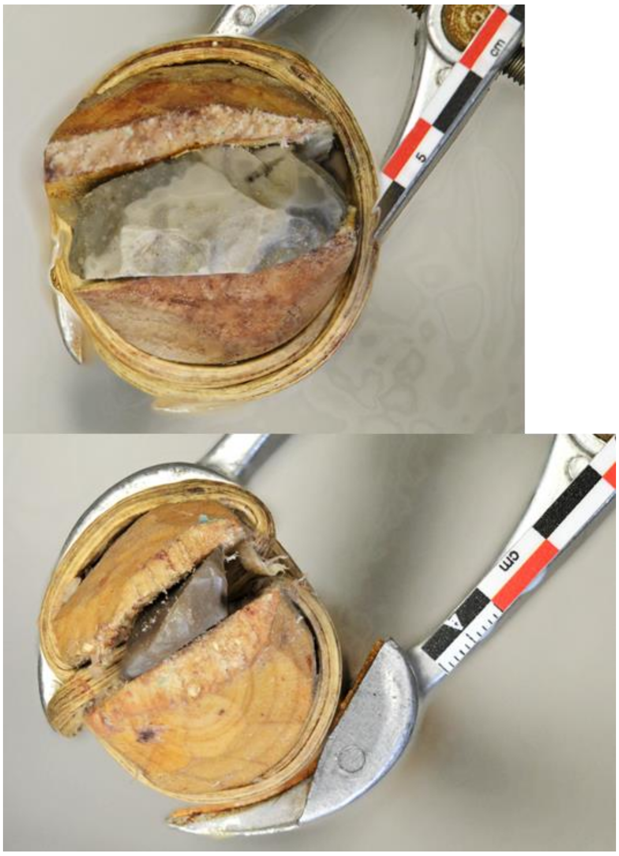


Figure 18: Experiments 3710 (above) and 3711 (below). Seen end-on.

4.3.2.3. Experiment 3: Chop secure

Experiment Numbers:	3732 (Fig. 19) and 3733 (Fig. 20)
Brief description:	wooden, male-split haft with vegetal bindings in contact with the stone tool
Haft material:	wood (maple)
Haft type:	male-split
Hafting method:	direct (no wrapping between tool and haft)
Bindings:	present (vegetal)
Stone tool placement:	terminal (at the end of a straight handle)
Stone tool direction:	axial (parallel to axis of the haft)
Stone tool orientation:	perpendicular (orientation of active part of the tool relative to axis of the haft)
Dimensions (haft length; haft weight; combined weight of haft and tool)	3732: L 54cm; W 148g; Combined 152g 3733: L 55cm; W 264g; Combined 269g
Use motion:	chopping (almost stabbing) motion. The hafted tool was mostly held in the right hand, whilst the left hand was placed on the hide or frame.

Reasoning: In this hafting arrangement, I wanted to see if the contact of vegetal bindings on the lateral edges of the tool created their own hafting-related traces, distinct from that of the maple wood haft, or whether they affected the overall hafting trace pattern in any way. The main contact areas between the haft and tool remained the ventral and dorsal faces, but there was also increased contact on the lateral edges with the vegetal binding materials. This experiment was to be compared with experiment 2, where the same scraping motion was used, but with a slightly different hafting arrangement (no bindings).

Figure 19: Experiment 3732 (dorsal face nearest the scale).

Figure 20: Experiment 3733 (ventral face nearest the scale).

4.3.2.4. Experiment 4: Push antler

Experiment Numbers:	3734 (Fig. 21) and 3735 (Fig. 22 and Fig. 23)
Brief description:	antler, male haft
Haft material:	antler
Haft type:	male
Hafting method:	direct (no wrapping between tool and haft)
Bindings:	None
Stone tool placement:	terminal (at the end of a straight handle)
Stone tool direction:	axial (parallel to axis of the haft)
Stone tool orientation:	perpendicular (orientation of active part of the tool relative to axis of the haft)
Dimensions (haft length; haft weight; combined weight of haft and tool)	3734: L 11cm; W 70g; Combined 71g 3735: L 12cm; W 75g; Combined 80g
Use motion:	held, often two-handed, and pushed away from the user, often upwards

Reasoning: This hafting arrangement was intended to highlight the traces that a different haft material would cause under the same scraping action as Experiment 1 (push). Antler has different material affordances as a haft material, when compared with wood, and this indicates that hafts would not necessarily be made in the exact same way in both materials. The structure of antler has a compact outer layer enclosing a spongy, cancellous core. When soaked, it is possible to remove some of the core and insert the scraper into the middle of the antler, which hardens again when dry. This ability, coupled with the fact that antler is more likely to split completely, rather than partially as is necessary for a male-split haft, suggested that it was reasonable to use the male haft type here. Contact areas with the haft were the ventral and dorsal faces and the lateral edges.

Figure 1: Experiment 3734.

Figure 2: Experiment 3735.

Figure 3: Experiment 3735. See end-on.

4.3.3. Recording the stone tools beforehand

Five of the flint scrapers used in the experiment were retrieved from a bag of small, unused, individually packaged scrapers in storage at the Laboratory for Material Culture Studies at Leiden University. These were knapped by experienced, Danish flint knapper, Mikkel Sorensen. Three additional scrapers were freshly knapped by Diederik Pomstra to be morphologically similar to the other five and to the sample of archaeological scrapers. Unfortunately, these three scrapers were directly inserted into their hafts, before the author could analyse them to find out if there were already traces on the tools due to production.

Regrettably, there was also paucity in the level of recording before the hafting of the other five scrapers as well, because of miscommunication and the assumption that the unused tools would have accrued very few microwear traces. The five were viewed under a stereomicroscope and the noticeable scars on the ventral face were recorded diagrammatically. However, they were not viewed under a metallographic microscope and no photos were taken. At the last minute, casts were taken of the edges of the stone tools which were to be the used edge. However, the existence and necessity of taking casts of objects before use was not revealed to the author until the day before the experiment took place. Had this been known earlier, it obviously would have made more sense to take casts of the whole dorsal and ventral faces of the tool, as my focus is not the used, but the hafted edge.

This lack of recording could be to some extent remedied, by observing some of the non-hafted, non-used scrapers from this store of unused tools in the laboratory. On the, not unlikely, assumption that these c. 20 scrapers were all made in the same knapping episode, they should represent similar types of traces to those present on the experimental tools before hafting and use. Furthermore, the author was able to take advantage of the fact that two of the scrapers (3709 and 3710) fell out of their hafts after the first hour of scraping. This enabled the author to analyse and photograph these two scrapers using a metallographic microscope, and make casts, between the two, hour-long episodes of scraping.

4.3.4. Scraping

All eight, hafted, experimental tools were used to scrape a deer hide which was stretched on a wooden frame (Fig. 24).

Previous use-wear studies of Vlaardingen material have demonstrated that scrapers were not necessarily exclusively used on animal skins, but also for processing wood, bone and antler. However, some of the most common traces found on scrapers are those interpreted as due to working fresh or dry hide, occasionally with the addition of abrasives (Van Gijn 1990; Garcia-Diaz 2017). Therefore it was reasonable to use these hafted scrapers to work an animal skin, particularly a deer, given the faunal evidence of wild fauna on many Vlaardingen sites.

The decision to scrape the hide whilst it was stretched on a wooden frame is not without contention. A frame is not necessary in order to process a hide and we have no evidence to say whether people at Leidschendam, Voorschoten or Vlaardingen used frames or not. Nevertheless, it is a possibility and still used in some ethnographic contexts (Beyries and Rots 2008). Furthermore, scraping on a frame helps to control another variable in the experiment, namely, that the influence of the worked material on microwear traces relates just to the hide, and not also to the ground underneath the hide, as it would be, if it was laid on the ground.

The majority of the scraping took place outside in sunny weather, but with sub-zero temperatures at the end of February 2018. In between episodes of use, the hide was kept outside and the prolonged period of cold, dry weather contributed to the drying out process. It therefore transpired that each scraper was used for an hour on relatively fresh hide and then was used again for another hour, about a week later, on considerably drier hide. Thus each scraper was used for two hours each, a combined total of 16 hours.

The assistance of Eric Mulder (Technician at Laboratory for Material Culture Studies) and Jaap Hogendoorn (EXARC member, craftsman) was sought for building the frame and the process of stretching the hide onto the frame, respectively, but all scraping was carried out by the author. Although having some experience of making and using flint tools in the context of butchery, this was the first hide I had ever scraped and it probably shows!

Figure 24: Assorted photographs of scraping in progress. The two lower images are from the first day of scraping. At this point the hide was very fresh and fatty. Photographer: Prof. Dr. Annelou van Gijn

4.3.5. Observations during the experiment

Carrying out the experiments provided some insights about the hafting arrangements and the limitations of the setup.

In experiments 3 and 4 no movement of the scraper within the haft was noticeable (experimental tools: 3732, 3733, 3734 and 3735). In contrast, in experiments 1 and 2 movement of the tool in the haft was noticed to varying degrees for all the tools (Experimental tools: 3708, 3709, 3710 and 3711), even extending to the scraper falling out onto the floor. For example, 3711 was leaning slightly to the left after the first hour of scraping, but moved much more and even fell out of both sides the haft during the second hour. Meanwhile, 3710, with its extreme dorsal ridge, repeated fell out of the haft throughout the two hours, despite modifications to the haft between the scraping sessions. It was not only the scrapers used in a chopping motion that moved or fell out of the haft. In particular, 3709 also followed the pattern of leaning to the left and repeatedly falling out of the haft throughout its use in a pushing motion. One of the reasons for all this movement may have been because the tools were all hafted in green wood and as the haft dried out the split widened slightly. However, I believe experiments 1 and 2 demonstrate that stone implements will experience movement within the haft regardless of specific scraping motion, if no further adhesive or bindings around the stone implement are present. The stone implement will work its way out of such a wooden, male-split haft, depending how it is held. If held right-handed, it will lean to the left.

At this point it may be worthwhile explicitly acknowledging that no adhesives were used in these experimental hafting arrangements. This was after personal communication with Professor Van Gijn, who reported not having seen much evidence of adhesives on Vlaardingen site assemblages. An adhesive would probably have prevented these scrapers from falling out, but also may have created its own microwear traces. Unfortunately, the use of an adhesive was just another variable which could not be tested within this small experimental programme.

Some comments about the perceived ease and efficiency of these hafted tools can also be made.

Firstly, the thin wooden planks used to make the frame turned out to be rather flexible. Although the frame was weighted down and braced against a wall there was a lot of movement when the hide was struck in a chopping motion. Therefore, the impacts were not so efficient at removing skin, especially as the scraper could only be used one handed, whilst the other hand held the frame still. The efficiency of the tools used in a chopping motion (3710, 3711, 3732, 3733) also deteriorated as the hide dried out. The scrapers just seemed to bounce off the dry hide without removing any significant amount of material.

Secondly, it was noticeable that for 3708 and 3709 the wood of the haft underneath the scraping edge came into contact with the hide during scraping (Fig. 15 and Fig. 16). Much of the pressure exerted by the user was transmitted to the hide through this rounded, wooden edge, rather than the edge of the scraper. In fact, the tool had to be held at a certain angle for the scraper to be effective at removing skin. In reality, this would not have been such an issue for prehistoric users, because they would have probably adapted the exterior morphology of the wooden haft, if it was causing a problem. I, however, did not have the tools or skills to adapt the haft myself, once I had noticed the issue.

Finally, from the perspective of cleaning the whole hide, it must be acknowledged that it was easier to use certain motions for certain areas of the hide relative to the height of the tool user. The pushing motion was easier to work areas of the hide which were at breast height or above, whilst the chopping motion was easier and more effective on lower areas of the hide, below the user's waist.

4.4. An appropriate reference collection?

The matter boils down to whether these experiments provide a worthwhile and appropriate reference collection of hafting traces, which can be compared with features noticed on archaeological scrapers.

It is abundantly clear that eight tools are nowhere near enough to form a detailed reference collection of hafting. There are so many more variables to test, materials which could have been used to haft, and actions which could have been part of the scraping process. Investigating higher level hypotheses, such as the idea of periodically rotating scrapers in the haft, would only be feasible once the development of hafting traces on these types of scrapers had been explored in a lot more detail. So it is obvious that a larger reference collection would have allowed more nuanced interpretations.

There is also the question of whether two hours of use was enough for hafting traces to develop to the extent that they are recognisable and/or bear similarity to traces found on archaeological tools. Rots (2010, 71) suggested that even after 10 minutes of use, one should be able tell between hafted and hand-held tools, and after 30 minutes a pretty certain interpretation of the hafting arrangement could be made. However, whether these time frames are significantly affected by the morphology of the experimental tools is unclear. Whilst clear hafting traces did develop on my experimental scrapers, they were not extremely well developed after two hours, so that I would be dubious about recognising any hafting traces after 30 minutes.

4.4.1. Limitations

In terms of the traces created, there are a number of issues, which have made these experiments not quite as insightful as I had hoped.

First of all, I am concerned that my novice level of skill may have created quite different traces from those on the archaeological tools. For example, scrapers repeatedly falling out of the haft onto the floor, and/or particles of dirt introduced into the hafting arrangement, may have affected the traces I created. I assume prehistoric hide workers would not have tolerated stone implements falling out all the time, although it may have occasionally happened, and so these types of traces may not be so common on archaeological scrapers.

Furthermore, it was very obvious that the experimental scrapers had more production-related traces than the archaeological specimens. These production traces included streaks of polish which may have been caused by an antler hammer. Whilst this difference between archaeological and experimental tools may be affected by the removal of traces during the former's use and/or resharpening, it may also be that experienced, prehistoric flint knappers would not have left so many, or such apparent, production traces on their implements. All experimental scrapers were knapped by experienced, modern flint knappers, but different production traces may be created through different production method. Moreover, as a still relatively unexperienced microwear analyst, these production traces made it harder for the author to distinguish which traces might be potentially interesting evidence of hafting.

As well as stereotypical production-related wear traces, there were a lot of strange and conspicuous, polish-based traces, sometimes, almost all over some scrapers (e.g. 3708-3710) (Fig. 25). These streaks and patches of polish, some of which were highly developed and/or flat, occasionally seemed to be on hafted areas of the tool, but then were also found on other locations, where they did not make any sense as traces of hafting. Further doubt about these odd traces came from the process of analysing two of the scrapers (3709 and 3710) between their two episodes of use. This revealed that none of the traces recorded by the author after the first hour developed further during the second hour's use. As these traces were pretty well developed, when analysed after the first hour, the complete lack of further development or extension of the polish may suggest that these traces were not related to hafting, but were present on the tool before the hafting experiment. These a-typical traces confuse the pattern of traces and make it difficult to suggest the types of traces to look out for on archaeological scrapers.

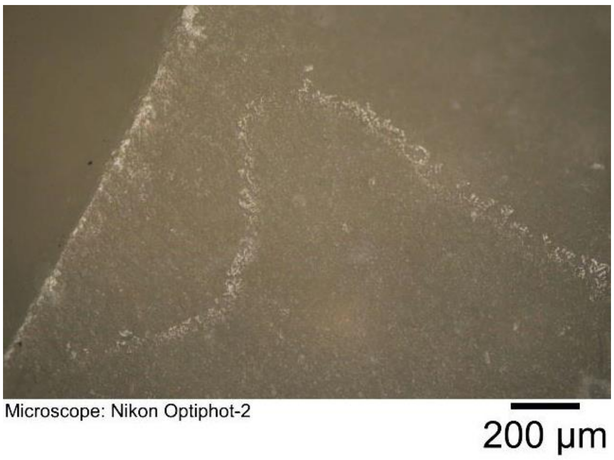


Figure 25: Unusual, smooth and greasy polish streak on 3708

4.4.2. Dorsal Ridges

It was particularly hoped that these experiments would demonstrate the sorts of microwear which hafts inflict upon dorsal ridges. Whilst this is a key location for the development of hafting traces within in a male haft, exposed ridges are also liable to be affected by PDSM. Therefore, it was hoped these experiments would indicate how much of the traces seen on archaeological dorsal ridges might be due to their time in the depositional environment.

Here, again, there are not many clear answers. A majority of the archaeological scrapers feature one, main dorsal ridge running from the proximal to distal end of the flake, perpendicular to the used edge. However, only three experimental scrapers (3708, 3711 and 3733) shared this morphology and were hafted in such a way that part of the ridge was within haft. Evidence of polish was found on the ridges of all three and seemed to be present along almost the entire ridge to a varying level of development. Although a distinct limit between the hafted and uncovered sections of the ridge did not appear obvious, on 3711 it was possible to distinguish a qualitative difference in the polish at the most distal end (resembling hide) and a point in the middle of the tool (resembling wood, which was the haft material)(Fig. 26).

On other experiments (3709, 3732, 3734, 3735), the main dorsal ridge lay parallel to the used edge, and critically, was outside of the haft, although often very near the haft limit. This makes it all the more confusing that some of these (3734 and 3735) have well-developed polish on the dorsal ridge. The polish does not conform to the characteristic polish of the worked material, but displays directionality and striations across the ridge, which would agree with the movement of the haft, yet it was not in contact with the haft. Admittedly, such traces have not been observed on the archaeological sample, so, for the author's current purposes, it may not be so critical to discover why this is the case. However, it does reiterate that analysts should be cautious about using evidence from dorsal ridges to suggest the *limit* of the haft, if even ridges outside the haft may be affected.

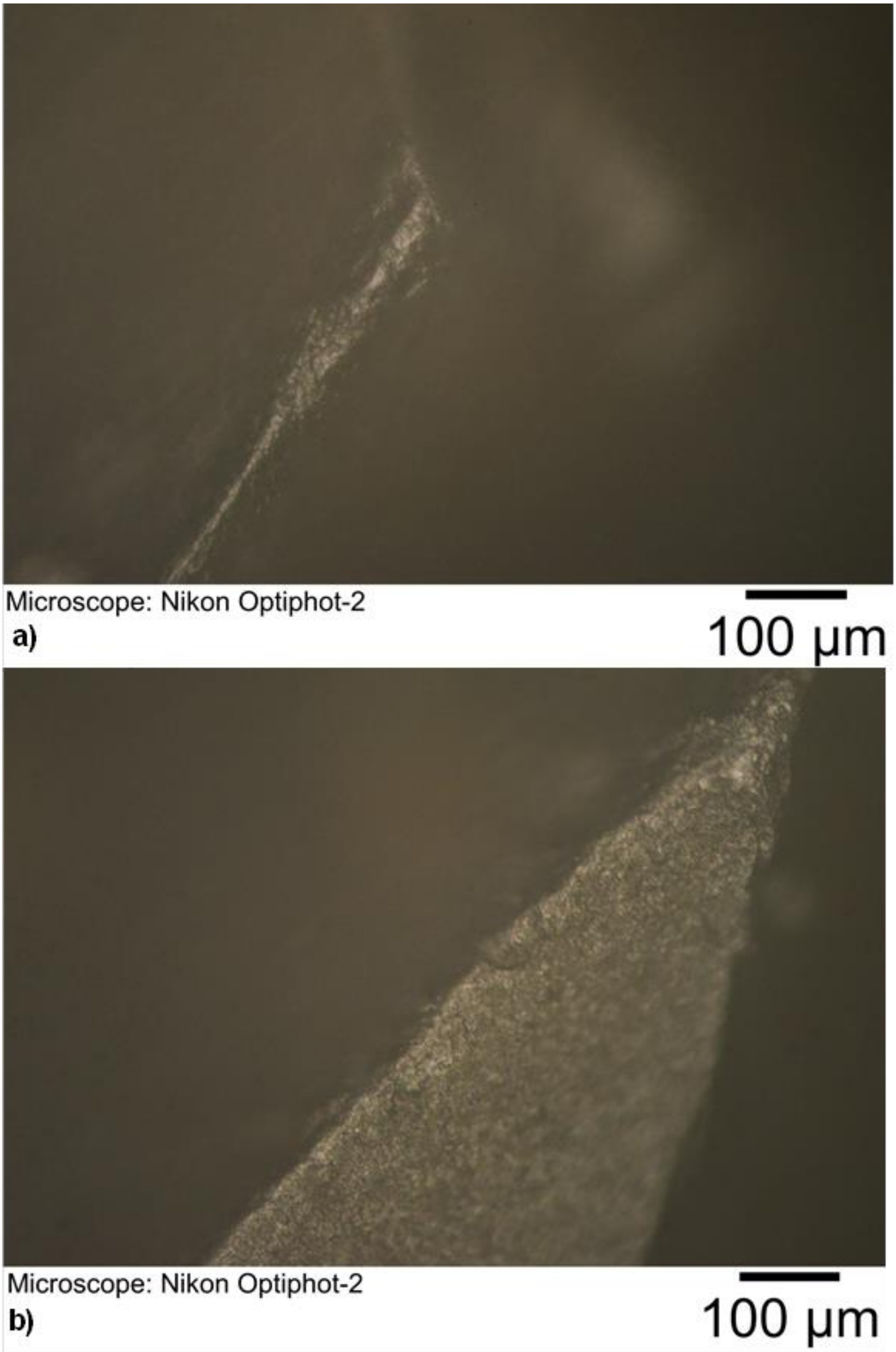


Figure 26: a) hide polish on the dorsal ridge of 3711; b) wood polish on the dorsal ridge of 3711.

4.4.3. Experimental peculiarities

There were also a few features of the experimental tools, which were not noticeable on the archaeological scrapers. For example, there was a very abrupt limit to the use-wear polish, which often stopped exactly where the haft material met the edge. The rounded edge and polish on the retouch ridges was visible to the eye, and even under the microscope at a finer resolution, this change appeared very stark and much more abrupt than witnessed on any of the archaeological specimens.

Furthermore, it was occasionally possible to discern a subtle difference in the overall background shininess of the hafted and exposed halves of the tool. For instance, on 3735 the area nearer the used edge appeared relatively brighter than the area largely within the haft (Fig. 27), although the limit observed during analysis did not completely match that of the recorded haft limit. In the case of archaeological implements, I believe even the low levels of PDSM, which affect every assemblage, will preclude the interpretation of such subtle background changes.

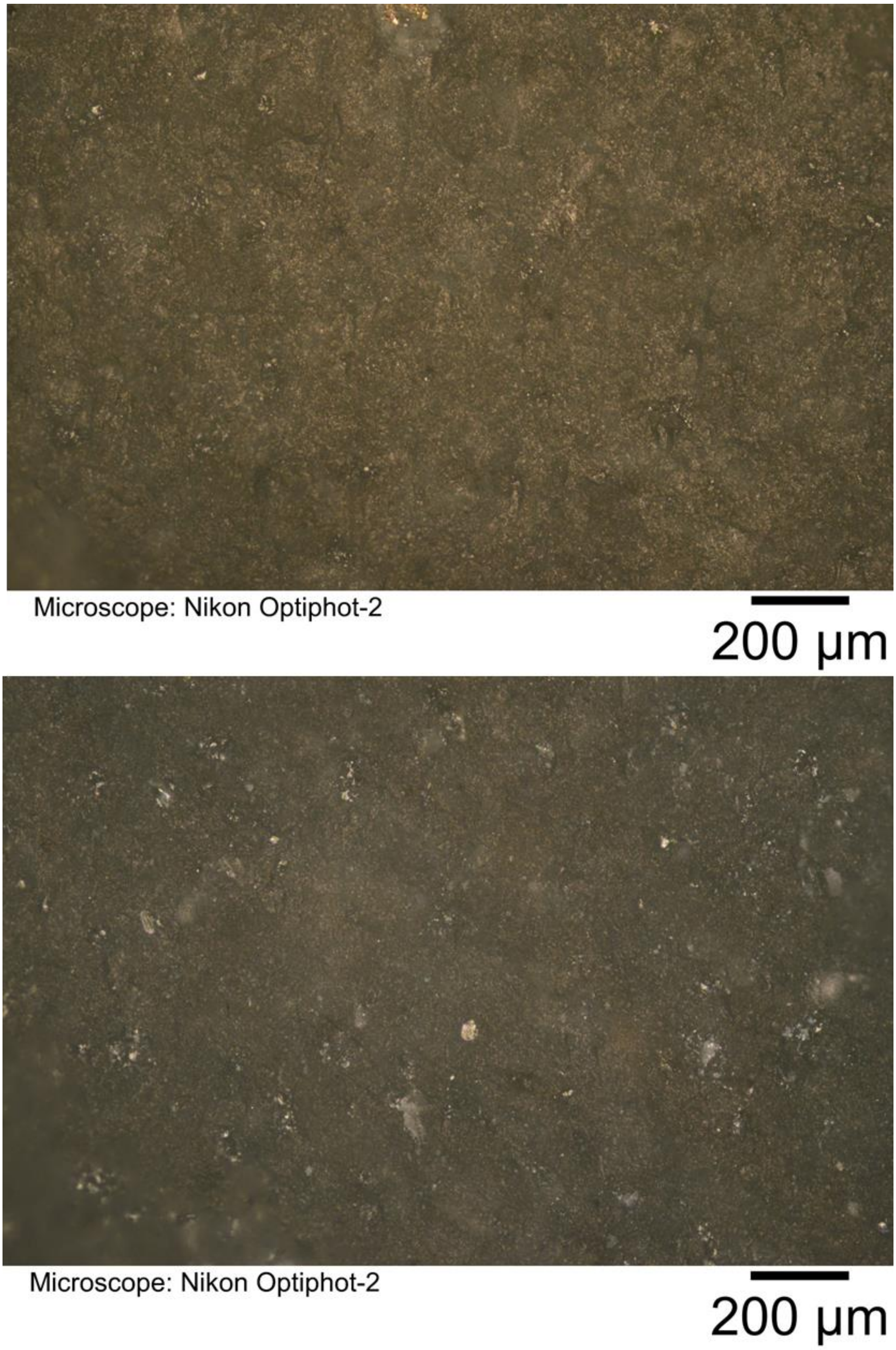


Figure 27: The difference in the overall, background level of flint shininess between an area near the used edge and outside of the haft (above) and an area deep within the antler haft (below) of experiment number 3735.

4.4.4. Testing interpretational skills

The experimental scrapers were analysed again a couple of months after the experiment, without using photographs of how they were hafted. In this context, I would have said with some confidence that 3711, 3732 and 3735 were hafted, based on the presence of polish on dorsal ridges and bulbar scars and, in the case of 3711, the location of edge damage. I would even have been pretty accurate in interpreting the exact haft limit of 3732. I would also have interpreted 3733 and 3734 as hafted, but with more uncertainty due to the less well-developed polish. However, for 3708, 3709 and 3710 with so many random polish patches all over the implements, I would have deemed the scrapers uninterpretable, and definitely would not have tried to interpret a haft limit.

Nevertheless, it is important not to underestimate the effect that knowing these scrapers had been hafted had on these semi-blind interpretations. Indeed, when I revisited the scrapers, armed with photographs detailing exactly where to look for the haft limit, I often observed microwear traces that I had previously not thought significant. Therefore, one should always be aware of an interpretation bias, where we find hafting traces if we believe they will be there. For that reason, it would be interesting to have an independent microwear analyst look at these experimental scrapers and see what traces they would interpret as hafting.

Finally, there was not much edge damage evidence to inform these interpretations. The author's expectations regarding the limited occurrence of hafting-related edge damage on heavily retouched scrapers seem to be substantiated. Although hampered by the fact that three scrapers (3711, 3734 and 3735) were not recorded for edge damage beforehand, it can be said that the remaining scrapers did not acquire more scarring than what they had had before hafting. There were no scars with the sliced scalar morphology which Rots (2010) argued indicated specifically binding traces. Most scarring was present on 3711, which has unretouched lateral edges, but these scars cannot be definitely attributed to hafting, because of the previously mentioned lack of recording.

4.4.5. Conclusion

In conclusion, these experiments have provided some good examples of microwear traces which can occur on small, highly retouched scrapers. Most importantly, they have reinforced in my mind the importance of individual tool morphology in the formation of clearly recognisable hafting traces. Moreover, scraper 3711 has encouraged me that the dorsal ridges of implements are a worthwhile location to look for indications of hafting. However, these experiments have also shown that the sense of an organised pattern of traces, which is said to be characteristic of hafting, can be lost amongst other traces, such as those from production. An analyst must have a good understanding and experience of the many microwear traces which develop throughout the life of a stone tool, in order to have confidence in their interpretations of hafting. I am not yet at such an advanced stage, but these experiments have been a very useful learning experience.

Chapter Five: Results

The results of my analysis will be presented firstly by archaeological site. For each site, the microwear traces interpreted as evidence of hafting will be briefly described. Following this, it will be considered whether these ‘hafted’ scrapers also share distinctive morphological characteristics, such as certain edge angles, when compared to those interpreted as not hafted. Finally, an inter-site comparison will be made to tease out any differences in the hafting practices at the three Vlaardingen Group sites.

The scrapers discussed here as hafted generally have a low level of post depositional surface modification (PDSM), so that the author could be fairly confident that the microwear traces were not simply PDSM. However, 16 scrapers (13 from Leidschendam and 3 from Voorshoten) were considered to have too much PDSM, such that it was impossible to make an interpretation of hafting, and in some cases, even the used edge could not be interpreted.

In the reporting of results, the edges of the flint implements will be referred to using a coordinate system developed by Van Gijn (1990). Edges are labelled when viewing the dorsal face of the implement with the butt nearest the analyst (Fig. 28).

The distribution of use-wear and hafting traces is also demonstrated in some flint drawings. The symbols used within these drawings are explained by the legend in Figure 29.

The full results of the edge damage analysis on hafted scrapers and non-hafted scrapers with unretouched edges can be found in Appendix F.

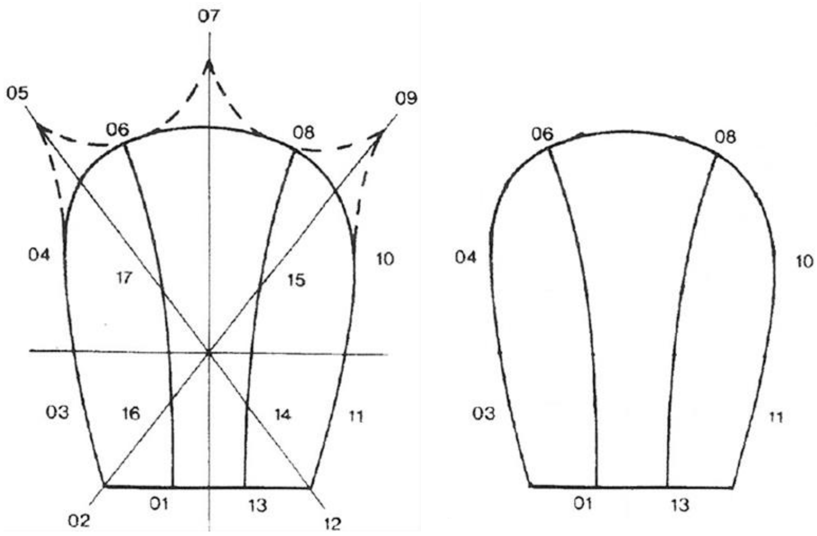


Figure 28: System of polar coordinates used to indicate the location of microwear traces (Van Gijn 1990, 16). Left: Original version; Right: Simplified version, showing the coordinates most often talked about in the following text.

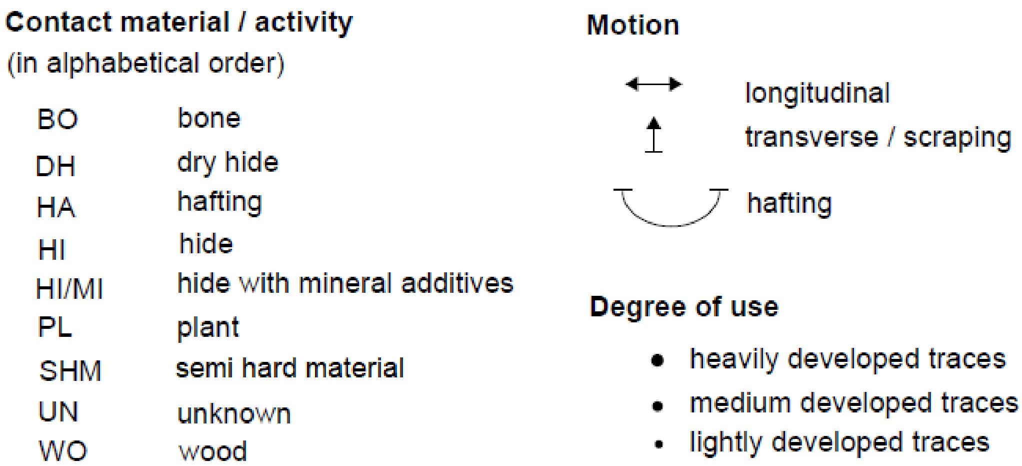


Figure 29: Explaining use-wear symbols on drawings

5.1. Voorshoten (VOOR)

Five out of ten scrapers from the site of Voorshoten were interpreted as hafted. Two scrapers were more tentatively interpreted as hafted (VOOR 14 and 35), whilst the better developed polish and/or edge damage lent more confidence to the interpretation of the three other scrapers (VOOR 18, 21 and 33).

VOOR14 has a rare, but not unique, overall morphology amongst the scrapers studied as part of this thesis (Fig. 30). Two of its main edges have retouch on the dorsal face (0608 and 1011), whilst on the remaining edge (0304) the retouch affects the ventral face. This would suggest that the three main edges could not all be used to actively scrape at the same time, perhaps suggesting multiple use processes as part of this tool's life history. Of course, a retouched edge does not always indicate use, as retouch can also blunt an edge to make it more suitable for holding or hafting.

The most developed use-wear polish appears on the edge 0304. On account of its rough appearance and accompanied edge rounding, this polish was interpreted as similar to that formed through scraping hide. The interpretation of a second, qualitatively different polish on two other areas of the tool was taken as possible evidence of hafting. This bright and very smooth polish was observed on small areas of both faces of the tool, potentially suggesting it was within a male haft. However, the potential haft material could only be interpreted as a semi-hard material. There was some edge damage nearby one of the smooth polish spots, but no clear association between polish and scar, as was suggested by Rots to be a hafting trace characteristic.

This is not such a confident interpretation of hafting, because it is based upon the distribution of a small amount of not very well developed polish. Furthermore, the potentially multiple ways to use this tool, make it difficult to decide which microwear traces might be significant for hafting.

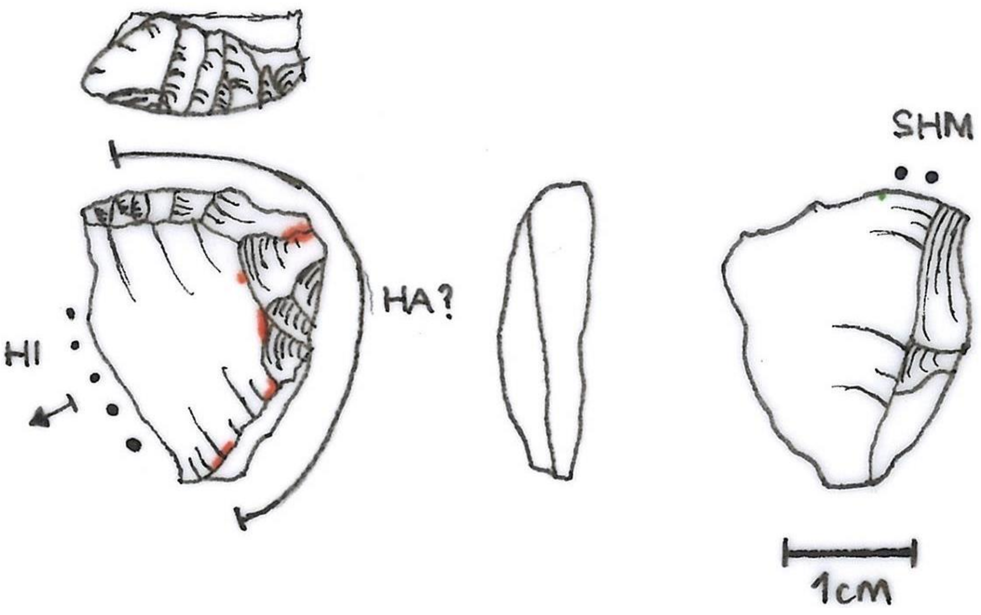


Figure 30: Drawing of Voorschoten 14, indicating hide use-wear polish (HI), and polish from a semi-hard material (SHM) which is also indicated in red on dorsal face. HA indicates suggested limit of the haft.

The evidence for hafting on VOOR35 is also limited, when compared to the following Voorshoten scrapers. VOOR35 appears to be a fragment of a broken scraper, as the well-developed polish on the distal end (06) stops abruptly where it meets the fractured 0304 edge. The transverse directionality of this polish clearly indicates a scraping motion, and its general distribution along the edge suggests hide working, but the brightness and very smooth texture of the polish is reminiscent of soft plant polish (Fig. 31). This polish may well be a combination of these two materials, as it shares many similarities to an example from the reference collection, where straw, charcoal and mud was rubbed on to the hide before it was scraped.

Although not as well developed as the use polish, it is the consistent, cross-ridge directionality of a smooth polish observed on the dorsal ridges which suggested contact with an unknown, semi-hard haft material. The steep-angled breaks and retouched edges of this scraper mean there is no significant scarring evidence to add to this interpretation and it may be that further hafting traces have been lost due to breakage.

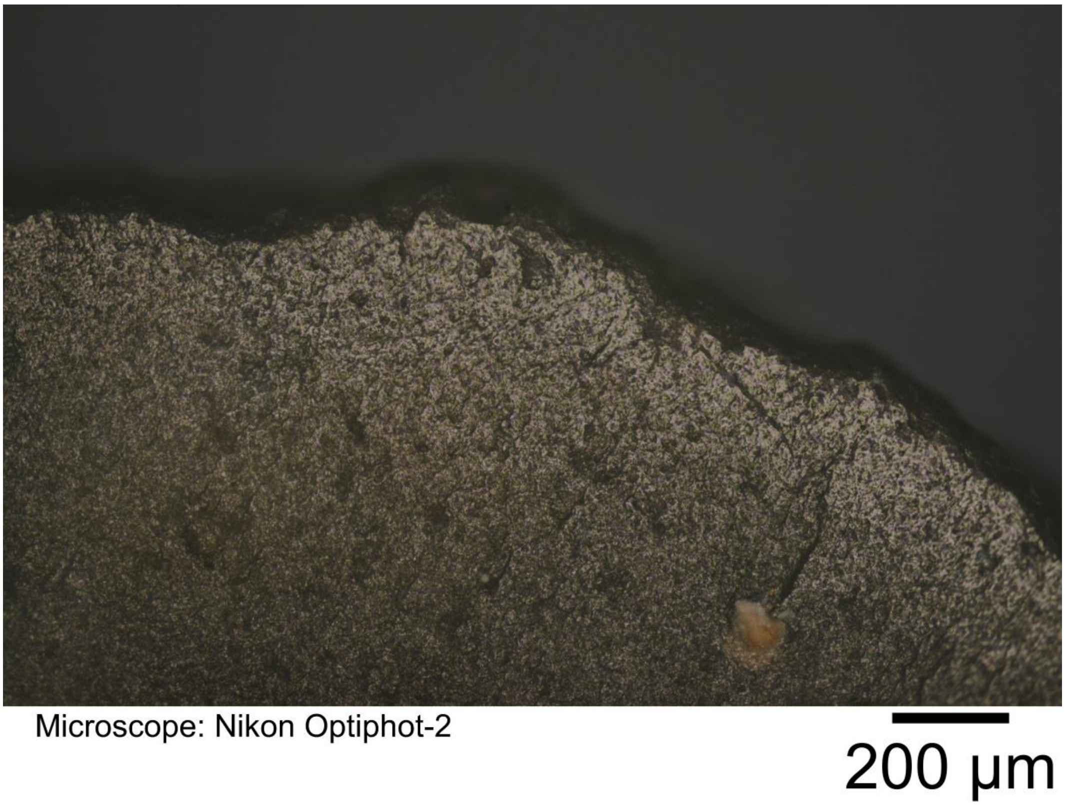


Figure 31: Rounded edge, but smooth textured polish on Voorschoten 35.

The retouched, distal end of VOOR18 is accompanied by edge rounding and rough, bright polish with transverse directionality which has been interpreted as evidence of scraping hide. However, amongst this rough polish, the occurrence of smoother polish, linked along the areas of higher micro-topography, suggests that some other, harder material, possibly a mineral additive, was also present during the scraping activity.

The proximal edge at 03 is also extremely rounded, but without showing the same rough, hide polish, which suggests this rounding is not use but hafting-related. This unusual roundedness is best observed on the ventral face, whilst in the same location (03) on the dorsal face, scarring associated with a smoother polish and occasional bright spots is present. The potential hafting polish, here, could only be assigned to a semi-hard material. However, the edge damage included sliced scalar and balloon shaped scar morphologies, which Rots (2010) particularly associates with hafting-related edge damage. Further scarring on the opposite edge (1011) could also be understood as an organised pattern of hafting-related edge damage (Fig. 32).

Finally, the prominent dorsal ridge is also the focus of hafting traces including bright, smooth polish, which is particularly well developed at the highest point of the ridge. There is also a distinct patch of scars and edge crushing confined to the right side of the ridge, suggesting it results from the application of continuous force from one direction, rather than the random impacts of post-depositional wear. All these traces seemingly combine to show an organised distribution of traces around the proximal end, which could be interpreted as due to hafting.

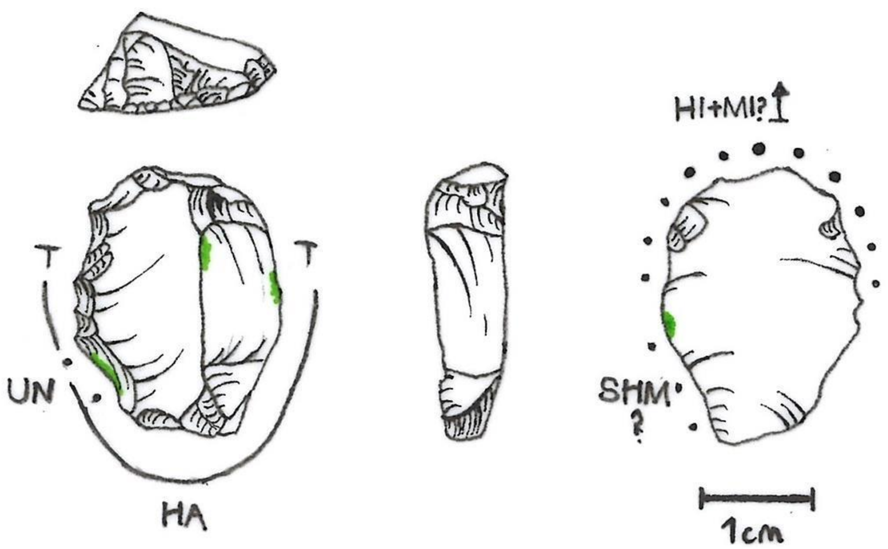


Figure 32: Drawing of Voorschoten 18, used on hide, possibly with some mineral additive. Polish from a semi-hard (SHM) and unknown material (UN) is possibly related to the haft material. Areas of edge damage mentioned in the text are indicated in green. HA indicates suggested haft limit.

VOOR21 is a lighter colour, and slightly different texture of flint, compared to the majority of the Voorshoten assemblage, but the traces are still clearly visible. A rounded edge and thin band of rough polish on the distal end (06-10) of the tool was interpreted as evidence of working fresh hide.

In contrast to VOOR18, VOOR21's main dorsal ridge is not raised much above dorsal surface, so that the overall morphology of the scraper is almost completely flat. It might, therefore, be assumed that traces would not be so concentrated or obvious on the ridge, because the haft would be in contact with a relatively large surface area of the tool. However, this is not the case. Both the dorsal ridge and a series of natural ridges and undulations in the surface of the flint at the proximal end display well developed polish (Fig. 33). This rough polish becomes smoother when well developed and follows the micro-topography of the flint. A very similar polish is also present all along a ridge formed by the bulbar scar on the ventral face of the implement. Over this larger area its characteristics seem to correspond with examples of polish from wood-working.

Overall, it is the presence of this wood (or at least semi-hard material) polish on dorsal and ventral faces of the proximal end which suggests that this scraper was hafted in a male haft of some type. Unfortunately, evidence from the lateral edges is lacking to narrow down this interpretation to male-split or male.

Figure 33: Polish on undulations in the surface of the flint at the proximal end of Voorschoten 21, interpreted as due to contact with wood.

The interpretation of VOOR33 as hafted might seem surprising given that very little evidence can be gained from the dorsal face, due to a large amount of cortex (Fig. 34). Rough, bright polish follows the distal edge (0608), although edge rounding is discontinuous, as if partially removed by resharpening retouch. These characteristics, along with transverse polish directionality, suggest hide scraping.

At the proximal end, a raised, u-shaped ridge related to the bulb of percussion displays a bright, rough polish, which becomes smoother at well-developed points. The same polish is found on tiny ridges nearer the two, lateral edges (03 and 11) (Fig. 34) and is definitely more than just the weak PDSM which affects this implement. In addition to this, the significant amount of scarring on both faces of the 0304 edge may suggest intentional retouch and/or hafting related edge damage. There is a sense of polish accompanying and in between these scar ridges, but, in this case, the level of PDSM does obscure the picture, so no confident interpretation of polish can be made.

Nevertheless, the presence of polish across the proximal end of the tool, as well as the location of scarring, suggested that this scraper was hafted. However, the cortex does prevent a comparison of ventral and dorsal faces, so that no comments can be made about a more specific haft type (e.g. male or male-spilt).

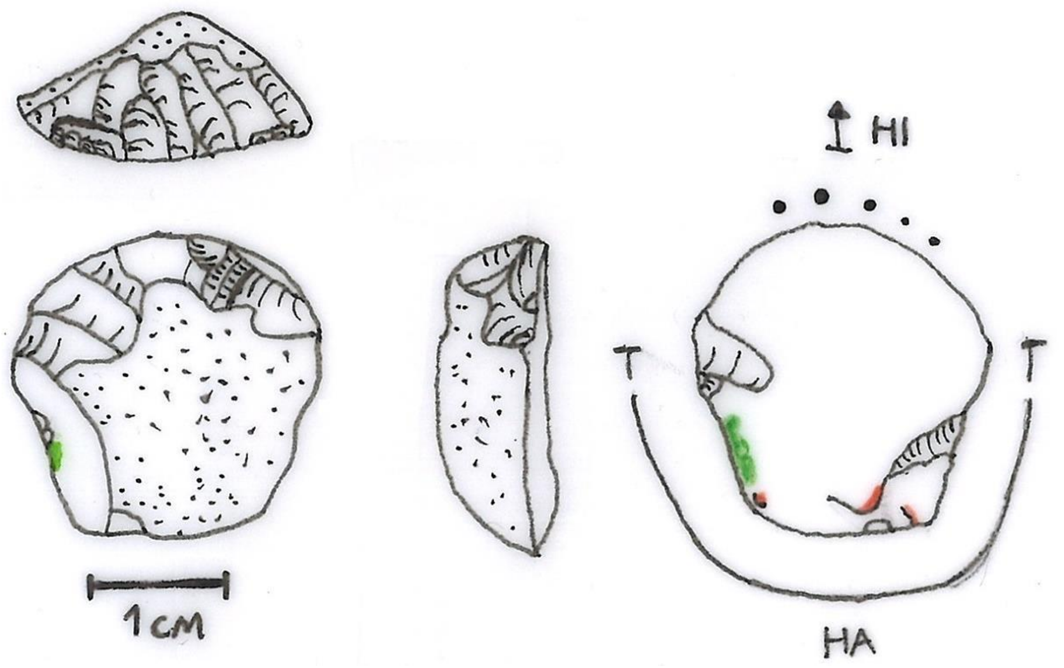


Figure 34: Drawing of Voorschoten 33, used on hide with polish from an unknown hafting material indicated in red and areas of significant edge damage indicated in green. HA indicates suggested haft limit.

5.2. Leidschendam (LDAM)

Only 4 of the 25 scrapers (16%) in my sample from the site of Leidschendam have been interpreted in terms of possible hafting wear traces. As I will discuss in more detail later, this small number is partly due to the high level of PDSM, which rendered many scrapers uninterpretable (see also 5.4.3). The four, hafted scrapers (LDAM12, 13, 17 and 59) can be split into two pairs based on the certainty with which the interpretations were made. It might not be coincidental that there are certain morphological differences between these two pairs.

The two, more uncertain interpretations (LDAM12 and 13) are based on the evidence of polish on ridges, as there was little, coherent edge damage evidence. Interpretation is made more difficult, because both scrapers have multiple areas of retouch, which potential offers multiple used edges and no, one, "logically" hafted area to investigate for traces. Moreover, very steeply retouched/resharpened edges seem to have reduced the amount of clear use-wear, making it difficult to establish which might have been an actually used edge.

For LDAM13 some of the clearest use-wear polish is on the dorsal face at 03, which corresponds with retouch on the ventral side. Although not immediately indicative, it was suggested by Van Gijn (pers. comm.) that this bright polish was similar to polish created by scraping meat from the bone. However, it was the presence and transverse directionality of polish on ridges near the opposite edge (11), which may cautiously be viewed as due to the unknown haft material.

The only clear polish on the ventral face of LDAM 12 is a patch of bevelled, bone polish at 04 (Fig. 35). A large retouch scar in the distal end (0608) disrupts the convex delineation of the edge. This might suggest why there was no clear use-wear polish for this edge. However, this makes it harder to decide whether the bone polish is related to use, re-use or hafting. In contrast, bits of smooth polish and scars on the dorsal ridge, if not PDSM, may be taken more likely as specifically hafting traces. However, it was the discovery of a black residue in a crevice at the proximal end of the tool, which really secured the designation of this scraper as probably hafted (Fig. 36).

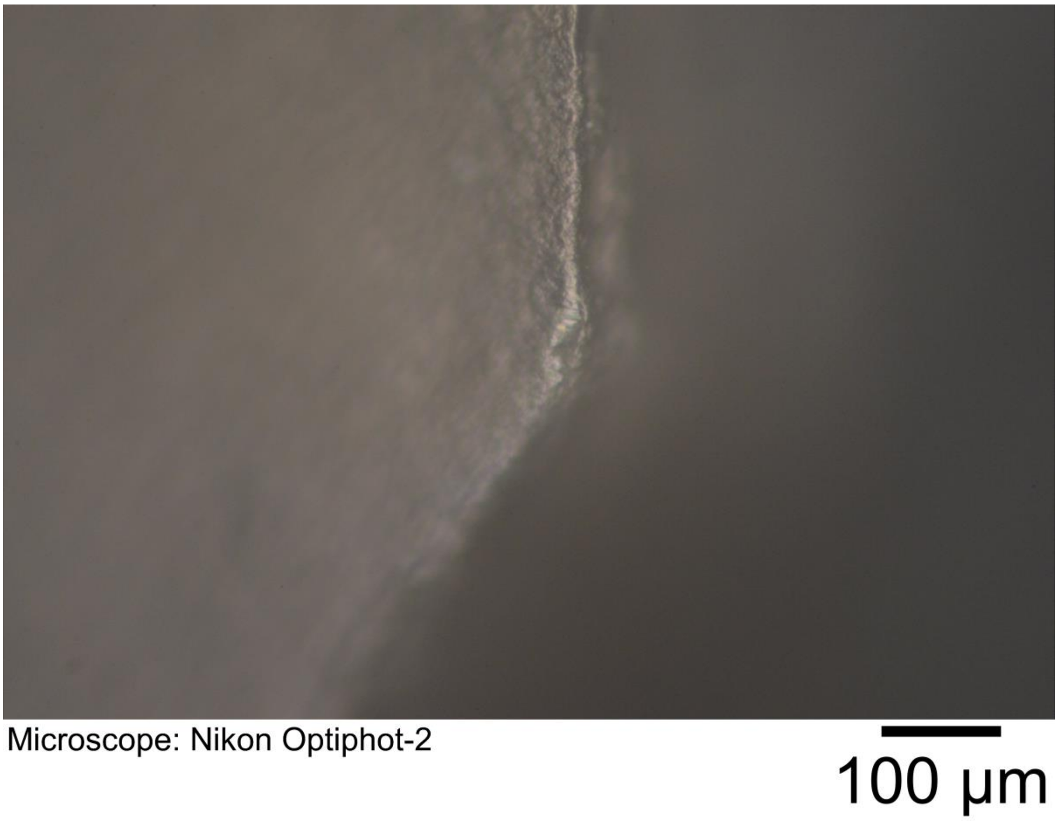


Figure 35: Bevelled, bone polish on the edge of Leidschendam 12.

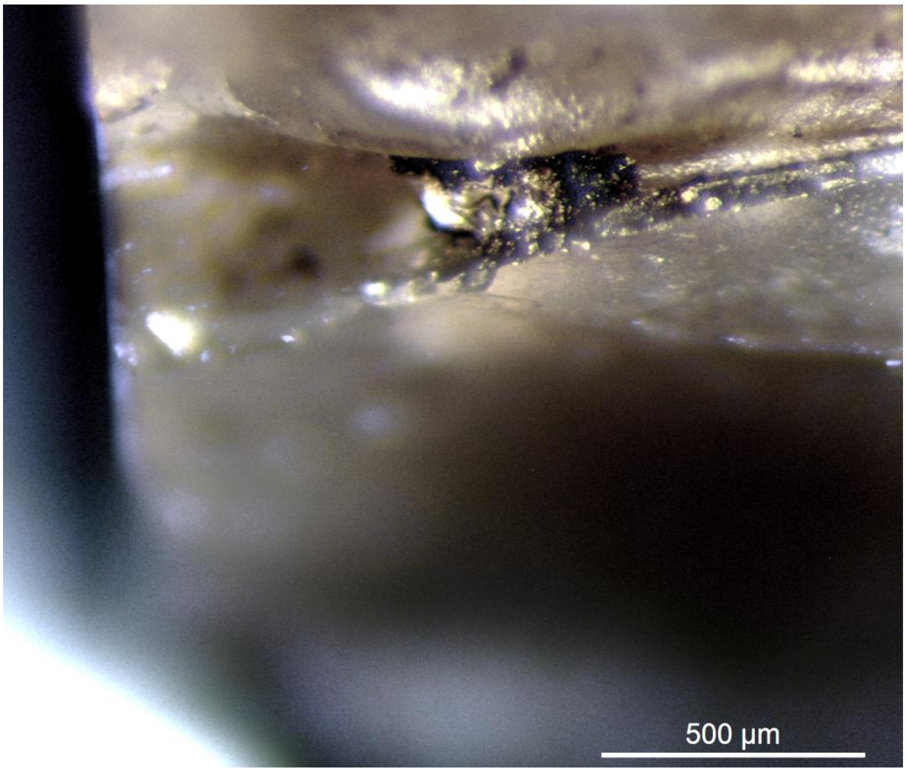


Figure 36: A grain of flint embedded in black residue within a crevice at the proximal end of Leidschendam 12. Photo taken using the Leica M80 Stereo-microscope with Leica MC120HD camera.

In contrast, LDAM 17 and 59 represent more confident interpretations. This is because of additional edge damage evidence on their unretouched lateral edges, less complicated morphologies and, in the case of LDAM 59, extremely well developed polish.

The rough polish and rounded edge at the distal end of LDAM 59 was interpreted as evidence of hide scraping, whilst the distribution of smooth polish on many different ridges and ledges of the proximal end suggested contact with a semi-hard material, most probably antler. The fact that this smooth polish does not continue all the way up the dorsal ridge may tie in with the scaring on the ventral face at 11, to suggest that only a third of the stone implement was in the haft (Fig. 37). Unfortunately, a fracture, which forms the 0406 edge, may have removed other traces which may have supported this hypothesis. Nevertheless, the distribution of this antler polish compared to the polish at the retouched edge may convincingly be interpreted as evidence of hafting.

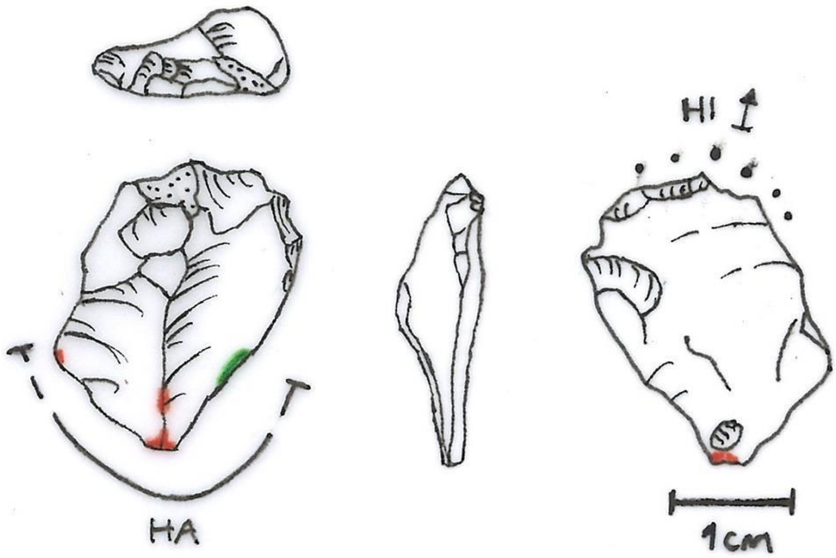


Figure 37: Drawing of Leidschendam 59, used on hide with a hafting polish (probably from antler) indicated in red and edge damage indicated in green. The broken line signifies less certainty in the extent of the hafting limit.

In contrast, the polish interpreted as hafting-related on LDAM17 is not so dramatically different from the polish observed on the used, retouched end. In fact, the slightly rough texture of polish around the bulbar scar has led to the suggestion that a hide wrapping might have been part of the hafting arrangement. This, in combination with edge damage evidence, encouraged the interpretation that this scraper was not simply hand-held.

5.3. Vlaardingen (VLA)

Five out of eleven scrapers (45%) from the site of Vlaardingen were interpreted as having traces of hafting. They will be discussed in order of the confidence with which they were interpreted as hafted.

VLA99 is the only completely retouched scraper from my thesis sample (n=46) which has been interpreted as hafted. The retouch is continuous, but on one edge (11) it extends onto the ventral rather than dorsal face (Fig. 38). There is no hafting-related edge damage on this steeply retouched piece (<60°) and only a small fraction (08) of the circumference displays a potential use-wear polish on the ventral face. Some characteristics of this polish suggest hide as the worked material, but it may be more responsible to simply say an unknown material caused this polish.

Randomly distributed, crystal-like spots of polish across the surface, and traces of retouch with an antler hammer, meant no areas of polish particularly stood out as making sense as hafting-related. Instead, it was the observation of a black residue adhering to the surface of the flint, particularly on the dorsal face of the proximal end (11 13), which suggests a hafting arrangement involving an adhesive, such as birch bark tar.

Considering the location of the proposed "used edge" (08) a haft limit may be suggested, which envelops the proximal end (0113). However, the author was struck by a certain morphological similarity between VLA99 and one of my experimental scrapers (3732) (Fig. 39). This prompted the idea that the 1011 edge could have been within the haft and 0304 the used edge. This suggestion maybe supported by the observation that the retouch at 0304 is much more step-fractured and crushed than that of 1011, suggesting different treatment of the two edges.

Whilst VLA99 raises some interesting possibilities, it is also an example of where residue rather microwear analysis may hold the key to interpreting hafting.

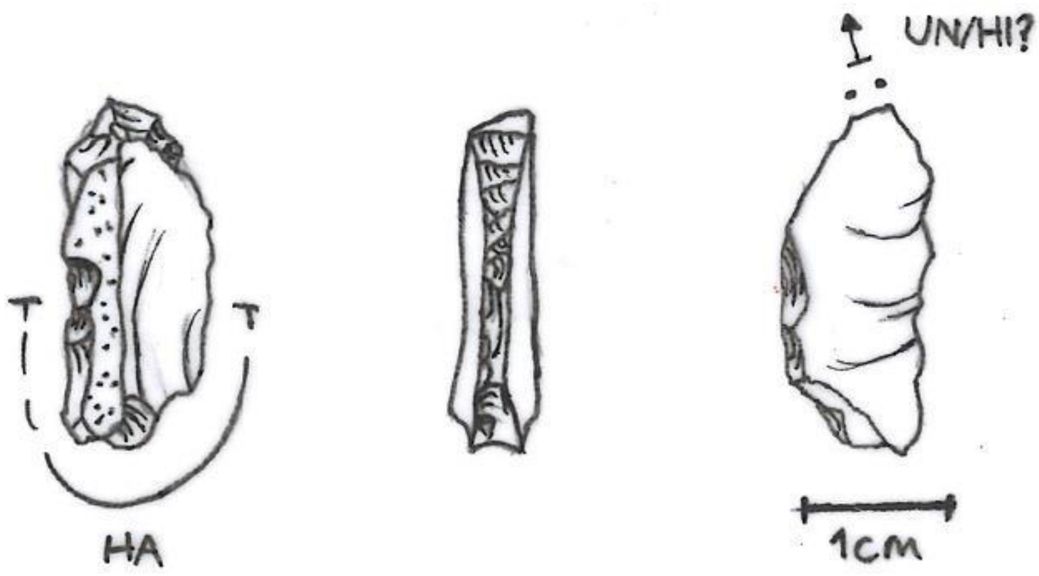


Figure 38: Drawing of Vlaardingen 99, indicating an unknown use-wear polish. HA indicates potential haft limit.

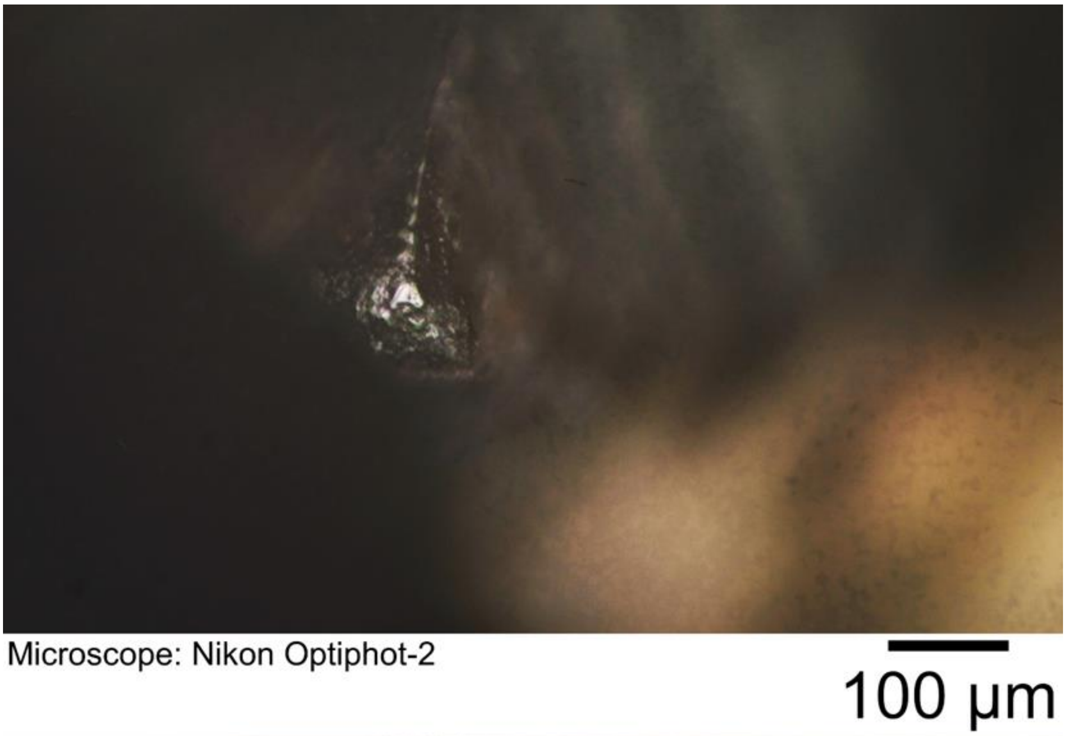
Figure 39: Experimental scraper 3732 alongside Vlaardingen 99.

VLA142 has the unusual morphology of having evidence of previous flake removals on both the dorsal and ventral face, so that there are slightly raised ridges on both faces. The retouched edge (040608) has only isolated spots of a very weak polish, which could not be interpreted in terms of a worked material. The steep edge angle here (61-80°) indicates that repeated resharpening might be responsible for the relative lack of polish along this edge.

In contrast, on the ventral ridges, a smooth, bright and cratered polish was clearly recognisable. It stuck to the higher micro-topography and had transverse, or cross-ridge, directionality. It would probably be safer to interpret this polish simply as resulting from contact with a semi hard material. However, I would suggest it is more likely to be from wood rather than antler, because, although bright smooth and slightly domed, it lacks the slightly rippled surface effect of antler. Similar, smooth polish, and also a slight rounding, is present on the dorsal ridges, but it is primarily the polish on the ventral ridges which encouraged an interpretation of this scraper as hafted.

The interpretation of microwear traces on VLA 1678 is limited by the fact that this scraper has been burnt, causing the ventral face in particular to crumble away. Surface modifications related to burning obscure use-wear traces in the ventral side, so it is not immediately clear what extent of the edge was used, but small sections of polish appear to indicate contact with hide.

However, from the perspective of hafting traces, very well developed smooth, domed polish on two ends of the highest dorsal ridge suggest that it was in contact with a plant material, probably wood (Fig. 40). Unfortunately, the highly damaged ventral face prevents a comparison of traces on the two faces in order to make an interpretation of hafting arrangement. However, hafting a tool with an extreme, triangular transversal curvature in a juxtaposed haft would be rather unstable, so maybe a male haft type is more likely.



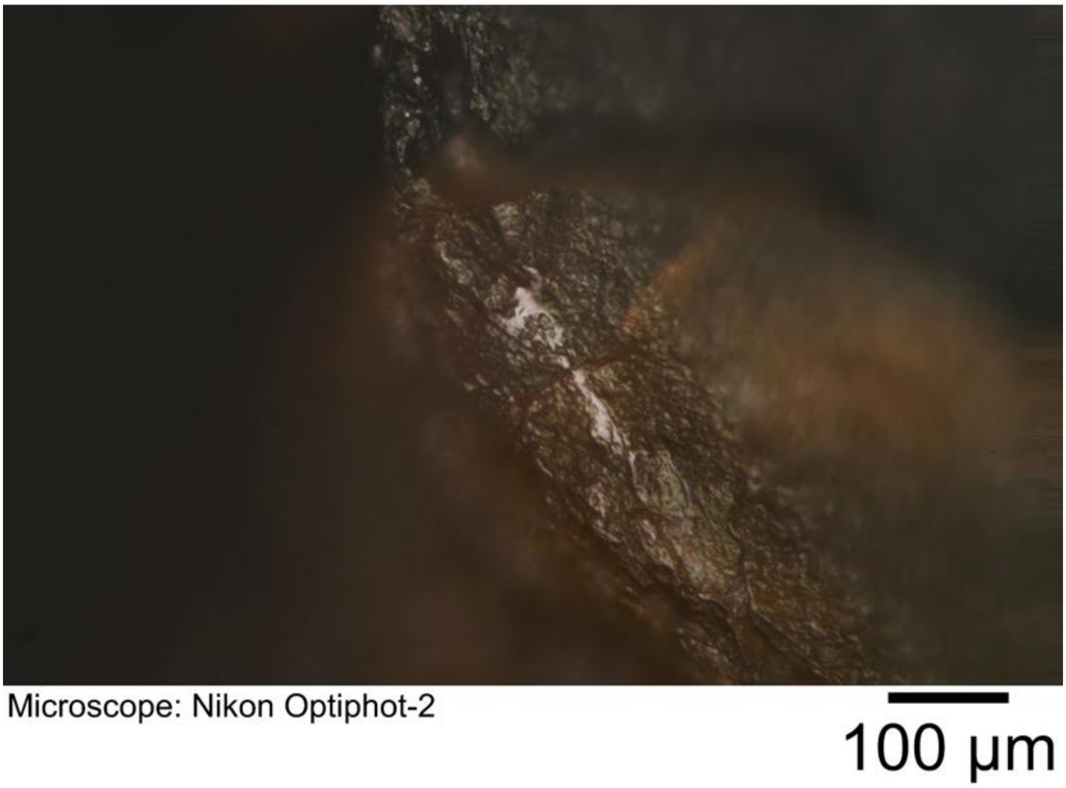


Figure 40: Smooth polish, probably from contact with wood, on opposite ends of the dorsal of ridge of Vlaardingen 1678.

VLA1681 has retouch only on its distal end (0608) and, therefore, there is more edge damage evidence to inform this interpretation than other scrapers. A rough, bright polish with discontinuous, but significant edge rounding is interpreted as evidence of hide working, which is somewhat interrupted by resharpening episodes.

Evidence of hafting on this scraper involves the distribution of a contrasting, smoother polish on both faces of the more proximal end (Fig. 41). Specifically, these areas are the ridge of the bulbar scar on the ventral face, and, more importantly, a well-developed smooth, slightly domed polish on the two main dorsal ridges (Fig. 42). Unfortunately, polish on such a small surface area is difficult to narrow down to a specific material. In this case, there are polish characteristics that could suggest wood and antler, so it is best to interpret this polish as resulting from a semi-hard material.

In addition to the polish, both lateral edges also have distinct patches of scarring (Fig. 41). Although these patches do not display some of the specialised, hafting-related scar morphologies suggested by Rots (2010), their alternating distribution along both edges does feature as a characteristic of male hafted tools (Rots 2010, 148).

The combined microwear traces from both faces of the scraper form a pattern which suggests VLA1681 was hafted, possibly in a male haft type.

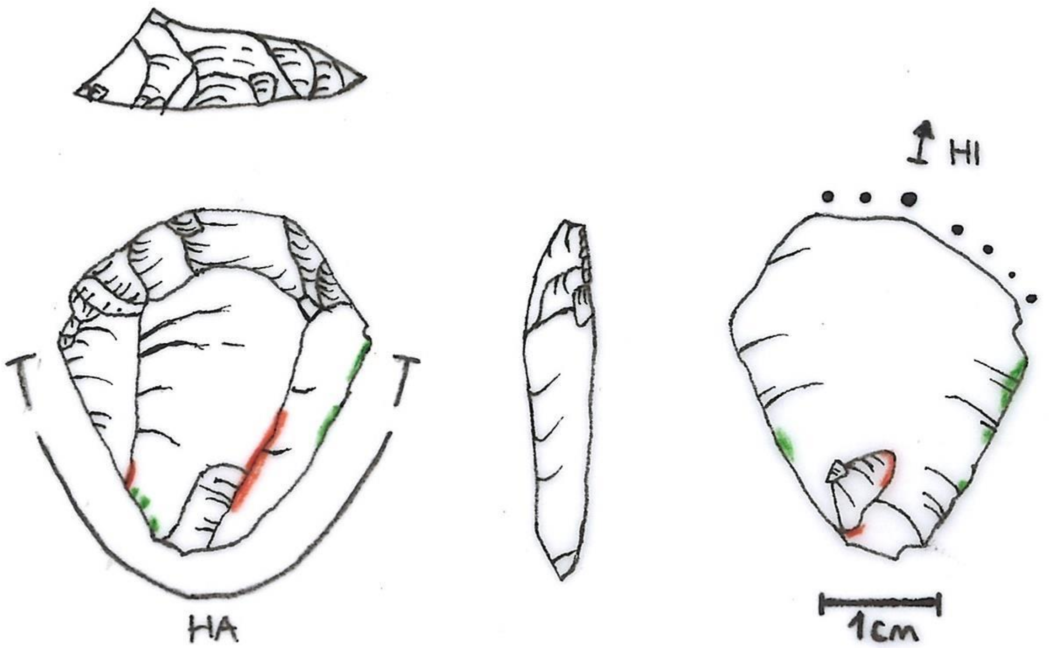


Figure 41: Drawing of Vlaardingen 1681, used on hide with polish from a semi-hard, hafting material indicated in red and areas of edge damage indicated in green. HA indicates suggested haft limit.

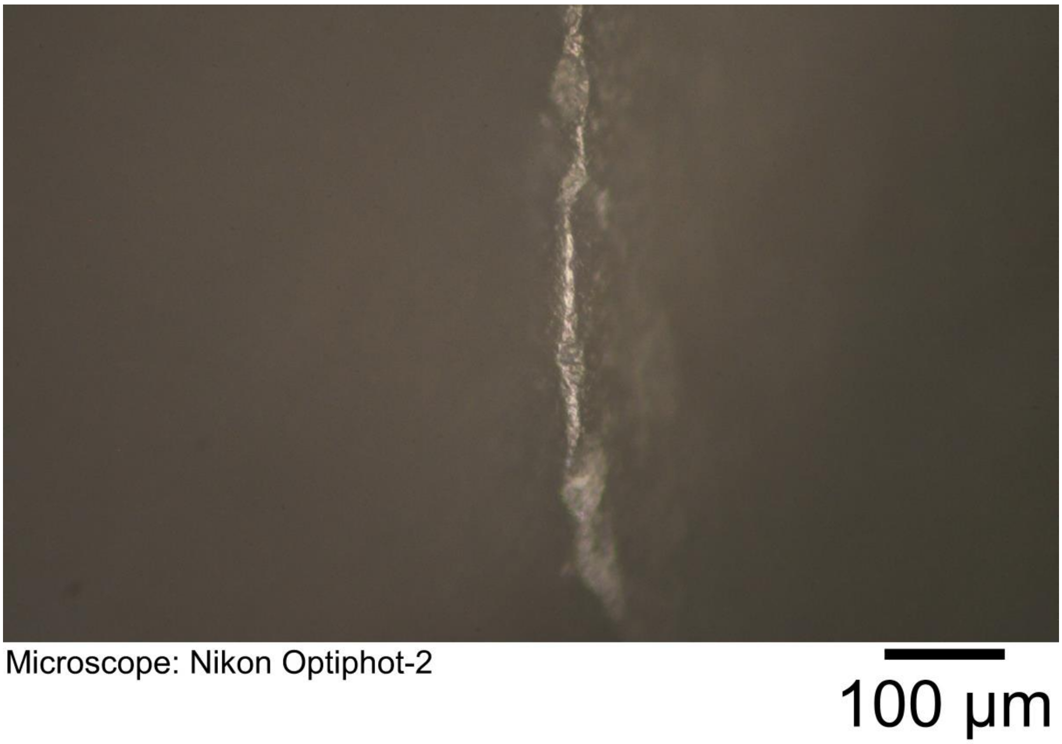


Figure 42: Polish on the main dorsal ridge of Vlaardingen 1681.

The confidence with which VLA1682 was interpreted as hafted is based on the distribution of areas of particularly well-developed polish. The distal end (0608) again displays the rough polish, transverse directionality and edge rounding that suggests hide scraping. In contrast, the proximal regions display a smooth polish often with a bevelled appearance, which is suggestive of the polish created by bone. Critically, this scraper has a very prominent bulb of percussion, which has resulted in a pronounced longitudinal curvature. This should theoretically reduce the potential contact area with a hypothetically straight haft material to a few key areas or pressure points. Indeed, this seems to be the case, with the smooth, bone polish on exposed points of the proximal end, such as the corner between 11 and 13 on the ventral face. Polish with the same characteristics is found on a ventral ridge near the butt, on the dorsal ridges and even in a small patch on the dorsal surface above the retouch at 10. In addition, there are some patches of edge damage on the main unretouched edge (0304), parts of which also have small spots of polish associated with the scars. The distribution of a polish which is qualitatively different from that at the retouched, used edge suggests this scraper was hafted.

5.4. Hafted scrapers in context

There are a couple of ways to group and compare these scrapers and it is important to make sure fair comparisons are drawn. Therefore, the main comparison discussed here will be between the group of scrapers interpreted as hafted (n=14) and the group of scrapers, where interpretation of hafting traces was considered possible, but where no positive hafting traces were found (n=16). The latter group excludes those scrapers which were deemed simply impossible to interpret either way, because of the level of PDSM and/or the coarse texture of the flint (n=16). Additional data for the group representing all interpretable scrapers (n=30) and the total thesis sample of scrapers (n=46) will also often be reported, but not discussed in detail. These additional groups demonstrate that the trends in the data are not significantly changed by the different groupings. A full results table can be found in Appendix E.

It may be wise here to acknowledge some caveats to the following comparisons. A very simple statistical analysis involving mode and average was all that was possible in the time available and due to the mainly categorical level of my collected data. I am also talking about relatively small sample sizes. The difference between some categories may seem significant, especially when talked of in terms of percentages, but in reality it could be the difference between two scrapers in category X and three in category Y. It may be that some patterns are not discernible in a total sample number of only 46 scrapers, but it may also be that these scrapers were not made and used in a very standardised way, so there are no significant patterns to find.

5.4.1. Morphology

First, I will report some morphological characteristics that are shared by the scrapers interpreted as hafted, in contrast to those scrapers which were interpretable, but displayed no possible hafting traces (hereafter referred to as 'non-hafted'). Many aspects of the scraper's morphology, from length and width, to longitudinal curvature, and delineation of retouch were recorded (see also Appendix E), but few proved to show a correlation with hafting traces.

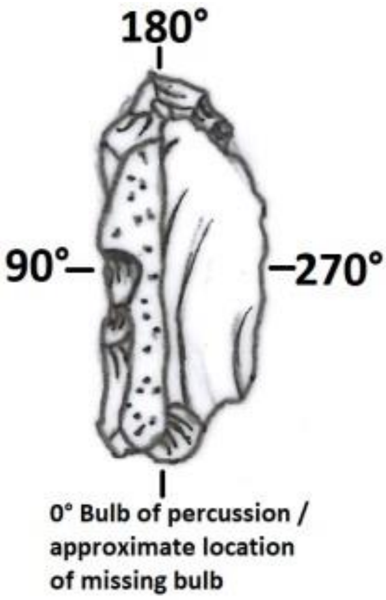


Figure 43: Diagram explaining where edge angle measurements were taken.

The main recorded variables which seem to set the hafted scrapers apart from the non-hafted are closely related. The variables are edge angle and location of retouch, and these reveal something about how the nature of the retouch affects the edges of the tool.

The edge angle was recorded at three points relative to the butt or, if the butt was missing, the approximate location of the butt based on conchoidal ripples on the ventral face (Fig. 43). These points often correspond to the left (90°), distal (180°) and right (270°) edges of the implement, but as some scrapers have a more rounded circumference, left is not always a helpful description. An edge angle was only recorded when retouch was present at these points, otherwise the spine-plane angle sufficed to describe the edge. The angle was recorded as one of six categories: not recorded; 0-20°; 21-40°; 41-60°; 61-80° and 81-100°. Comparing the most common edge angle categories at the three points does reveal some subtle differences between hafted and non-hafted scrapers (Table 1). But first, looking at all the scrapers taken together (n=46), when retouch is present on an edge at any of these three points, it most commonly contributes to an edge angle which is between 61-80°. These pretty steeply retouched edges often have a stepped and/or overhanging appearance and could suggest repeated resharpening of the edges (Van Gijn 1990).

For hafted tools, the most common edge angle at points 90 and 270 was 'not recorded' (64% for both), in other words there was no retouch at those points. Whilst not recorded (NR) was also the most common result for non-hafted scrapers at 90, the percentages of NR at 90 and 270 on hafted tools are far greater (26% and 39% greater respectively) than the percentages for non-hafted scrapers (see Table 1).

At 180 the most common edge angle for both hafted and non-hafted is 61-80° (64 and 50% respectively). It would appear that hafted scrapers show a tendency towards less steep angles, as the next most common category is 41-60° (21%), whilst for non-hafted it is 81-100° (25%). However, we must remember that for hafted scrapers 21% means 3 scrapers, and the difference between the second and the third most common edge angle(81-100° = 14%=2 scrapers) was just one scraper. Therefore, this statistical pattern most likely does not represent a significant real world pattern in the scrapers.

Table 1: The proportions of edge angle categories at three locations on Vlaardingen scrapers. The highest percentage in each group is highlighted in red.

Location on tool		Edge angle category				
		Not recorded	81°-100°	61°-80°	41°-60°	21°-40°
90°	Hafted (n=14)	64%	21%	0%	14%	0%
	Interpretable Non-hafted (n=16)	38%	13%	31%	13%	6%
	All Interpretable (n=30)	50%	17%	17%	13%	3%
	All (n=46)	48%	15%	24%	11%	2%
180°	Hafted	0%	14%	64%	21%	0%
	Interpretable Non-hafted	13%	25%	50%	13%	0%
	All interpretable	7%	17%	60%	17%	0%
	All	9%	22%	57%	13%	0%
270°	Hafted	64%	0%	36%	0%	0%
	Interpretable Non-hafted	25%	6%	56%	13%	0%
	All interpretable	43%	3%	47%	7%	0%
	All	41%	9%	41%	9%	0%

Analysing the location of retouch on hafted scrapers shows a focus on the edges 06 and 08, normally referred to as the distal end (Table 2). 36% of hafted scrapers have retouch only on the 0608 edge, compared to 25% of interpretable non-hafted scrapers. Occasionally, the retouch extends further down the left (040608) or right (060810) edges, but only one scraper (VLA99) can be described as completely retouched, in other words, it has retouch around its entire circumference.

Turning to the number of retouched edges on each scraper (Table 3) we also see that the scrapers with the most retouched parts tend to be within the group interpreted as non-hafted. Three non-hafted scrapers (19%) have 8 retouched edges, whilst only 1 hafted scraper (7%) is completely retouched. In addition, there are three uninterpretable scrapers with 8 retouched edges, so that only one out of seven, completely retouched scrapers from this thesis sample had traces which could be interpreted as due to hafting.

Table 2: Location of retouch for scrapers interpreted as hafted. The numbers for the location of retouch relate to coordinates as demonstrated in Figure 28, p. 67

Scraper ID Number	Location of retouch
LDAM 59	0608
VOOR 33	0608
VOOR 35	0608
VLA 1678	0608
VLA 1681	0608
VOOR 18	040608
VLA 142	040608
LDAM 17	060810
VOOR 21	060810
VLA 1682	060810
LDAM 13	06081011
LDAM 12	06081011
VOOR 14	030406081011
VLA 99	0103040608101113

Table 3: Number of retouched edges on scrapers as a proportion of each group. One coordinate from Figure 28, such as 06, is considered one edge. The first, second and third most common edge groups is highlighted in red, blue and green respectively.

	2 edges	3 edges	4 edges	5 edges	6 edges	7 edges	8 edges
Hafted (n=14)	36%	36%	14%	0%	7%	0%	7%
Interpretable non-hafted (n=16)	31%	19%	19%	6%	6%	0%	**19%**
All interpretable (n=30)	33%	27%	17%	3%	7%	0%	13%
All (n=46)	33%	22%	20%	2%	9%	0%	15%

In summary, it appears that the scrapers interpreted as hafted have fewer retouched edges than non-hafted scrapers. There may be a number of ways to think about the potential significance of this.

One suggestion might be that scrapers with unretouched lateral edges were preferentially hafted. In other words, prehistoric tool makers applied retouch to a section of the flake edge in order to make it a scraper and then the rest of the flake was left unretouched, because that part would be within the haft. Following this train of thought, it could then be suggested that scrapers with retouch around a significant proportion of their circumference were intended to be used along the full extent of this retouch, and so were not hafted, but used handheld. Unfortunately, a majority of the completely retouched scrapers suffer from PDSM and extensive rejuvenation of the retouched edges; this often precludes the confident interpretation of microwear, which might inform this hypothesis. The prevalence of steep, or even overhanging, retouched edges on many of these scrapers may be due to repeated resharpening. This means there remains the possibility that these completely retouched scrapers were hafted, at least at some point in their lives, but that the hafting traces were subsequently removed.

However, a more cynical or cautious view might urge caution about whether the pattern reflects prehistoric decisions or the interpretative capabilities of the analyst. Both Rots' (2010) and the author's experimental programmes have shown that retouched edges are less likely to be damaged by the haft. Therefore, it may be that hafting traces, such as edge damage, are likely to be more obvious on largely unretouched implements. Hafting traces may not form, or will be harder to see, on highly retouched scrapers. If hafting is easier to interpret on unretouched edges, this trend within the hafted group may reflect the interpretative bias of the analyst, rather than the prehistoric decision. This issue will be further considered in the following discussion chapter.

5.4.2. Use wear

A very brief note on the how the interpreted use-wear of these scrapers compares to their hafting status. There is no significant difference between hafted and non-hafted scrapers in terms of the materials on which they were used (Table 4 and extended results table in Appendix E).

Table 4: Summary of interpreted use-wear polishes found on the scrapers. Note that one interpretable, non-hafted scraper was interpreted as having two different material polishes, so the sum of polishes exceeds the number of scrapers

	Hide (in various states)	Bone	Meat and bone	Unknown material
Hafted scrapers (n=14)	10	1	1	2
Interpretable non-hafted scrapers (n=16)	13	1	2	1

So, we turn to consider the scrapers for whom it was considered possible to make a use-wear interpretation (n=37). This is not exactly the same as the group which was deemed interpretable in terms of hafting wear (n= 30). This is because, in some cases, a used edge could be distinguished above the level of the PDSM. However, the more isolated hafting traces, thinly distributed over a larger area of the implement, were less distinguishable from the level of PDSM polish.

Amongst these 37 scrapers, the transverse directionality of the use-related polish consistently indicated a scraping motion taking place. A majority of the use-wear polish (65%) on the scrapers was interpreted, with various levels of confidence, as being similar to the polish created by scraping hide in diverse states, such as dry, fresh and/or with a mineral additive.

In addition, there was another polish present on a few scrapers which was similar to that of working a soft and hard material at the same time, and suggests an activity such as cleaning bones of their meat. At other times, as seen with the hafting-related traces, it was not possible to interpret the polish as a specific material. Instead, the polish was interpreted in terms of the relative hardness of the worked material, for example, a semi-hard material could be something like antler or wood, but we cannot be more specific. Finally, there were also polishes, where a sense of directionality indicated that they were use related, but it was not possible to interpret the polish as a material category, so they were interpreted as an unknown material (see Appendix E).

5.4.3. Inter-site comparison

Despite the general similarities, it is worth highlighting a few trends which differentiate these three sites.

Although it must be reiterated that we are dealing with small sample sizes here, it is worth comparing the three sites purely by the numbers of scrapers interpreted as hafted.

When looking at the numbers of hafted scrapers as a percentage of total number of scrapers from each site, it would appear that the sites of Voorshoten and Vlaardingen have similar rates of hafting (50 and 45% respectively), whilst Leidschendam lags behind (16%) (Table 5). However, as previously discussed, Leidschendam was disproportionally affected by PDSM, and once we remove all scrapers deemed uninterpretable in terms of hafting traces, the picture changes slightly. The prevalence of hafting within the Voorshoten assemblage is further emphasised and the proportion of hafted scrapers at Leidschendam is no longer such an outlier (see Table 5). However, it is still clear that proportionally more hafted scrapers were deposited at Voorschoten than at Vlaardingen or Leidschendam. The implications of this for archaeological interpretations of these sites will be explored later in my discussion chapter.

Table 5: The proportion of hafted scrapers by site, also taking into consideration the effect of PDSM.

	Voorshoten	Vlaardingen	Leidschendam
Hafted scrapers divided by total number of scrapers from each site	50%	45%	16%
Hafted scrapers divided by number of interpretable scrapers from each site	71%	45%	33%

There is no noticeable difference between the three sites in the way that hafted scrapers differ from interpretable non-hafted scrapers. For example, for all three sites (except at point 270 in the Voorschoten assemblage) the percentage of not recorded (i.e. non-retouched) at points 90° and 270° is higher (between 60 and 80%) than the non-hafted scrapers. In other words, the hafted scrapers from all three sites similarly share this trend of unretouched lateral edges.

However, there are some overall, morphological differences between the scrapers from the different Vlaardingen sites. Most noticeably, a difference in the steepness of the retouched edges can be observed between Vlaardingen, Voorshoten and Leidschendam. Leidschendam has more, steeply retouched edges (i.e. 81-100°) than Vlaardingen and Voorschoten, whilst, correspondingly, Vlaardingen has the most scrapers edges within the less steeply retouched category of 41-60°. Nevertheless, the most common edge angle category for all three sites is 61-80°.

There may also be some subtle differences in the types of use-wear found on the scrapers from different sites. All instances of the polish which was influenced by both soft and harder materials at the same time, and was likened to the polish created by cleaning meat from bones, were found on scrapers from Leidschendam. In addition, less than 50% of the interpreted use polishes at Leidschendam were designated in the broad category of hide working, compared with over 80% of interpreted use polishes on Voorschoten and Vlaardingen scrapers (Appendix E). However, this discrepancy may again be influenced by the levels of PDSM at Leidschendam, which led to more polishes having to be interpreted simply as an unknown material.

Chapter Six: Discussion

6.1. Morphology

In contrast to the dominant variables (use motion and material worked, hafting material and arrangement) Rots (2010, 173-181) discusses various aspects of tool morphology and the presence of retouch as secondary variables, which “do not determine the formation of hafting traces; they merely cause slight variations on an existing pattern” (Rots 2010, 173). However, in Rots’ more detailed discussion she cautions that morphological characteristics, such as transverse cross-section or bulbar traits, will limit the amount of contact the stone tool has with the haft, and therefore, surely, also the potential for the formation of hafting traces. Regardless of the use motion or hafting arrangement, if there is limited contact, there will be limited traces, and perhaps not enough traces to indicate this organised pattern that Rots (2010, 42) claims distinguishes hafting traces from other transportation or post-depositional traces.

In addition, the effect of a stone tool’s retouched edge on the formation of hafting traces is a recurring comment in Rots discussion of the results of many experiments. In this secondary variables section, Rots (2010, 180) explicitly acknowledges that retouch has a negative influence on the formation of hafting-related scarring, which seems at odds with her quoted statement above. Retouch usually serves to create a more obtuse edge angle, which is less likely to be damaged by a haft than an acute edge. The less scarring also reduces the chances of associated polish bright spots forming, which Rots’ argues are created in moments of intense friction between the stone tool and the tiny flake that is breaking off. This association of scars and bright spots is one of Rots’ (2010, 200) key hafting characteristics, and if this is adversely affected by a retouched edge, it seems we have lost a potential form of evidence. In addition, depending on when in the life of the tool the retouch took place, it could remove evidence of hafting scars and polish. Alternatively, retouch could add to total amount of scarring on the implement. This complicates interpretations, as it is already widely acknowledged that the presence of retouch can make it difficult to distinguish which scarring is from tool production, use damage or hafting.

I feel that the influence of overall morphology and retouch on the formation of hafting traces is not really discussed as a major issue by Rots (2010). This may be, because her experiments tended to involve implements with more, unretouched edges and/or tool morphologies which were more likely to sustain a wide range of hafting traces. For example, all scrapers utilised in Rots' experiments were endscrapers on a blade (Rots 2010, 20). With a limited typo-morphological set of stone tools used within her experiments, perhaps she did not have to opportunity to see how all these morphological characteristics combined together could present a serious issue with investigating hafting traces on some stone tools, such as my sample.

The majority of scrapers within my sample had extensive and steep retouch around most of their circumference. Although there were not too many extreme longitudinal curvatures, in some cases, a pronounced bulb of percussion significantly reduced the surface area which could have been in contact with the haft. Most importantly, there are many obtuse, retouched edges, which are unlikely to accrue hafting-related scarring.

On top of that, the hafting trace distribution patterns, which Rots (2010, 78-88) suggests are characteristic of different use motions, are also based on the idea that there are clear proximal and distal ends and distinct lateral edges. In other words, they have been worked out with an endscraper on a blade in mind. My concern is whether these insights can be translated to tiny, thumbnail scrapers on flakes, which are often completely retouched, so that no distal or proximal end can be distinguished. Some insights may be more easily applied to an investigation of such morphologically different tools than others. For example, the development of traces on dorsal ridges relative to the tool edges may be applied to most tools, as there is usually at least one dorsal ridge and edges, regardless of their position relative to a potentially non-existent bulb of percussion. However, comments on the likelihood of traces on the proximal part of the tool are not really useful when a proximal part cannot be determined for the tool in question. The extensive retouch around a significant part of the circumference of the tool also begs the question of which section of the retouched edge was in use, or whether various sections were in use at various times. Raising the possibility that these kinds of scrapers were rotated and different sections used, also suggests that several different sections could have been within a haft. Different hafting episodes would then overlap and a sudden limit between the inside-haft set of microwear traces and outside-haft traces would not be as distinct or even distinguishable at all!

Without sounding too much like a bad workman, who blames her tools, I would argue that the morphological traits of my sample present an additional challenge for the formation, and hence interpretation, of hafting traces over and above the challenges faced by Rots. However, the interpretation of hafting traces on archaeological assemblages faces yet a further challenge in the form of post depositional surface modification.

6.2. Post depositional wear

All microwear studies of archaeological artefacts have to take into consideration the level of post-depositional surface modification (PDSM) that has taken place. Whilst PDSM is not exclusively a problem for investigations of hafting traces, I would argue that they are particularly affected by a poorly preserved assemblage. On a heavily used implement, the presence of a well-developed, use-wear polish may still be distinguishable from the general background of PDSM, even if the PDSM obscures the characteristics of the worked material. In other words, from a high concentration of polish and perhaps evidence of edge rounding, an analyst may still be able to interpret whether a scraper was used or not, and which is likely to be the used edge. However, hafting traces are less likely to form in overwhelming concentrations and could be distributed over a number of areas on the tool. Therefore, it is much more unlikely that hafting traces would stand out above PSDM and be distinctively different from PSDM, which can take many forms depending on each site’s depositional environment. This was definitely the case with the assemblage from Leidschendam, and had the author known, such a damaged assemblage probably would not have been chosen for an investigation focused on hafting traces.

6.3. Vlaardingen settlement patterns

Before exploring some possible implications of my results for broader interpretations of Vlaardingen sites, some caveats must be stated. My samples from each site are small and may not be fully representative of the whole site. In some cases, they are samples of a previously-defined sample of one trench, and it could always be that this trench happens to be cut through a specialised part of the settlement. Only my Leidschendam sample can be related back to a more detailed, published microwear study which did not find evidence for clear-cut activity areas (Van Gijn 1990, 138).

Firstly, it may be interesting to note a dissimilarity in the evidence of hafting between Leidschendam and Voorschoten, which are two sites occupying the same, coastal dune environmental zone. In many accounts of Vlaardingen sites (Raemakers 2003; Van Gijn 1990; 2010; Van Gijn and Bakker 2005) Leidschendam and Voorschoten are considered similar in terms of evidence of permanent settlement, domestic animals and cereal cultivation. However, the percentage of hafted scrapers at Leidschendam and Voorshoten is dramatically different. Even excluding all those Leidschendam scrapers which were considered uninterpretable due to PDSM, only 33% of Leidschendam scrapers showed traces of hafting, compared with 71% of interpretable Voorschoten scrapers (see Table 5).

If we return to some of Keeley's (1982) arguments about the effect of hafting on the archaeological record, as mentioned in Chapter Two, we could argue that what we see at Voorschoten is not simply a lot of hafted scrapers, but a lot of retooling taking place on the site. This also suggests that Voorschoten was considered a suitable place to undertake retooling, presumably because of access to the necessary resources, including time. So why was there apparently relatively little retooling taking place at the similar and nearby site of Leidschendam? Moreover, it makes the presence of hafted tools and the activity of retooling at Vlaardingen look even stranger. The predominance of imported, southern flint at Vlaardingen would seem to indicate that it is not the convenient flint resources which would make this site suitable for retooling. Or, instead, are people making use of available haft materials and (re-)making the whole tool (new haft and new stone implement), leaving behind the old, hafted stone implement at Vlaardingen?

If retooling preferentially took place when convenient, rather than when necessary, this might suggest it would happen at a more permanent settlement, where resources could be amassed, and where people would prepare their tools, before leaving to carry out activities elsewhere. It might, then, make sense to see a high proportion of hafted stone tools at more permanent settlements.

However, in contrast to Leidschendam and Voorschoten, the site of Vlaardingen is often subsumed into a group, along with Hekelingen III and the Hazendonk, where occupation is interpreted as more temporary and focused on the seasonal exploitation of specific resources (Van Gijn and Bakker 2005, 299; Van Gijn 2010, 57)[1]. Furthermore, the flint tools found on levees sites in the freshwater tidal zone, such as Vlaardingen, are generally characterised as larger, but less intensively used than those found on coastal dune sites, and the use of the tools is described as very *ad hoc* in nature (Van Gijn 2010, 137). It might be surprising, then, that Vlaardingen's sample has more hafted scrapers than Leidschendam, with 45% of interpretable scrapers displaying hafting traces. This evidence of hafting might suggest stone tool use at Vlaardingen was not quite so expedient as conventionally interpreted. Although, it would be interesting to undertake further research into the prevalence of hafting traces on other types of tool and unretouched flakes at this site. This might elucidate the expedient and curated aspects of the technological strategy people were using for their flint in this area.

Finally, if people at Vlaardingen are taking the time to retool hafts, or possibly remaking complete hafted tools, might this suggest a more permanent kind of occupation than commonly portrayed in the literature? Is it fair to categorise Vlaardingen as something qualitatively different to Voorschoten and Leidschendam? This all serves to highlight issues with interpreting different levels of settlement permanency. What evidence would really discriminate repeated, short- term occupation of a site during one or two different seasons, from a year-round, permanent settlement?

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[1] Researchers do, however, acknowledge difficulties in interpreting Vlaardingen settlement functions, and disagreements and conflicting evidence, including three, possible houses at the site of Vlaardingen (Van Gijn and Bakker 2005, 297), can be found in the literature.

However, this discussion about Vlaardingen does not really bring us further with the question of the extreme difference between Leidschendam and Voorschoten. Of course, high levels of PDSM on the Leidschendam assemblage has caused big problems for microwear analysis and means these results may not be truly representative of the site. However, there are also some morphological traits which set these two groups of scrapers apart and may suggest there is still a significant difference underneath the issue of PDSM. Leidschendam scrapers are more steeply retouched and a greater extent of their circumference is retouched (on average 60% of the circumference, n=25) compared to Voorschoten scrapers (on average 46% of the circumference, n=11). If we subscribe to the idea put forward in the previous results section, that a scraper's lateral edges are left unretouched, because they will be within a haft, this might suggest there were actually more hafted scrapers at Voorschoten, and that at Leidschendam they were not hafting their scrapers as often. However, I think any interpretations involving the Leidschendam assemblage have to remain cautious, because of poor post-depositional preservation. In addition, I would very much like to see such morphological differences between hafted and non-hafted scrapers replicated in analysis of other Vlaardingen site assemblages, before putting this hypothesis forward more confidently.

Chapter Seven: Conclusion

Unfortunately, Rots' research was not able to support my interpretations to the extent that I had first hoped. This was mainly because of morphological differences between the assemblages we studied. Furthermore, it became clear that certain processes in the life of an archaeological scraper, such as resharpening episodes and/or post depositional surface modification, obscured the pattern of microwear traces which was more obvious on Rots' experimental tools.

Nevertheless, traces which could be interpreted as hafting traces were observed on some of these small scrapers! Microwear polishes suggesting at least two different haft materials, as well as some hafting-related edge damage and even spots of potential adhesive residues were recorded. This was enough to suggest at least 14 out 46 may have been hafted. For a few hafted scrapers, the pattern of microwear traces was sufficient enough to suggest some kind of male haft type, but, for many, it was not possible to make a more detailed interpretation of the hafting arrangement. Rots (2010) argued she could interpret the presence of distinct traces related to binding materials and could distinguish male from male-split hafts, but the microwear record of this assemblage did not allow such interpretations to be put forward.

Whilst dealing with an admittedly small sample size, there does not seem to be many obvious patterns associated with the presence of hafting traces. Apart from their morphological similarity to each other, in terms of less retouch on lateral edges, these hafted scrapers do not seem have been used in a particular motion, or on a specific worked material. Instead, they fit in to the general picture of people using scrapers whilst engaged in activities related to processing animal skins.

However, hafted scrapers are also evidence of the activity of retooling a haft, and as such they must be recognised as having a significant effect on our interpretations of the archaeological record at a site. Indeed, their relative abundance at some sites rather than others might contribute a further line of evidence to the debate about the nature of settlement at certain Vlaardingen sites.

Useful, further research would be to analyse other types of flint implements at the same three sites, and at other Vlaardingen sites in different environmental zones, to see if similar or different patterns between hafted and non-hafted implements appear. However, it might be prudent, first, to investigate more thoroughly the effects of retouch on the development of hafting wear. In other words, more experiments should be undertaken to better characterise the types of hafting traces that occur on heavily retouched stone tools, as this was not such a focus of Rots', otherwise very informative, research.

In terms of the assumption that small tools had to be hafted in order to be used, I now see this assumption as rather odd. Yes, some of these tiny scrapers were interpreted as hafted, but many were not, and I would argue that hafting traces are not so prevalent as to suggest that it was the default mode to haft small scrapers. Of course, there are many factors which prevent us from recognising hafting traces on such tiny, heavily retouched archaeological tools, but after spending months handling them, I argue some of them can be manipulated effectively in the hand.

To conclude, this has been a very useful piece of research, highlighting continuing challenges for microwear analysis, and proving that these stubborn, little scrapers do not give up their secrets easily!

Abstract

In this research, I wanted to personally test whether Rots (2010) extensive experimental research could aid my interpretation of hafting traces on a sample of artefacts from several Vlaardingen Group sites (Leidschendam, Voorschoten and Vlaardingen) (3400-2900 BC). This sample is particularly interesting to study, because it allows me to test the assumption that these small, flint scrapers must have been used hafted, because of their small size. Whilst testing a methodology against a seemingly common-sense assumption, the wider implications of hafting evidence for the interpretation of settlement function have not been forgotten.

Unfortunately, certain processes, common in the life of an archaeological scraper, such as post depositional surface modification (PDSM) and resharpening episodes, have obscured the patterns of microwear traces which were more obvious on Rots' experimental tools. My own experiments with replica hafted tools did, to some extent, elucidate the kinds of hafting traces that might occur on such tools, but for the scrapers from Leidschendam, PDSM often rendered the scrapers uninterpretable.

Nevertheless, traces which could be interpreted as hafting traces were observed on some of these small scrapers! Microwear polishes suggesting at least two different haft materials, as well as some hafting-related edge damage and even spots of potential adhesive residues were recorded. This suggested at least 14 out 46 may have been hafted. For a few scrapers, the pattern of microwear traces was even sufficient to suggest a more detailed interpretation of the hafting arrangement.

A couple of potential, hafting-related patterns emerged with differences in the incidence of hafting on different sites, and hafted scrapers having a subtly different morphology to non-hafted scrapers. The implications of these insights are then explored in the relation to the debate about the permanency of settlement at certain Vlaardingen sites. Although further hafting wear analysis of material from other Vlaardingen sites would also be useful in this discussion.

Ultimately, the methodology proposed by Rots is found to be less applicable to the material studied than I had hoped and extra challenges for interpreting heavily retouched, archaeological tools are outlined.

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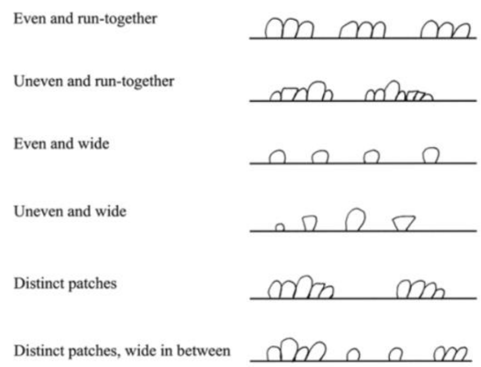
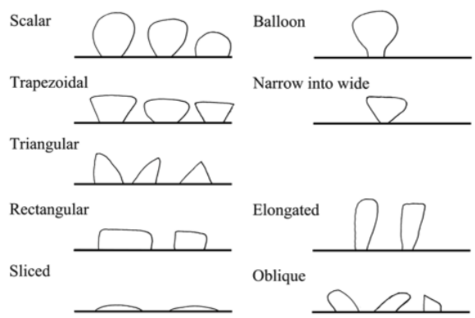
Appendices

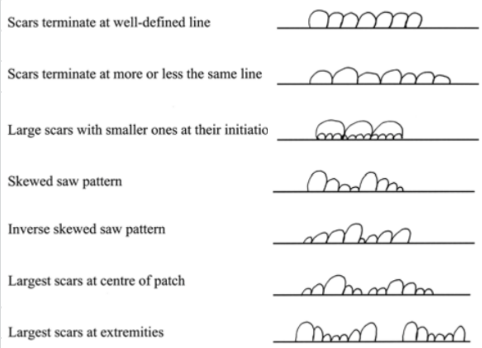
Appendix A

Sample edge damage recording sheet

			VOOR 21			
			V03	V04	V06	V08
	Distribution along edge					
0	One	0				
1	even and run together	1				
2	uneven and run together	2				
3	even and wide	3				
4	uneven and wide	4				
5	distinct patches	5				
6	patches with some in between	6				
7	continuous	7				
	Morphology					
1	scalar	1				
2	trapezoidal	2				
3	triangular	3				
4	rectangular	4				
5	sliced	5				
6	sliced scalar	6				
7	edge crushing	7				
8	balloon	8				
9	oblique	9				
10	Narrow into wide	10				
11	nibbling	11				
	Initiation					
1	wide	1				
2	narrow	2				
	Termination					
1	snap	1				
2	feather	2				
3	hinge	3				
4	step	4				
	Intrusiveness					
1	Intrusive	1				
2	Moderate	2				
3	Abrupt	3				
	Size					
1	small <0.5mm	1				
2	medium 0.5-1mm	2				
3	large 1-2mm	3				
4	v large >2mm	4				
	Pattern					
1	well defined termin line	1				
2	more or less same line	2				
3	large, with little overlapping	3				
4	skewed saw	4				
5	inverse skewed saw	5				
6	largest @ centre	6				
7	largest @ extremity	7				
8	only one	8				



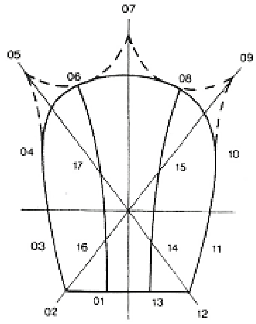




Appendix B

Use-wear recording sheet, supplied by the Material Culture Studies Laboratory at the University of Leiden

Use Wear Form Laboratory For Artefact Studies



Date ______________ **Individual nr** ______________

Analyst __________ **Site** ______________

Tool type ______________ **Contractor** ______________

Raw material **<u>Flint</u>** **Stone** **Bone** **Antler** **Shell** **Amber** **Jet** **Other**

Further specification ______________________________

coordinate					
extent					
sec mod					
edge angle					
degree wear					
HP material					
LP material					
motion					
residue					
macro wear					

Cleaning ______________________________

Photo/Video ______________________________

Appendix C

Distinctive traits per hafting arrangement (Rots 2010, 156)

Trace attribute	Juxtaposed hafting	Male split hafting	Male hafting	Leather wrapping
POLISH				
number of polishes	two: haft + bindings	two: haft + bindings	one: haft	one: bindings; sometimes two: prehension polish
polish frequency	haft = bindings	haft > bindings	only haft	only bindings (> prehension polish)
polish morphology	cf. usewear	cf. usewear	cf. usewear	cf. usewear
opposition	dorsal versus ventral	centre tool versus edges	no opposition	no opposition (only with butt: prehension polish)
concentration haft polish	ventral contact: most proximal & haft limit	dorsal medial ridge, bulb	dorsal ridges, medial edges, ventral butt	none
concentration binding polish	dorsal contact: dorsal ridges	edges	none	no real concentrations
SCARRING				
scar morphology				
* sliced	present	present	absent (exception: perforating, drilling)	present
* crushing	low	low	high	low
morphological detail				
* sliced into scalar scars	present	present	absent (exception: perforating, drilling)	present
scar initiation				
* straight into curved	present	present	absent (exception: perforating, drilling)	present
* curved	present	present	absent (exception: perforating, drilling)	present
* twisted	present	present	absent (exception: perforating, drilling)	present
scar termination				
* snap	present	present	tends towards "rare"	present
* feather	present	present	tends towards "rare"	present
* hinge	tends towards "rare"	tends towards "rare"	present	tends towards "rare"
* step	present	present	present	limited presence
* vertical	present	present	tends towards "rare"	present
* superposition	tends towards "rare"	tends towards "rare"	present	tends towards "rare"
scar size	not distinctive	not distinctive	not distinctive	not distinctive
scar depth	not distinctive	not distinctive	not distinctive	not distinctive
scar intrusiveness				
* intrusive scars	present	present	tends towards "rare"	present
scar definition	not distinctive	not distinctive	not distinctive	not distinctive
scar distribution				
* alternating	tends towards "rare"	rare	present	absent
* bifacial	absent	absent	present	absent
* continuous	rare	rare	present	rare
scar pattern				
* crushed initiations	rare	rare	present	rare
* (inverse) skewed saw pattern	present	present	absent	present
* clear intrusion / notch	rare	rare	present	rare
scar interpretability	moderate	moderate	high	high

Appendix D

Lab Name	Microscope Name	Eyepieces	Objective1	Objective2	Objective3	Objective4	Objective5	Camera	Type
Met A	Nikon Optiphot-2	10x	CF plan 5x DIC	CF plan 10x DIC	CF plan 20x DIC	CF plan 50x DIC	100x 0,80	Nikon DXM 1200 or Nikon D5100 (DSLR)	Metallographic
Met E	Leica DM1750	HC plan s 10x / 22m	Hi plan5x	N plan EPI 10x/ 0,25	Hi plan20x	-	-	Leica MC120HD	Metallographic
Stereo D	Nikon SMZ800		zoom range	0.75-6.3				Nikon DXM 1200 or Nikon D5100 (DSLR)	Stereo
Stereo E	Leica M80	10x / 23	zoom range	0.75-6.4				Leica MC120HD	Stereo

Further details of the microscopes used during the microwear analysis at the Material Culture Studies Laboratory at the University of Leiden.

Appendix E

Full Morphological and Microwear Results Tables

Legend:

C = cortex

NI= Non-interpretable due to post depositional surface modification (PDSM)

Other, rarer symbols, including ‘1’ or ‘*’, are explained in the comments column of the affected scraper

ID		Max Length (mm)	Max Width (mm)	Max Thickness (mm)	Weight (g)	Spine-Plane angle: medial left	Spine-Plane angle: medial right	Edge angle at 90°	Edge angle at 180°	Edge angle at 270°	Longitudinal curvature	Transversal curvature	Location of retouch	Position of retouch	Distribution of retouch	Delineation of retouch	Extent of retouch	Angle of retouch	Morphology of retouch	Length of retouch (mm)	Total circumference
LDAM	1	17	15	5	1.4	21-40	21-40	41-60	61-80	81-100	TWIST+ LIGHT-CURVE	TRAPEZOIDAL 1	060810	1	1	2	1	1	2	30	55
LDAM	2	21	20	6	2.6	21-40C	21-40C	-	-	61-80	CURVE	SEMI-CIRCLE	1011	1	2	2	1	3	2	18	70
LDAM	3	27	21	9	7.4	21-40	21-40	61-80	61-80	61-80	STRAIGHT	TRAPEZOIDAL	0103040608101113	1	2	2	2	1	2 (4)	80	80
LDAM	4	22	25	7	4.7	21-40	21-40	61-80	-	41-60	CURVE -BULB	SUB-TRIANGLE	030411	1	2	1,2	1	1	1	36	76
LDAM	5	22	15	8	2.9	41-60	21-40	81-100	81-100	61-80	TWIST	SUB-TRIANGLE	0103040608101113	1	2	2	1	2	2	59	59
LDAM	9	24	24	9	5.3	21-40	21-40	81-100	81-100	-	CURVE	TRIANGLE	03040608	1	2	2	1	2	2	41	78
LDAM	12	18	15	6	1.5	21-40	21-40	-	41-60	61-80*101-120	LIGHT-CURVE	TRIANGLE	06081011 (1011)	1(2)	2	2	1	1	1	36	58
LDAM	13	19	16	6	2.1	21-40	21-40	81-100	61-80	-	LIGHT-CURVE	TRAPEZOIDAL 1	03040608	2	2	1,2	1	1	2	31	61
LDAM	17	27	20	6	3.8	21-40	21-40	-	81-100	-	CURVE	TRIANGLE	060810	1	2	1	1	2	2	26	81
LDAM	21	27	26	11	10	41-60C	41-60C	-	81-100	61-80	CURVE -BULB	TRAPEZOIDAL 1	06081011	1	2	2	1	1	2	50	92
LDAM	22	26	22	11	6.3	41-60C	41-60C	-	81-100	61-80	TWIST+ LIGHT-CURVE	TRIANGLE	0610113	1	2	2	1	1	2	40	80
LDAM	24	26	22	10	6.8	21-40	21-40	61-80	61-80	81-100	STRAIGHT	SUB-TRIANGLE	0103040608101113	1	2	1,2	2	2	2	79	79
LDAM	25	14	11	4	7.0	0-20	21-40	61-80	61-80	61-80	STRAIGHT	TRAPEZOIDAL	030406081011	1	2	2	1	1	2	29	49
LDAM	26	25	22	12	7.1	41-60	21-40	81-100	81-100	81-100	CURVE	TRAPEZOIDAL	0103040608101113	1	2	2	1	2	2	79	79
LDAM	28	20	15	9	2.9	21-40	21-40	61-80	61-80	61-80	LIGHT-CURVE	TRIANGLE	0103040608101113	1	2	2	2	1	2	57	57
LDAM	40	23	20	9	3.9	21-40	21-40	-	61-80	-	TWIST	TRAPEZOIDAL	0608	1	2	2	1	2	2	23	69
LDAM	45	15	13	5	1.3	21-40	21-40	41-60	61-80	-	STRAIGHT	TRAPEZOIDAL 1	040608	1	2	2	1	1	2	22	49
LDAM	49	15	15	8	2.2	41-60	41-60	61-80	81-100	61-80	CURVE	TRIANGLE	0304060810	1	2	2	1	2	2	32	54
LDAM	51	18	17	8	3.1	41-60C	21-40	C	61-80	81-100	LIGHT-CURVE -BULB	SUB-TRIANGLE 1	06081011	1	2	2	1	2	2	32	58
LDAM	53	30	25	7	5.3	21-40	21-40	41-60	61-80	61-80	STRAIGHT	SUB-TRIANGLE	030406081011 (11)	1	3	2 (4)	1	3	1	56	91
LDAM	55	25	21	7	4.6	21-40	21-40	-	81-100	-	CURVE	SUB-TRIANGLE	0608	1	2	2	1	2	2	26	78
LDAM	57	14	19	7	1.9	21-40	21-40	-	61-80	-	CURVE -BULB	TRIANGLE	0608	1	2	2	2	3	1	29	53
LDAM	58	21	24	11	6.5	41-60C	21-40C	C	C	61-80	CURVE	SEMI-CIRCLE	0810	1	2	2	2	1	2	26	78
LDAM	59	24	15	8	3.1	21-40	21-40	-	61-80	-	STRAIGHT	TRAPEZOIDAL	0608	1	1	2	1	1	1	20	67
LDAM	60	26	22	9	6.6	41-60	21-40	61-80	61-80	61-80	LIGHT-CURVE	TRIANGLE	0103040608101113	1	2	2	1	1	2	82	82

ID		Use wear	Hafting wear	Additional comments
LDAM	1	Hide?		No dorsal ridges, but retouched edges create an overall tool morphology which is trapezoidal
LDAM	2	NI	NI	Semi-Circle because of cortex
LDAM	3	Hide dry		
LDAM	4	NI	NI	Longitudinal curvature is curved because of a large bulb of percussion
LDAM	5	Hide?		
LDAM	9	Semi-hard material	NI	
LDAM	12	Bone (use or haft?)	Unknown	
LDAM	13	Meat and bone?	Unknown	No dorsal ridges, but retouched edges create an overall tool morphology which is trapezoidal. Retouch on ventral face, so measurements taken with tool flipped onto the other side compared to other tools
LDAM	17	Hide	Hide wrapping + unknown	
LDAM	21	Meat and bone		No dorsal ridges, but retouched edges create an overall tool morphology which is trapezoidal
LDAM	22	Unknown	NI	
LDAM	24	Unknown	NI	
LDAM	25	NI	NI	
LDAM	26	Unknown	NI	
LDAM	28	Meat and bone?		
LDAM	40	NI	NI	
LDAM	45	NI	NI	No dorsal ridges, but retouched edges create an overall tool morphology which is trapezoidal
LDAM	49	Unknown		very crushed dorsal ridge
LDAM	51	Hide dry	NI	No dorsal ridges, but retouched edges and cortex create an overall tool morphology which is sub-triangle. Bulb of percussion influences longitudinal curvature
LDAM	53	Hide?		
LDAM	55	Unknown	NI	Extremely overhanging retouch
LDAM	57	NI	NI	
LDAM	58	Hide??		Semi-Circle because of cortex
LDAM	59	Hide	Semi-hard material, antler	
LDAM	60	NI	NI	

ID		Max Length (mm)	Max Width (mm)	Max Thickness (mm)	Weight (g)	Spine-Plane angle: medial left	Spine-Plane angle: medial right	Edge angle at 90°	Edge angle at 180°	Edge angle at 270°	Longitudinal curvature	Transversal curvature	Location of retouch	Position of retouch	Distribution of retouch	Delineation of retouch	Extent of retouch	Angle of retouch	Morphology of retouch	Length of retouch (mm)	Total circumference
VOOR	14	24	20	7	4	21-40	21-40	41-60*121-140	61-80	61-80	STRAIGHT	TRAPEZOIDAL 1	030406081011 (0304)	1 (2)	2	2	2	3	2	60	75
VOOR	16	21	18	5	2.3	21-40	21-40	-	81-100	-	CURVE	TRIANGLE	0608	1	2	2	1	2	2	12	60
VOOR	18	24	18	8	3.6	21-40	41-60	81-100	61-80	-	LIGHT-CURVE	TRIANGLE	040608	1	2	2	1	2	2	26	68
VOOR	19	20	18	6	3.1	21-40	21-40C	61-80*101-120	-	-	STRAIGHT	TRIANGLE	0304	2	2	2	1	1	1	22	64
VOOR	20	15	13	6	1.4	61-80	21-40	-	61-80	41-60	LIGHT-CURVE	TRIANGLE	0608	1	2	2	1	1	2	15	41
VOOR	21	21	22	5	2.3	0-20	0-20	-	61-80	61-80	LIGHT-CURVE	TRAPZOIDAL	060810	1	2	2	1	2	1	30	76
VOOR	31	18	18	5	1.9	21-40	0-20	61-80	41-60	-	LIGHT-CURVE	TRAPZOIDAL *	03040608	1	2	2	1	1	1	33	60
VOOR	32	20	23	12	6.6	41-60	41-60	61-80	61-80	61-80	LIGHT-CURVE	SUB-TRIANGLE	030406081011	1	2	2	2	1	2	56	74
VOOR	33	23	22	9	5.3	41-60	21-40C	-	61-80	-	STRAIGHT	SEMI-CIRCLE	0608	1	2	2	1	1	1	30	73
VOOR	35	13	18	8	2.5	21-40	41-60	-	61-80	61-80	STRAIGHT	TRAPEZOIDAL	0608	1	2	2	2	1	2	23	52

ID		Use wear	Hafting wear	Comments
VOOR	14	Hide	Semi-hard material	At 90° the retouch on ventral not dorsal face, so edge angle could be expressed as obtuse or acute. No dorsal ridges, but retouched edges create an overall tool morphology which is trapezoidal.
VOOR	16	Hide , Bone		
VOOR	18	Hide + something like salt	Semi-hard material	
VOOR	19	Hide dry		At 90° the retouch on ventral not dorsal face, so edge angle could be expressed as obtuse or acute.
VOOR	20	NI	NI	
VOOR	21	Hide fresh	Semi-hard material, wood	
VOOR	31	NI	NI	Trapezoidal, but very flat
VOOR	32	Unknown	NI	
VOOR	33	Hide	Unknown	Semi-Circle because of cortex
VOOR	35	Hide + something like straw, charcoal and mud	Semi-hard material	

ID		Max Length (mm)	Max Width (mm)	Max Thickness (mm)	Weight (g)	Spine-Plane angle: medial left	Spine-Plane angle: medial right	Edge angle at 90°	Edge angle at 180°	Edge angle at 270°	Longitudinal curvature	Transversal curvature	Location of retouch	Position of retouch	Distribution of retouch	Delineation of retouch	Extent of retouch	Angle of retouch	Morphology of retouch	Length of retouch (mm)	Total circumference
VLA	92	20	19	6	3	41-60	21-40	81-100	61-80	61-80	STRAIGHT	TRAPEZOIDAL 1	06081011	1	2	2	1	1	1	43	63
VLA	99	23	10	5	1.7	41-60	21-40	81-100	61-80	61-80	LIGHT-CURVE	TRIANGLE	0103040608101113 (0304)	1 (4)	2	1 (2)	1	2	1	51	61
VLA	108	20	17	7	2.9	41-60C	41-60	C	41-60	-	TWIST+LIGHT-CURVE	SUB-TRIANGLE	0113	1	2	2	2	3	1	19	63
VLA	142	15	20	6	1.7	21-40	21-40	41-60	61-80	-	CURVE	SUB-TRIANGLE	040608	1	2	2	1	1	1	33	60
VLA	156	20	26	8	4.7	21-40	41-60	21-40	61-80	41-60	CURVE	SUB-TRIANGLE	0608	1	2	2	2	1	2	27	84
VLA	189	20	26	9	5.2	21-40C	21-40	C	61-80	41-60	STRAIGHT	SUB-TRIANGLE	060810	1	2	2	1	1	2	31	77
VLA	213	13	16	5	1	21-40	21-40	-	61-80	-	TWIST	TRAPEZOIDAL	040608	1	2	2	1	1	1	24	50
VLA	240	21	27	8	5.4	21-40	21-40	61-80	41-60	61-80	TWIST	TRIANGLE*	04060810 (10)	1	2	2 (3)	2	3	2	45	76
VLA	1678	20	19	8	2.9	21-40	21-40C	-	61-80	-	CURVE	TRIANGLE	0608	1	2	2	1	2	2	27	66
VLA	1681	28	25	8	5.8	21-40	41-60	-	41-60	-	STRAIGHT	SUB-TRIANGLE	0608	1	2	2	3	3	1	38	86
VLA	1682	17	24	6	2.2	21-40	21-40	-	41-60	-	CURVE -BULB	TRIANGLE	060810	1	2	2	1	3	1	32	69

ID		Use wear	Hafting wear	Comments
VLA	92	Hide dry		No dorsal ridges, but retouched edges create an overall tool morphology which is trapezoidal
VLA	99	Unknown	Residue	
VLA	108	Hide dry		
VLA	142	Unknown	Semi-hard material, wood	
VLA	156	Hide		
VLA	189	Hide		
VLA	213	Hide?		
VLA	240	Hide dry		* main ridge is perpendicular to butt, running across rather than down tool
VLA	1678	Hide	Wood	A burnt, crushed ventral face - potlid
VLA	1681	Hide	Semi-hard material	
VLA	1682	Hide	Bone	

Appendix F

Edge Damage Results

V03 – ventral face 03 edge, D1011 – dorsal face along whole 10 and 11 edge

Distribution along edge/Morphology/Initiation/Termination/Intrusiveness/Size/Pattern

When separated by a comma, it indicates multiple answers in this category.

See also Appendix A for legend as to what the number mean.

VLA 213			VOOR14		
	V03	2,5/1,6/1/2/1/3/3		V06	0/4/1/4/3/1/8
	VO4	1,5/2/2/4/3/1/3		V11	4,5/2,10/2/2,4/1/1/6
	V10	2,5/1,5/2/2,4/3/1/7		D03	0,4/3,8,10/2/2,4/2/2/2
	V11	4/6/1/2/2/1/7		D04	2,5/2,3,11/2/4/3/1/3
	D1011	2,5/1,2,6/2/4/3/1/6	VOOR18		
	D03	2,7/1,2,5/1,2/4/3/2/3		V03	0/1/1/2/2/1/8
VOOR16				V04	1,5/1,5/1/2,4/1/3/2
	V03	0/3/1/4/1/2/8		V0608	0/2/2/4/3/1/8
	V04	2/1,5/1/2,4/2/2/2		V10	1,5/6,7/1/2/1/3/3
	V0608	0/2/2/4/3/1/8		V11	1,5/1,3,6,9/2/2/2/1/3,6
	V10	2,5/1,5/1/2,4/3/1/2		V0113	0/2/2/4/3/1/8
	V10 LOWER	2,7/11/1/2/3/1/2		D03	1,6/1,5,6,8/1/2,4/1/2/2
VOOR20				D10	4/1,8/2/2/3/1/2
	D16	4/1,2/2/2/3/1/2		D15	2,5/1,7,11/2/4/3/1/2
LDAM40			VOOR21		
	V04	2,5/1,2/2/4/3/1/6		V03	0/4,9/1/4/2/3/8
	D04	2,5/1,8/1,2/2/1/2/3,6		V11	0/2,9/2/4/2/3/8
	D03	1,5/1/2/2/2/1/1		D03	2/1,7/1/2,4/3/1/3
LDAM53				D06 LOWER	1,5/4,8/1/4/3/1/2
	V11	1/5/1/4/3/2/2	VOOR33		
	D11	4/1,5/2/4/3/1/2		V03	1,5/1/2/3,4/2/2/3
LDAM55				V04	4/1/2/2/3/1/2
	V06	1/1/1/2/1/2/1		V06	3/1,11/2/4/2/1/5
	V11	2,5/1,5/2/4/3/1/2,5		V10	2/1,5,6,9/1,2/2,4/1/4/3
	D11	4/1,6,10/1,2/2,4/2/1/2		V11	1/1/1/2/1/3/2
VLA142				D0304	2/2,4,7/1/4/1,2/3/3
	V08	1/1,3/1/2,4/1/2/7	VOOR35		
	D1011	2/1,6,10,11/2/2,4/1/2/2		V0608	4/2/2/2,3/2/1/2
VLA1678			LDAM12		
	V0304	0/1/2/2,4/1/3/8		V0304	2/1,11/2/2/2/1/3
VLA1681			LDAM13		
	V03	2,5/1/1/2,4/2/1/6		V10	4/1,11/2/2/1,3/1,3/3
	V04	1,5/1,2,8/2/2,4/2,3/1/1,7	LDAM17		
	V10	2,5/1/1/2/2/1/7		V03	1/5/1/4/3/1/5
	V11	0/2/1/4/3/1/8		V04	0/2,5/2/4/2/2/8
	D10	4/2/2/4/3/1/2		V06	0/2/2/4/2/1/8
	D11	4/1,3/2/4/2,3/1/4		V11	2/1,3/1/2,4/3/1/6
	D03	2,7/1,11/2/4/3/1/2		D04	2,5/1,2/1/4/2/1/5
VLA1682			LDAM59		
	V06	1/4/2/4/3/1/2		V11	1/11/2/4/3/1/2
	V11	2/1,5,11/2/4/3/1/2		D11	2/1,2,4/1/4/1/2/2
	D0304	2,6/1,2,11/2/4/3/1/2		D03	2/3/1/4/3/1/2