Sivs festskrift

Primitive tider

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Spesialutgave 2023

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Dear Siv,

Throughout the years you have inspired us all immensely, with your books, articles, talks in museums and beyond, and not least the many informal chats. You approach people like you approach the archaeological material, with curiosity and enthusiasm, seeing and supporting us at the different stages in our careers. You generously share your vast knowledge and keen insights. Combining a sharp eye with a kind and inviting attitude, you encourage people around you and make them aware of their strengths. With this book we hope to give something back to you as a token of our appreciation. Here is a collection of articles from researchers and museum staff you have encountered at different times in your career, and a Tabula reflecting your wide international network of colleagues and friends.

When sending out the invitation to a selected group to contribute with a paper to this collection, we made the order both specific and open, simply asking for ‘something you would like Siv to read!’ The invitation included texts to be peer reviewed, and more popularising, non-reviewed papers. The result is a mix of texts from scholars in various fields, including craft practitioners and designers. The outcome shows that the contributors have taken our request to heart, making this a personal book, with contributions both in English and all the Scandinavian languages on various “Siv-related” topics.

The book testifies to your huge impact, and how your thinking and publications have stimulated research in various fields. You will notice how the contributors have a secondary agenda, reminding you of all the research projects – big and small – and all the discussion and dialogue still ahead of you. We hope you will take these hints as subtle invitations towards further joint efforts and collaborations in the years to come.

The editors, Anja Mansrud, Ingunn Røstad, Unn Pedersen og Kristin Armstrong Oma,
on behalf of all of us

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Fagfellevurderte artikler:

Andre artikler:

Mesolithic cross-crafting

Experiments with the manufacture of bone blanks from elk metapodials

Anja Mansrud
Museum of Archaeology, University of Stavanger

Introduction

Manufacturing anatomical blanks and preforms makes up the initial operational step in the production of bone implements. During the middle Mesolithic period (8500-6300 BC) ungulate metapodials were sought after raw materials for making bone tools such as harpoons/leisters and straight, slotted and toothed points. Fragmented metapodials and bone debris identified as elk (*Alces alces)* and red deer (*Cervus elaphus*) have been identified in many faunal assemblages dated to this period (David 2017). The manufacture techniques and operational steps involved in blank production have previously been assessed by means of traceological analysis and experiments (David 1998; David and Johansen 1997; Treuillot 2019). These studies suggest that bone implements which look similar as finished tools were not fashioned in the same way. Different regional modes of production have been described for bone blank manufacture: in Southern Scandinavia, the "groove- and splinter technique" (D-method) was used, mainly on red deer metapodials, while in north-eastern Europe the "shaft-wedge-splinter technique" (Z-method) was employed using elk metapodials (David 2017, fig. 1). Since elk and red deer were both present in the fauna, raw material choice as well as the different modes of production, are presumed to reflect cultural and technological preferences (David 2017). These regional techno-complexes remained continuous for long timespans, further indicating that the middle Mesolithic communities maintained culturally prescribed traditions in their bone industries (David 2009, 2017; David and Kjällqvist 2017). The experimental work that made up the basis for interpreting the techniques and constructing the *chaîne opèratoire* (CO) for blank manufacture were however not performed using elk bones. Instead, smaller metapodials bones from goat (*Capra hircus*) and red deer were utilised (David and Johansen 1997; David 1998). Goat, red deer and elk metapodials differ greatly in terms of size, thickness and robusticity. This significantly affects the manner in which they may be worked and their usefulness for bone-tool production. For example, the average length of a goat metatarsal is 13 cm, while the metatarsal measures 26 and 38 cm for red deer and elk respectively (Badenhorst and Plug 2003: figure 43; Treuillot 2019:265). In terms of density, an elk metatarsus has an average of 1.58-2.06 g/cm^3 compared to 1.27 g/cm^3 for red deer (Treuillot 2019:265). Other factors such as the animal's age, sex and health may also influence the affordances of the bone and the subsequently the end results (Karr and Outram 2015).

The main objective of the experiments presented here, were to test the two different modes of production using elk metapodials (Figure 1-3) in order to obtain hands-on knowledge of the "groove-splinter" and the "shaft-wedge-splinter" techniques. The results further provide a framework for considering the interpretive value of practical experimentation, especially in relation to experiential archaeology and Mesolithic cross-craft interaction. The Mesolithic bone-technology remain severely understudied in Norway and so far, no experiments have been published which evaluate the know-how, or non-discursive knowledge, involved in bone tool-production in this region (Bergsvik and David 2015:210). The present study purposes to start addressing this knowledge gap. The use of experimental approaches remains limited in Norwegian Mesolithic research, and current studies are restricted to either lithic or osseous raw materials (for example Eigeland 2007, 2015; Damlien 2015; Mansrud and Kutschera 2020). Bone and stone technologies were, however, fundamentally entangled during this period — stone tools were used for making bone objects and bone retouching tools were involved in stone tool manufacture (Bergsvik and David 2015; David and Sørensen 2016; Gummesson *et al.* 2017). Transverse stone axes, commonly interpreted as woodworking tools, have also been shown as useful for making rock art through indirect percussion (Lødøen 2015). Furthermore, technological changes, such as increased use of grinding/abrasion for making bone and stone implements, and use of indirect knapping technique occurs across technologies (Bergsvik and David 2015; Lødøen 2015). The aim of cross-craft analysis is to consider these entangled technologies and address connections and similarities in the production of contemporary forms of material culture (Elliott 2019).

Experimental and experiential archaeology: methodology and interpretive challenges

Following Outram (2008:2) the term *actualistic experiment* is employed to describe our approach. The term is coined to denote practical field experiments, which purposes to recreate hypothetical scenarios of past tool-making practices by testing methods and materials identified in the archaeological record. The end goal is not to make a copy of an artefact but to reconstruct the principles or processes underlying the technical procedures (Outram 2008; Nami 2010:110; Lin *et al.* 2018: 668). By employing raw-materials, tools and techniques which would have been available to the Mesolithic crafters, the insights gained will further be used as analogies for interpreting the past practices (cf. O'Neill and O'Sullivan 2019:26; Mathieu 2002). In Mesolithic archaeology, experimental methodologies make up the basis for studying microscopic traces on the surfaces on bone and stone tools, to enable interpretations about how the implements were used or produced (David 2007; Bamforth 2010; Little *et al*. 2017). Traceological microwear studies, like functional analysis and use wear analysis, permit interpretations of the tools and techniques involved in artefact manufacture and help distinguishing tools from debris. In combination with spatial analysis, such methods have proven important for exploring Mesolithic site activity and differentiate between working spaces and toss zones, for example (Gummeson 2016; Bates *et. al.* 2022). Such methods however require well-preserved debitage and objects. Osseous materials are particularly sensitive to preservation biases, and bone and antler artefacts and debitage are not necessarily preserved or even discernible in the archaeological record. Most middle Mesolithic bone assemblages in south Norway are made up of fragmented, burnt and/or heavily weathered bones (Matland 1999; Mansrud and Persson 2017). This impedes species identification, makes the utilization of osseous raw-materials difficult to assess, and leaves us with tools and bone debitage that is often ill-suited for traceological analysis. Even when bone tools are in good condition, the final operational steps of the tool-production, such as the grinding and polishing of the surfaces of the bone tools, removes traces of techniques applied at earlier stages. Intensive use of abrasive techniques, as previously identified in Middle Mesolithic assemblages, reduces bones to powder, and leaves little debitage to be studied (Bergsvik and David 2015: 3-4). Practical experimentation is helpful for identifying possible steps in production sequences which cannot be identified archaeologically and connect bone debitage to particular techniques (Chaudesaigues-Clausen 2018; Mansrud 2017). Conducting tests allows us to target gaps in the production sequences to generate new data and refine our understanding (Hurcombe 2014). Actualistic experimentation may thus be considered a form of inductive method, continually generating new questions rather than providing definitive answers. Every singular experiment increases experience, generate reflection, and may add to our understanding of Mesolithic technologies and crafting activities. Small steps are taken towards broader understandings while we work back and forth between archaeological remains and experimentally reproduced tools and debris, and through practical tests we can identify and explore solutions to various technological and material challenges. Following the terminology used in cross-craft interaction-studies, the term craft is used to denote the production of material culture (Brysbaert 2014).

Since past techniques can only be comprehended through present observations, a general understanding of a technology can be gained through replicating past activities and behaviours. Manufacturing bone implements ‘the Mesolithic way’ require equipment, practical understanding, and experience, which most archaeologists lack. Access to a variety of lithic raw materials, as well as knowledge and ability to replicate tools such as blades and grinding tools that were used for working the bones is needed. Exploration of Mesolithic cross-crafting therefore require collaboration between archaeologists and experienced practitioners (cf. Outram 2008, Kristoffersen and Stoltz forthcoming). A proficient crafter is uniquely equipped to evaluate the degree of difficulty and know-how involved in mastering the different techniques. Years of practical training and experience permits qualified insights of the qualities of the materials, and ability to notice manufacture details that would often go unnoticed by a regularly trained archaeologist, such as assessing whether the maker of a point was right- or left-handed (cf. Hill 1971). Rendering the tacit, practical experience into text, and “translating” the embodied knowledge into scientifically accepted concepts and interpretations, however, also presents a challenge, where the practitioner can benefit from the academic. Using an experimental approach as analogy for interpreting past technologies and craftwork creates epistemological pitfalls, which need to be considered critically (Reynolds 1999; Dobres and Robb 2005; Dobres 2006). Tacit knowledge based on acquired experience makes us inclined to apply our individual, embodied experience as the primary analogy for making sense of the past practice (Dobres 2000). We should, however, always be cautious about using personally acquired understandings as direct analogies for making inferences about the wider implications of Mesolithic crafting activities. Past technological procedures involved materials, ecological knowledge and social variables that are impossible to repeat in the present (Nami 2010:110). Social and ideological notions, as well as cultural predilections with regards to aesthetics and the role of tradition, may also underpin a technology (Klepp 1984; Roe 1995). For example, technological studies in anthropology and ethnology shows that traditional crafters are often consenting to cultural traditions in style and technical procedures, while individual creativity is restrained (Roe 1995; Stout 2002).

Practical field experiments involve subjectivity, and often, some degree of improvisation. They can therefore be difficult to replicate and have been critiqued as being unscientific (Reynolds 1999). Current development in the discipline have however begun to acknowledge and value the subjective, sensorial and experiential understandings acquired from material engagement through experimental work (Bell 2014; Kuijpers 2018; Molloy 2019; Little *et*

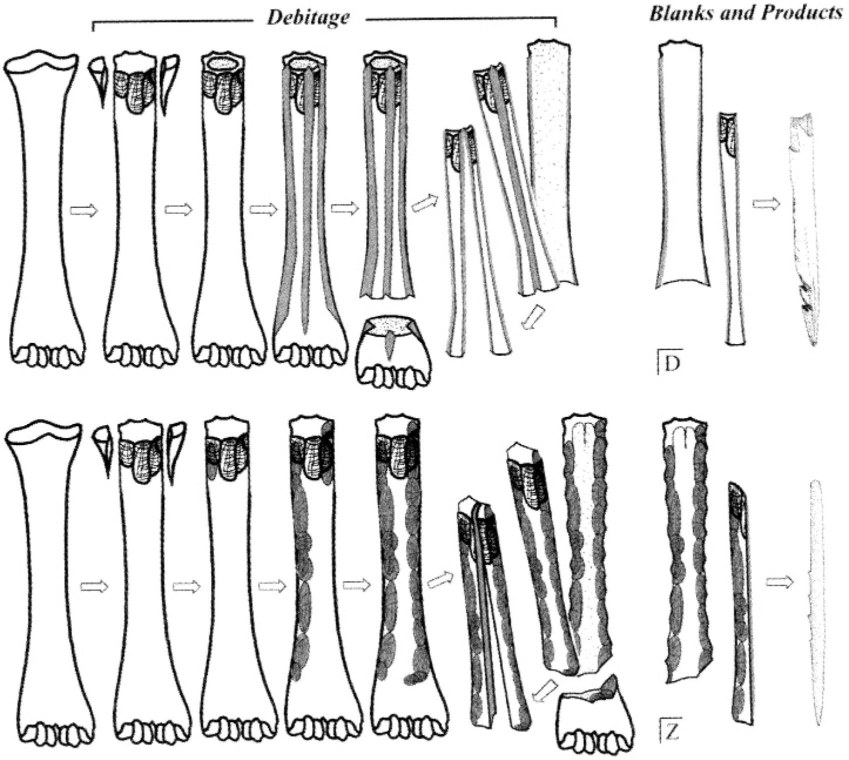

Figure 1. Two different modes of production suggested for manufacturing bone blanks from ungulate metapodials. The blanks can be further worked into different tools (after Bergsvik and David 2015. Reprinted with permission from the authors).

al. 2023). Importantly, hands on field experimentation allows insights into the *embodied human action* carried out by the crafters making the material culture (cf. Dobres 2010; van Gijn 2010). Experiments and experiential achievements are therefore important to document and report.

The experiments: Manufacturing blanks from elk metapodials

Based on well-preserved archaeological assemblages from Denmark, Russia and the Baltic countries, several modes of production for turning metapodial bones into blanks and tools have been proposed (David 1998, 2004; David and Johansen 1997). As a point of departure for our field experiments, we used the descriptions and illustrations reported in the literature (Figure 1). The practical experiments were performed by Morten Kutschera, an archaeologist with more than 30 years of experience with Mesolithic stone and bone tool manufacture. Kutschera is a skilled knapper, capable of performing indirect, pressure and handheld microblade knapping techniques. Elk metapodials were acquired, and blades and grinding implements associated with Middle Mesolithic technologies (Sørensen *et al.* 2013) were reproduced by Kutschera and used for working the bones. The experimental work was documented by photo and video[1].

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[1] Practical experimentation work can be difficult to illustrate in a way that makes the whole process understandable to the reader, and this special issue has a limit to the number of illustrations. Videos including these experiments can be assessed at YouTube https://www.youtube.com/watch?v=Mp1jfYCsLU0&t=18s

As shown on Figure 1, the hypothetical *chaîne opèratoire*s for bone blank production can be divided into three steps: **Step 1**. First, the articular ends must be removed, to obtain a regular tubular cylinder, whilst preserving the total length of the bone (this is termed the "calibration stage"). For both the D-and Z-method, this is done by means of indirect percussion. The articular surface serves as a knapping platform, as a flint flake is placed at a 45-degree angle and struck with a heavy hammer. Another technique described is termed "inverted percussion", identified microscopically by longitudinal and parallel divergent striations visible around the proximal surface. These markings are interpreted as resulting from knapping or scraping by means of a transverse stone axe (David 1998: 40-42). **Step 2**. During the second step the metapodial is divided in two. At this stage the two methods fundamentally diverge. The groove- and splinter technique (D-method, Figure 1 upper, Figure 2a, b) implies dividing the tubular metapodial bone by grooving following the natural longitudinal depression on the diaphysis (*sulkus dorsalis*). For the shaft-wedge-splinter technique **(**Z-method Figure 1 lower) the bone is divided by means of indirect percussion using a wedge (Figure 2b). **Step 3**. The last step comprises cleaning out the marrow from the rough outs, removing excess bone on the ventral side of the metapodials, flattening the bone tube, and finalising the anatomical blank. The blank can subsequently be divided by grooving and flexion breaks, and can be further worked into various bone tools such as slotted points, straight or toothed points, harpoons/leisters, or even fishhooks. According to David (1998:44-45) both methods are easy and quick to perform (a matter of minutes) but the Z-method requires a lot of polishing work and longitudinal scraping on the bone edges to flatten the cortical crests produced by the knapping. In addition, a **Step 0** can be added: before **Stage 1** can commence, the metapodial must be cut loose from the carcass and skinned (Figure 3a). This procedure entails removal of the sinews, which are useful for a variety of tasks and important materials in a cross-craft perspective. So, how do these two modes of production flow in the hands of a skilled craftsperson, by means of Mesolithic toolkits?

Test 1. The Z-method, elk calf metacarpal

Step 1. In the first try-out, a metacarpal from a sub-adult elk was utilised. The bones had been frozen soon after butchering and appeared as fresh after thawing. As noted, bones of younger animals differ from those of adults, particularly in terms of the density and how the bones fracture and split. In this young specimen, the distal articular end was not fused to the bone shaft and fell off after the bones were skinned. Performing **step** 1 ("calibration") was therefore not necessary, and Kutschera could immediately proceed to remove the proximal end by means of indirect percussion (Figure 2a). He placed the metacarpal between his feet. A flint wedge was selected from a debitage pile, and placed carefully to prepare for the blow, before being struck with a wooden club. This gave a precise

Test 1. The Z-method, the shaft-wedge-splinter technique. 11.05.2018	
Bone material	Metacarpal from elk-calf, with loose epiphysis, measuring 22 cm. The bones, acquired by Jostein Gundersen during seasonal elk hunting in Norway fall 2017, had been frozen for six months.
Stone material	2 flint flakes used as wedge in stage 1 (slightly hinged, 6, 4x3, 3 and 5, 9x3, 3 cm, broke during test). Two flint wedges (6, 7x5, 6 and 3, 6x3, 1 cm) used in stage 2, hard hammer stone (not measured). Grinding slab.
Other material:	Wooden hammer, wooden stump for support (documented on images)
Techniques tested	**1.** Removal of bone flakes struck with wooden club and a large wedge. **2.** Removal of bone flakes struck with hard hammer. **3**. Removal of bone flakes by placing the bone on top of wedge and give the blow to the bone rather than the wedge
Time used	3 hours
Participants	Morten Kutschera, Anja Mansrud

Table 1. Materials and data involved in experimental test 1.

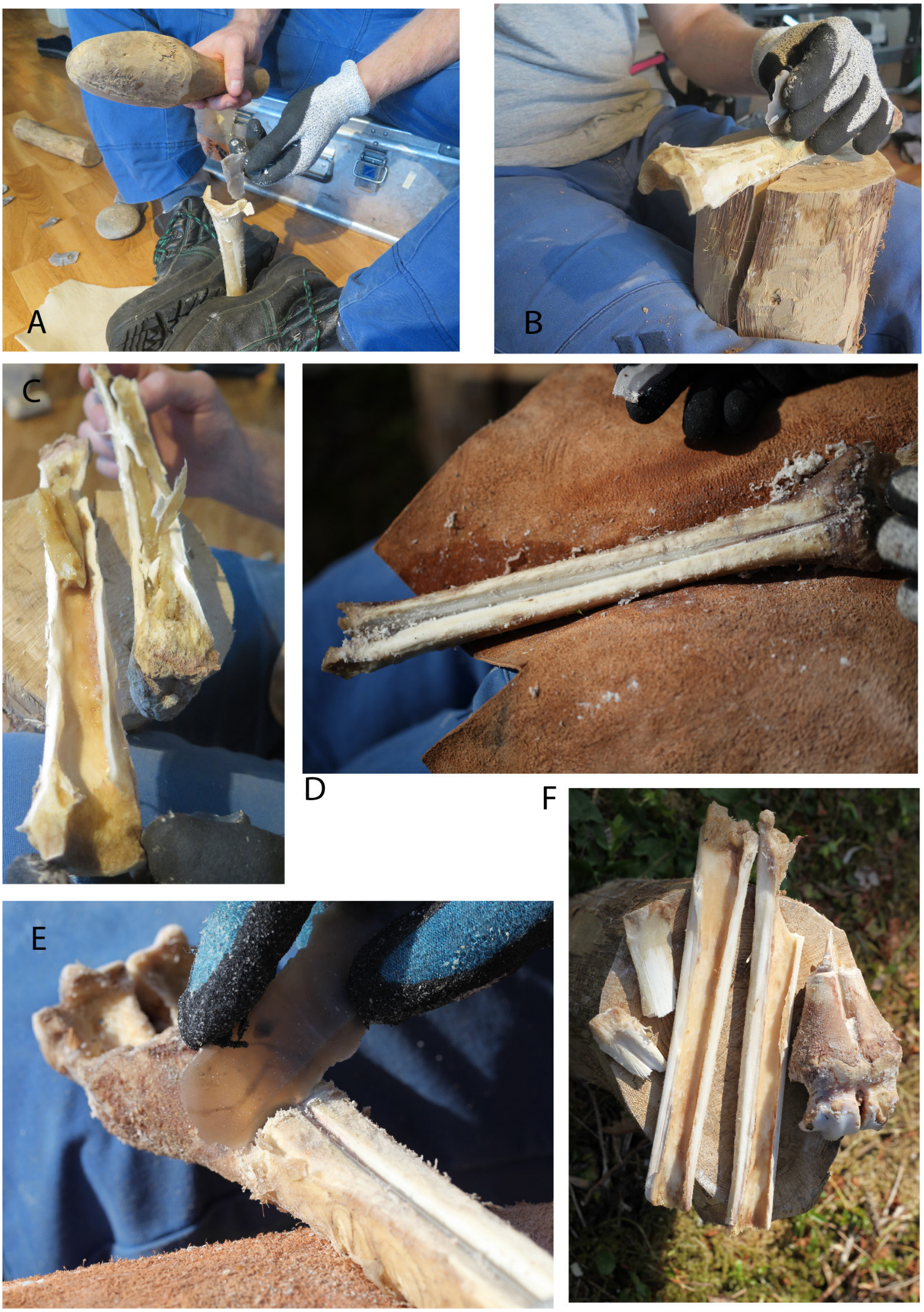

Figure 2. Experimenting with the manufacture of bone blanks using a sub-adult elk metapodial. A. "Calibrating" elk metacarpal using flint wedge and bone club, B. Attempts at shaft-wedge-splinter technique, C. Metatarsal divided by the shaft-wedge-splinter technique, D. Groove end splinter technique used for dividing elk metatarsal, E. Transversal sawing with a flint blade to remove the articular end. F. Divided metatarsal (fragmented in the proximal part when split) and distal articular end after sawing (Photos: Anja Mansrud/University of Stavanger).

blow that directed force in a controlled amount and direction. The bone matrix of the elk calf was soft, and the bone pieces easily came off. Kutschera then proceeded to **step 2**. According to the literature, the proximal end of the bone should be knapped with a flint flake positioned perpendicularly on one side of the bone, starting on one of the preceding negatives. From the initial percussion a longitudinal split will appear, and the bone is knapped along the split, until the opposite epiphysis is reached (David 1998:45). It was, however, difficult to comprehend and copy the technique based on the descriptions and the illustrations provided. Kutschera attempted first to employ indirect percussion, using a flint wedge and the wooden club. He placed the bone on his lap, but they were long, slippery, and difficult to place and keep steady. A wooden stump was therefore brought in and used for support (Figure 2b). Two different flint wedges were used. The first wedge was light and small and was used to make small inserts along the natural groove of the bone. The thin wedge however caused damage to the wooden hammer, and Kutschera therefore switched to a hard hammer. This eventually broke the wedge, and a larger more robust flint wedge was employed. Several techniques and tools were subsequently applied to split the metapodial. Kutschera attempted to knap by indirect percussion sideways and by inverted percussion; placing the metapodial on top of the wedge and strike the bone instead of the flint wedge. He finally settled for a hinged blade as the optimal wedge for knapping along the groove, and the final splitting was done with a larger flint wedge. Eventually the metacarpal split (Figure 2c). Accomplishing steps 1-2 took 3.5 hours. In terms of experiential cross-craft awareness gained through this work, the size and shape of the wedge is important for the result. The wedge needs to have a certain size to be strikable by the hammer. Using flint as a wedge quickly turns it into something that looks a lot like a bipolar core with crush marks in both ends. We therefore came to speculate on whether the numerous flint implements catalogued as bipolar cores sites rather reflects bone working. The hard hammer stone utilised also resembles a hammer often associated with bipolar lithic reduction. Flint was used in this test for practical reasons, but other stone tools, for example a chisel, could also probably have worked. This remains to be tested. The shaft-wedge-splinter technique produces bone flakes and negative scars from the knapping that are visible on the internal edges of the metapodials found at archaeological sites. Some of the bone flakes acquire a "bulb of percussion" which have been interpreted as evidence of the use of indirect percussion on bone (David 1996: 45). These have been used for identifying the technique at Mesolithic sites (Bergsvik and David 2015). Kutschera was, however, able to accomplish similar bone flakes by means of direct percussion.

Step 3 involves the removal of excess bone and flattening the metapodials into pre-forms. It has been suggested that the **Z-method** involved the use of grinding slabs and smaller grinding tools for this operation (David and Bergsvik 2015). To test this, we employed a large sandstone grinding slab. Water and crushed flint were used for speeding up the grinding process. Flattening the elk calf metapodial took about one hour, resulting in an oval quadratic bone piece with a smooth, but slightly U-shaped ventral side.

Test 2. The D-method, elk-calf metatarsal

In the second test we attempted to test the **D-method**, using the groove- and splinter technique. A metatarsal from the same sub-adult elk was used. The metatarsal (hind limb) is longer than the metacarpal. For **step 1** the proximal end was calibrated in the same way described for Test 1. Kutschera initially used a large flint flake, but the edge was too broad. He therefore modified the flake and made it narrower. As noted in the first test, in order to efficiently remove the bone flakes from the articular end without cracking it, each blow must be carefully prepared. Placing the bone vertically on a wooden stump was an effective way to carry out this operation and made the handling of the bones easier. Such a

Test 2. The D-method (groove and splinter technique). 12.05.2018	
Bone material	Metatarsal from elk-calf, with loose epiphysis, measuring 27 cm. Same individual as in test 1.
Stone material	Flint blades/bladelets produced by indirect percussion, two flint flakes used as wedges (7, 4x5, 5 and 6, 1x3, 3 cm). Flint flake used as wedge for removing excess bone on the inside (7, 3x3, 5 cm). 7 blades, 13 bladelets/microblades used for making the groove and scrape/whittle the bone into a flat blank.
Other material:	Wooden club, wooden stump (documented on photo)
Techniques tested	Calibrating the proximal articular end, removal of distal articular end by sawing, grooving along *sulkus dorsalis,* splinter by wedge.
Time used	45 minutes
Participants	Morten Kutschera, Anja Mansrud

Table 2. Materials and data involved in experimental test 2.

method could also have been used by Mesolithic crafters, but this is something that we will never be able to ascertain. The distal articular end of the metatarsal was then removed by transversal sawing around the circumference of the bone using flint blades (Figure 2e). The articular end was removed by a flexion break using a hammer. **Step 2:** To split the bone, a deep groove was made on each side of the metatarsal, following the natural groove (Figure 2d). A bladelet, made by Kutschera with indirect percussion and a soft antler hammer, was utilized for this. The bone was soaked at regular intervals during the grooving. This procedure was relatively quick and easy compared to the splinter-by wedge procedure. Subsequently, when the flint has almost broken through the diaphysis wall, a flint wedge was used for making a controlled split. **Step 3** flattening the rough outs, was done by scraping/whittling with flint blades. The bone matrix on this sub-adult elk was soft and easily whittled, but the scraping consumed a large number of blades/bladelets (20, see Table 2), because the flint quickly became blunt. Kutschera was well familiar with the groove and splinter technique. Removing the articular end and splitting the metapodial by grooving was a procedure he has regularly employed. Finalizing the blank took about 45 minutes.

Test 3. Experiments with elk metatarsal, fully grown elk

In test 3, an attempt was made to make blanks using metatarsals from fully grown elks. This experiment involved quite a bit of improvisation, as things quickly started to go wrong. The bones had been kept in a freezer for years and had thawed and re-frozen several times. The metapodial measured c. 50 cm in length and was incredibly massive and compact. Even skinning it turned out to be quite challenging, requiring strength and an experienced, steady hand (Figure 3a). On commencing **step 1** Kutschera was not able "calibrate" the proximal articular end by means of indirect percussion. The cartilage and the periosteum surrounding the bone matrix was thick and impenetrable with the copies of Mesolithic tools that Kutschera had made for the occasion (Figure 3b). Kutschera proceeded instead to remove the articular end by sawing with a blade (Figure 3c). **Step 2** was also done using the groove- and splinter technique. The diameter of the bone matrix was massive, approximately 1 cm thick, and penetrating the matrix using a blade took several hours. Step 1 and 2 consumed a large number of blades, because the flint quickly became blunt. In total, 10 large blades were used. **Step 3.** After splitting the bones, massive amounts of excess bone on the ventral sides had to be removed (Figure 3d-f). Kutschera attempted various techniques to remove the bone. First, whittling/scraping was tried. He then proceeded to attempt indirect percussion. Attempts at removing excess bone were made with several different types of wedges: a flint wedge (Figure 3f), a bone wedge, and a copy of a grinded stone axe. Turning this metatarsal into a blank by means of Mesolithic tools and techniques was however a near-impossible task. Realizing at this point that we would not have

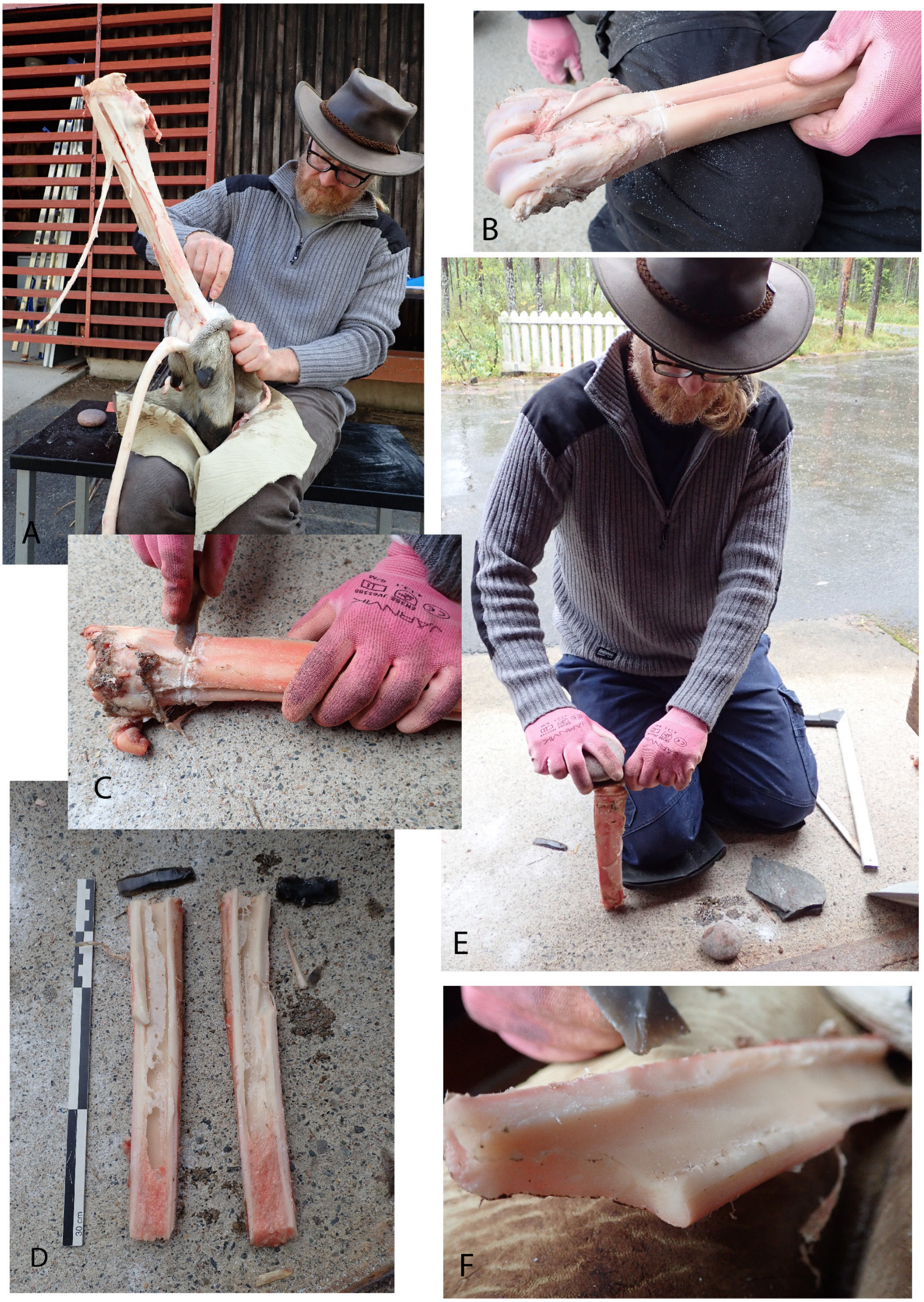

Figure 3. Experimenting with the manufacture of bone blanks using fully grown elk metapodials. A. Morten Kutschera skinning an elk metatarsal using flint blades. B/C. Transversal sawing to remove the articular end, D. Dividing the metapodial with groove and splinter technique and controlled splitting by means of a flint wedge, E. Divided metapodial and flint wedge used for splitting. F. Removing excess bone on the inside of the metatarsal using indirect percussion and flint wedge (Photos: Anja Mansrud/University of Stavanger).

Test 3. Attempts at the D- and Z-method, 19.08.2018	
Bone material	Metatarsal from fully grown elk, acquired at the Kierriki Stone Age center, measuring 50 cm. in length. Frozen for several years, probably frozen and thawed several times.
Stone material	10 large blades made by indirect percussion used in step 2 (two used as wedges for splitting, broke during use), 8 large blades used scraping (totally worn out), whittling, grinded stone axe used as wedge
Other material:	Wooden hammer, wooden stump, bone wedge, modern saw
Time used	Approximately 5 hours. Attempts at timing each sequence of the work hampered by difficulties arising
Participants	Morten Kutschera, Anja Mansrud, Solveig C. Clausen and Mikkel Nørtoft

Table 3. Materials and data involved in experimental test 3.

time to complete the other, primary experiments planned for the four-day workshop, we decided to abort the task. Eventually, Kutschera used a modern saw to be able to finalize the blank. Making it into a reasonable flat blank took about five hours (Table 3).

Employing the shaft-wedge-splinter technique on massive elk metapodials was thus not achievable by Kutschera on the initial attempt. By using the groove-and splinter technique it was possible to divide the metatarsal, but this operation and the subsequent task of removing the massive amounts of excess bone took a lot of effort and muscular strength. Presumably, the metapodials were not held and knapped between the legs as demonstrated with the goat bones pictured in David and Johnsen (1997). We therefore suspect that this operational step was accomplished differently by the Mesolithic crafters. Suggestively, some kind of mechanical device like a vice could have been constructed for securing and fastening the long and heavy elk bones. This would have allowed more freedom to use both hands and body weight and perform the indirect knapping technique in a more efficient way. Considering the thickness and robusticity of the distal articular end of an elk metatarsal, the method of nicking it off with an adze, as formerly suggested (David 2007, 2009) neither seem conceivable. In terms of cross-crafting, we may speculate that middle Mesolithic transverse axes with a hollow edge, made from local rocks like diabase (Eymundsson *et al.* 2017), were somehow utilized as wedges. We did however not have access to raw materials or capability to manufacture such an axe for experimental purposes over the course of the weekend that this experiment was undertaken. Further testing is certainly needed to achieve more experiential insight into how the grown elk metapodials were calibrated and divided into anatomical blanks.

Experiential learning, cross-craft interaction and skill: preliminary results and discussion

In terms of cross-crafting, an interesting observation throughout was that grooving, scraping and whittling of bone consumes large amounts of flint. Earlier experiments indicate that flint has preferable qualities to quartz and other silica for working bone. Flint seems to have been the preferred material for this activity, even at sites in regions where flint was not locally available (Gummesson *et al.* 2017:151). In south-eastern and south-western Norway flint was consistently acquired and used by middle Mesolithic groups – perhaps not merely because this material is “good to knap” (Eigeland 2015), but because it was invaluable for modifying bones and creating significant hunting and fishing equipment. Yet, as shown, the blade edges quickly become blunt and worn out. Using large blades thus seem rather extravagant, and if flint was a scarce resource, using large blades for bone work is not a good economic strategy. This would not be an issue for middle Mesolithic groups in regions where flint was abundant but could have impacted regions where access to flint was restricted. Microblades and bladelets are commonly retrieved from middle Mesolithic sites in Norway (Solheim 2013; Redmond and Eilertsen 2020) and it has previously been demonstrated that these artefacts are excellent tools for manufacturing Middle Mesolithic implements like slotted bone points (Sjöström and Nilsson 2009). During earlier experiments, we noted that small, unhafted bladelets and microblades actually functioned better than larger blades for grooving bones and crafting small bone tools like fishhooks. A new sharp working edge can repeatedly be created by snapping of the exhausted end (Mansrud and Kutschera 2020). In a wider perspective, these experientials insight might contribute to explaining why microblade-production, in combination with shaft-wedge-splinter and grinding techniques, became widespread and persistent technologies in Southern Norway during the 8th millennium BC (Bergsvik and David 2015).

Another artefact in question is the bipolar core – an artefact commonly reported in middle and late Mesolithic lithic assemblages in Southern Norway (Bjerck 2008; Reitan 2016). The bipolar technique has been interpreted as a local adaptation to flint scarcity (Jaksland 2001) and a way of maximizing the amounts of flakes/blades that can be knapped from a core. As shown here, the morphology of a 'bipolar core' may also be the outcome of flakes used as wedges. With regards to cross-crafing, 'bipolar cores' can be also used as wedges in indirect pecking techniques, employed for making transverse stone axes (Kutschera per. comm). This could imply that exhausted conical cores were re-used as wedges in the final stage in their life cycle. An obvious methodological weakness of the present work is the lack of traceological analysis on archaeological artefacts and debitage. So far, only a handful of lithic use-wear studies have been undertaken, suggesting that bladelets, microblades and microliths (insets) retrieved from other middle Mesolithic sites were used for a wide range of tasks, including bone modification (Jaksland 2001; Knutsson and Knutsson 2011, 2013). In future research, the interpretations related to cross-crafting suggested above should be more systematically tested and verified by functional and use-wear analysis.

Evaluating the level of skills and know-how required for a method is often deemed important in technological craft studies. During the middle Mesolithic in Southern Norway indirect percussion and pressure blade/handle core techniques are characteristic. These techniques are assumed to indicate craft specialisation, since they require specific knowledge about gestures, tools, and knapping methods, in addition to know-how which can only be acquired through repeated practice (Eigeland 2015:381; Damlien 2016:88). Bergsvik and David (2015:210) maintains that the skills required for manufacturing bone tools were not specialised and probably maintained and transferred among local groups in a direct vertical (parent–child) relationship where a tutor guided the beginner towards the necessary level of knowledge. They further note that the particular techniques used in middle Mesolithic bone-modification in Norway; shaft-wedge-splinter, drilling techniques and grinding requires specific skills or equipment which is directly related and transferrable to the way lithics were worked (Bergsvik and David 2015:212). Lithic experiments have identified characteristic mistakes made by beginners, which can be used as proxies for interpreting the presence of novices/apprentices at archaeological sites (Finlay 2015; Högberg 2018). Identifying proxies revealing skill and know-how of bone tool manufacture is less explored. Neither of the proposed manufacture methods for making the bone blanks were quick and simple to accomplish, as previously suggested (David 1998:44) even for an experienced crafter like Kutschera. As demonstrated throughout these tests, some parts of the manufacture process require strength and well-developed knapping skills, while other steps in the blank production are simpler to accomplish. Modifying elk bones with flint bladelets, wooden clubs and grinding tools was strenuous, time-consuming and took a lot of muscular strength. Both modes of production (the D-method and the Z-method) were feasible when metapodials from subadult elks with shorter and less robust bones were utilised, while making blanks from fully grown, massive elk bones by means of Mesolithic tools and techniques was barely achievable on this initial attempt. In the first attempt at performing the shaft-wedge-splinter technique, Kutschera was unfamiliar with the technique. He thus perceived it to be an irrational and needlessly time-consuming way to proceed. This illustrates the challenge associated with altering a technique with which you have become familiar and embodied. On the second attempt, experience had been gained and the process went much faster. In terms of skills needed; grinding, scraping and whittling is not difficult per se. These tasks can be undertaken by anyone with reasonable strength and patience. Handling fully grown elk metapodials, and in particular the large metatarsals, however, requires a certain strength and hand size that would be beyond the capabilities of a young child. The collective and communal efforts involved in tool production have often been disregarded in archaeological studies of Mesolithic craft (Finlay 2003). Bone manufacture in general may not have been a specialist task as such, but rather a joint activity, undertaken by various members of a community crafting together (cf. Glørstad 2010).

Making blanks from elk metapodials takes time, independently of skill, strength, and know-how, because removing excess bone and turning them into usable pre-forms take hours of work through scraping/whittling or grinding. This is work which feels tiresome to an untrained person, and time-consuming when you only have a weekend to finish the experiments. Admittedly, these assessments clearly remain subjective and our guesstimate of what counts as a time-consuming, challenging, or mundane task is hardly a relevant analogue for understanding how Mesolithic individuals perceived or valued time spent on a task, or whether they conceived it as difficult or not. When taught and trained techniques would have been embodied and tacit knowledge for a Mesolithic craftsperson. Whether actualistic experimentation provide credible information of past skills can thus be questioned, yet the experiential knowledge gained contributes more to advance our understandings of Mesolithic craftwork than assessments made solely on morphological classification and artefact typology.

Conclusion and future prospects

The aims of the present work were to test and reproduce the operational steps involved in bone blank manufacture by means of prehistoric toolkits, explore the cross-craft interaction involved, and assess whether the level of skill and know-how needed could provide additional insight into Mesolithic craftmanship. Even though some of the attempts turned out to be unsuccessful, the experimentation generated many questions and provided useful experiential insights with regards to the material properties and affordances of different animal bones and the lithic tools employed (see also Mansrud and Kutschera 2020). Through collaboration with Kutschera, it has been possible to explore links across stone- and bone crafting, which for a long time have been noted by Mesolithic scholars, but never before tested in practice. During the three experimental sessions discussed here, we have learnt that producing blanks by means of wedge-splinter technique is strenuous and challenging, even for an experienced practitioner. We further raised doubts that the initial steps in modifying metapodials from adult elks were followed in the way that has previously been suggested. Although a lot of experimental work remains to be done, the preliminary results contribute to a fuller understanding of Mesolithic bone technologies, and the lithic tools used to produce them. This shows that there is value and lessons to be learned, by conducting archaeological experiments using as authentic raw materials as possible.

In later years, technological investigations have led to important insights into long term stability, change and movements of people and technologies during the Middle Mesolithic period in Norway (Sørensen *et al.* 2013, Bergsvik and David 2014; Damlien 2016, Eymundsson *et al.* 2017). In these studies, the craftwork is commonly considered as large-scale technological systems and industries. These systems were however made up of individual agents/actors, operating within temporally overarching techno-complexes. Practical experimentation enables appreciation of the individual agency and consequently addressing the relationship between technological traditions and individual choices and creativity employed by the past crafters. Actualistic experimentation enables us to address the small scale, focusing on details and the life histories of singular artefacts. I believe that experimental archaeology and cross-craft analysis, integrated into a larger scheme of research and combined with other methods such as microwear analysis, will vitally increase our knowledge of the manufacture, use and functions of Mesolithic material culture in the future. For example, joint such an approach can offer useful information about the perishable components of composite technologies, such as slotted bone points, which were characteristic of the middle and late Mesolithic periods in Norway (Knutsson 2009; Sørensen *et al*. 2013; Bergsvik and David 2015; Manninen *et al*. 2021). Making replicas also provides valuable visual information regarding aesthetics and how such artefacts may have originally appeared to their makers and users.[2]

A key point for future investigations would be to avoid pitting ‘practitioners against theorists’ and acknowledge that practical experience and theoretical understanding are both fundamental for building a bridge between our subjective hands-on experiences, and the ways in which past individuals and societies practised and organised their technologies and craftwork. As with any other approach to the study of past material culture, actualistic experiments fundamentally involve interpretation and this practice need to be holistic and theoretically informed (Dobres 2000, 2010, Dobres and Robb 2005; Knutsson 2009; Elliott 2019).

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[2] Many examples can be found at Kutscheras Facebook-page: https://www.facebook.com/profile.php?id=100057180891784

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