FIELD TRIALS IN
NEOLITHIC WOODWORKING
(Re)Learning to use Early Neolithic stone adzes
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Dedicated to Helmut (Hugo) Windl, on the occasion of his 70th birthday.

Abstract

Excavations of several Early Neolithic wells with excellent preservation of the wooden lining in the past years, have made clear that stone age woodworking already attained a very high level of perfection. This poses the question how it was possible to execute this type of work with the means available at that time. To find an answer we started an ongoing series of experiments with replicas of Neolithic stone and bone tools, to understand prehistoric craftsmanship, integrating all available archaeological evidence. Besides flawless tools the key to success lies in rediscovering the way to handle them and a serious amount of experience.

Early Neolithic polished stone tools

As the Neolithic was first defined in 1865, it was done without any regards to agriculture, sedentarism, pottery and all other innovations, now known to be associated with the Neolithic transition, but on the basis of the occurrence of polished stone tools (LUBBOCK 1865, 3). In many ways the polished stone axe or adze is indeed emblematic for this new way of life, which was introduced to Central Europe in the middle of the 6th millennium BC. It was a prerequisite for the clearing of the land to create fields and settlements. In many aspects including the felling of the trees for the construction of the first permanent architecture and the production of agricultural tools the Stone Age is a Wood Age. The first farmers, inhabiting the fertile loess-soils in Central Europe, were the carriers of the Linear Pottery Culture (LPC), more commonly designated as LBK for the acronym of the German Linearbandkeramik (for an older but still valid overview in English: MODDERMAN 1988). Apart from the eponymous pottery, decorated with curves and spirals, they introduced diverse crops, domestic animals, timber-built longhouses and polished stone tools to the region. Such tools are of a typical shape with a very pronounced asymmetrical section, characterized by a domed upper side and a flat bottom with a distinct bevel towards the cutting edge (fig. 1). This shape as well as hafting traces and use-wear is clearly indicating that they were hafted as adzes with the cutting edge perpendicular to the handle instead of parallel as
There are two general forms: a flat, mostly broad blade, known in the older literature as “Flachhacke” or flat hoe, and a higher, often narrower variety, formerly known as “Schuhleistenkeil” or shoe-last celt. According to the most recent classification (RAMMINGER 2007) four types are distinguished, based on the absolute width of the blade in combination with the height-breadth-ratio. A respective index is calculated by dividing the thickness of the blade by its breadth, multiplied by 100.

The most common type (type 2) is the flat blade with a height-breadth-index (HBI) of less than 50, which means that the breadth is more than two times the height. In contrast to type 2 the medium high blades of type 3 have a breadth between one and two times the height (HBI between 50 and 100). The high, mostly quite narrow (between 30 and 40 mm) adzes of type 4 have a height that exceeds its width.
Type 1 blades are characterized by a width of less than 20 mm. Although it is not a classifying characteristic, nearly all type 1 blades have a HBI larger than 50, mostly even around 100. As these narrow blades are mostly quite short, often less than 50 mm, they look like miniatures of type 3 or 4 blades and are often regarded as children’s toys or non-functional amulets. Four more or less clearly delineated clusters can be recognised, if for larger series of adzes the height-breadth-index is plotted against the absolute breadth in a diagram (fig. 2). This supports the validity of the classification and it can be assumed that the four types have had different specialised functions.

Towards the end of the LBK, around 5000 BC, the first perforated tools appear. Initially they retain the form of “shoe-last” adzes, but becoming broader with a more rectangular cross-section resulting in the well-known broad wedges (‘Breitkeil’) of the Rössen Culture during the Middle Neolithic (fig. 3). The perforations in these frequently very heavy axes are remarkably small, often not more than 15 mm in diameter. They are always drilled parallel to the cutting edge, suggesting a more axe-like handling (RAEMAEKERS et al. 2011). In Central Europe the use of genuine axes hafted with the cutting edge parallel to the handle starts to appear only in the 5th millennium and becomes the dominant heavy woodworking tool with the emergence of the Michelsberg culture in western Central Europe in the second half of the 5th millennium. At the same time we see the development of polished flint axes in Northern Europe with the emergence of the Funnel Beaker Culture.

Archaeological evidence

Although the Early Neolithic polished stone tools have long been seen as parts of primitive ploughs or hoes for tilling the earth, it is now widely accepted that these are specialised woodworking tools with a wide range of use. However, it is often questioned whether an adze can be used for felling trees. Even a specialist like MODDERMANN (1988, 106) writes “I doubt whether trees were ever felled with LPC adzes. There are, after all, other methods of doing this.”, leaving open to the imagination of the reader which methods these could be and in which way the enormous amounts of wood which were necessary for the construction of the well-known longhouses have been harvested. The amount required has been estimated at a staggering 52 solid cubic metres with a total length of 1200 metres (LULEY 1992, 64). Generally reconstructing the use of LBK adzes is severely hindered by two circumstances: firstly no complete adze, consisting of a stone blade still lashed to its wooden handle, has been found yet and secondly there is only a very restricted amount of timber known from the Early Neolithic on which the tool-marks can be studied. In both cases the sparse evidence comes from the few LBK-wells found in the last decades in waterlogged conditions under the groundwater level where parts of the wooden lining and some organic finds were preserved (TEGEL et al. 2012). These constructions made clear that woodworking in the LBK had already reached a very high level of perfection with sophisticated
carpentry joints and the ability to fell trees with a diameter of over a meter and the successive clearing of the trunks as well as trimming and dressing of the thus produced timbers. Currently the best available evidence for woodworking comes from the well found in Altscherbitz near Leipzig in Eastern Germany, which has been dated dendrochronologically around the end of the 51th century BC (TEGEL et al. 2012). This well was blocklifted from the archaeological excavation and subsequently excavated under laboratory conditions using sophisticated methods like complete 3D-recording and documentation of the finds using a laser scanner. On several timbers from the lining toolmarks produced by at least two different tools can clearly be distinguished (fig. 4). The sides were partially dressed using a tool, very probably a flat bladed adze of type 2, with a cutting edge of at least 50 mm wide. Whereas the split timber was trimmed to length using a much narrower and higher blade, leaving marks with a width of less than 20 mm, which would suggest the use of a tool with a blade of type 1.

From the same well comes the best evidence for the hafting of LBK adzes (ELBURG 2008). In a layer a few decimetres above the level of complete organic preservation a stone blade of type 2 was found with in the adjoining sediment the imprint of a decayed wooden handle still visible. This find allowed the identification of two wooden objects from other Early Neolithic wells as hafts of adzes. All three handles are of a unique common morphology, for which no archaeological or ethnographic parallels are known. Whereas the head of the haft on which the blade is attached in all known haftings of stone adzes always forms an acute angle with the handle as in modern steel adzes, in this case the angle is obtuse, between 95° and 115°
(cf. fig. 5). As all three known LBK-hafts as well as a possible discarded rough-out from the well from Altscherbitz show this peculiarity, it seems that this was the (or at least a) customary way to haft the flat blades of type 2.

**Experimental archaeology and ethnography**

Work involving stone axes goes back to the very beginnings of experimental archaeology in the 1870s with the work of Frederik Sehested in Denmark, which consisted of building a log-cabin using flint tools (STEENSBERG 1986, 149–151). Later work also focussed on the felling of trees using either original blades (JÖRGENSEN 1985; POTRATZ 1941) or modern replicas (CHOULOT et al. 1997; HOLSTEN & MARTENS 1991; MEIER 1990). In all cases, however, parallel hafted axes were used. Hardly any experimental work involving adzes had been carried out or at least been published in full. Moreover, respective articles never contain much information about the handling of the tools or a critical review of the work-flow (BÖHM & PLEYER 1990; WEINER 1986). The few reports found on the internet (e.g. ALBRECHT n.y.) are not really usable as a reference as they have been carried out on thin softwood trees.

Although stone axes and adzes have been used well into the 20th century particularly in Oceania, many aspects of their use are still poorly understood and have been insufficiently documented in ethnological context. The ethnographic literature is full of descriptions of stone and shell adzes from Oceania, particularly New Guinea, but hardly anything is published on the use of the tools in felling trees (e.g. HINDERLING 1949; BLACKWOOD 1950). Mostly only a few photos are
shown and longish descriptions are given of the manufacture of the blades and their hafting. Only one author provides a more precise account of the actual utilisation, but the tool used is a crossover between a stone axe and an adze, with the blade set in an angle of approx. 30° to the handle (STEENSBERG 1980; 1986). On the other hand especially the work of PETREQUIN & PETREQUIN (1993 esp. fig. 313) demonstrates that it is very well possible to fell large hardwood trees using a stone adze. The main question remaining is if these findings can be directly applied to the European Early Neolithic. Against this background user ‘rolfpeter’ started in the fall of 2010 a discussion on the mostly experimental archaeological oriented internet forum ‘archaeoforum.de’ by asking if there was anything known how large trees were felled in the Early Neolithic, when only adzes had been available. Quickly the conclusion was reached that hardly anything was known and a field trial with reconstructed LBK-adzes was urgently needed. An ample number of the forum’s members volunteered for such an action. Based on the scant information available the first set of questions was, quite basic:

• Can large hardwood trees like oaks with a diameter of 50 centimetres and more be felled using stone adzes?
• How were these tools hafted?
• Which cutting techniques were employed?
• How can the thoroughly documented toolmarks on the original timbers from the LBK-wells be replicated experimentally?

The most critical point in most of such experiments, namely finding some woodland where one can legally cut down quite large oaks, was amazingly quickly solved. Via the late Werner Scharff contact was established with the Archaeological Association Ergersheim and Surroundings and thus with the municipality of Ergersheim (district Neustadt an der Aisch-Bad Windsheim, central Franconia, Bavaria, Germany). There a number of oaks with the desired diameter were made available. The forest where the experiments are carried out is located to the north-east of the village of Ergersheim, around 49° 32' N/10° 21' E and belongs to the western part of the Steigerwald Forest. It is traditionally managed, presumably continuously since the Middle Ages, as a coppice-with-standards, dominated by oak. The sections, several hectares in size, are harvested on a rotation of around 30 years. The wood is nearly exclusively used as firewood; only the very best and mature standards are milled for timber. The fieldwork takes place towards the end of the felling season in late March, as the annual plot is cleared from coppice and undergrowth with only the standards left. This is quite an ideal situation as there is ample space to work and document and there is very little chance for the felled trees catching in the crowns of the wide-spaced standards. The trees used in the felling experiments have a diameter ranging from 25 to 55 centimetres and are aged between approx. 90 to 120 years, having been left as standards for two or three periods, which is clearly recognizable in the rhythm of wider and narrower growth rings in the wood.
Reconstructions

One of the present authors (WH) made a number of replicas of all four types of LBK adzes. Most blades were manufactured from erratic stones from the beach of the Baltic Sea, presumably a type of diabase, although a precise identification still has to be conducted. A few blades were made out of actinolite-hornblende schist from the Jizera Mountains in Eastern Bohemia (PŘICHYSTAL 2013, 192–195), the most widely used raw material for polished stone tools in the LBK. It is characterised by great toughness and can be ground to a very fine edge, making it one of the best raw materials for the manufacture of adze blades. Before the blades were hafted a detailed documentation was made including micro-photos of the cutting edges and high-resolution 3D-laser scans to be used as a reference for future use-wear studies.

The design of the hafts for the type 3 and 4 blades largely follows the theoretical and practical considerations of Jürgen Weiner (WEINER & PAWLIK 1995). The angle between the head of the hafting and the handle was a bit under 60° (type 3, figure 5, 1st from the right) and 70° (type 4, figure 5, 2nd from the right), based on publications of New Guinea haftings. In one publication (BLACKWOOD 1950) the angles of ten haftings are listed, ranging from 46° to 76°, with an average of 62°, in another paper (GODELIER & GARANGER 1973) the measurements for eight adzes are given, ranging from 53° to 88°, averaging 70°. In the latter work it is explicitly stated, that there is no relation between the size and the weight of the blade and the angle of the haft. For the flat type 2 adzes two different forms of haftings were made, one following the ‘classical’ design known from ethnography and later archaeological finds (cf. MÜLLER-BECK 1965, 30–38) with an acute angle between the blade and the handle (figure 5, 3rd and 4th from the left) as well as one based on the obtuse haftings from the bandceramic wells (see above; fig. 5 in the centre). For the very small blades of type 1, copies of an original found in the well from Altscherbitz (Fig. 1, 1st from the right), also two alternative hafts were produced. The first one broadly follows known forms from lake-side settlements of very light adze-handles (fig. 5, second from the left). The second one is much more massive and the blade is set, following hafting-polish on the original, with its butt in a socket in the wood, lying on a slightly protruding tongue. The heavy head of the more or less hammer-shaped hafting compensates for the lack of weight of the stone blade (fig. 5, first from the left). All lashings were made with commercially available, probably chemically tanned, leather strips.

Fieldwork

The first field-trial was conducted in March 2011 and was a success in most respects, although according to Murphy’s Law, nearly everything that could go wrong did go wrong. For the first felling experiment an oak with a diameter at breast height of 42 centimetres was selected. Contrary to what is mostly seen with archaeological experiments, the falling direction of the tree was controlled by
cutting two opposing notches (directional notch and a back-cut slightly higher up the trunk to give a good hinge) instead of a continuous, circling groove around the circumference of the tree. This results in a pencil like point to the trunk, which gives no control on the direction the tree will fall (e.g. POTRATZ 1941, Tafel 140). The main difference in cutting down a tree with an adze compared to an axe, is that all strokes are delivered overhead, which leaves the lower side of the notch looking like a brush as none of the splinters is cleanly cut off at the base (fig. 6). A complicating factor of the use of a stone tool compared to a metal blade is the fact that the cutting has to be done in a much steeper angle, always with the grain of the wood and that the chips are removed more by cleaving than by cutting (cf. JØRGENSEN 1985, 33; MÜLLER-BECK 1965, 131). As only one of the authors and none of the participating volunteers had any previous experience in cutting wood with a stone adze, quite some time was required to get used to the work. This resulted in many uncontrolled strokes, which put a large strain on the tools, causing damage to the lashings which had to be rebound frequently. A more structural problem was the angle of the hafting of the type 3 blade, designated as the main felling tool, which was with 60° clearly too narrow. This induced a disproportional strain on the top of the blade, resulting in the breaking-off of the bevelled underside. After replacement of the blade by an identical specimen, the cutting edge broke in exactly the same manner, thus demonstrating that the breaking-off was not the result of a invisible flaw within the stone. The first blade could be used again after regrinding and polishing, but on the second day of the work the strain on the supporting wood of the head became too heavy, resulting in irreparable breakage. The angle on the handle of the type 4 blade of 70° was adequate, but here a flaw in the wood of the handle resulted in a cross fracture, which could be provisionally repaired with the aid of very modern epoxy glue. A replacement hafting, made from freshly cut wood was of no use, as it broke after just a few strokes. All in all it took well over eight hours, spread over three days, to fell the tree, leaving only very little time for the planned processing of the wood like cleaning, trimming and dressing (cf. WEINER & LEHMANN 1998). The only other tools which were employed were the small type 1 adzes. Especially the blade hafted in the heavy, hammer-like handle turned out to be extremely effective for debranching and trimming, leaving marks closely resembling those on the original planking of the wells.

Documentation of the whole process was carried out by photo and film and for the registration of the development of the felling notches a reflectorless total-station...
was used. Although the data collected with this instrument were usable, the measurements were taking too long, causing extended forced breaks in the work. In combination with the unskilled workers, the very tiring work overhead and flawed tools this taught us a very thorough lesson of how not to fell a tree with stone adzes and provided ample suggestions how things could and should be improved the next time.

The following year several aspects of the toolkit were optimized. The heavy blades were set in handles with an angle between 70° and 80°, the lashings being made with rawhide, resulting in a tighter yet slightly elastic binding, but the most important factor was the familiarisation with the unusual tools. This time a massive oak with a diameter of 55 cm and thus a cross-section of approx. 0.24 m² was felled in less than five hours, which is compared to the eight hours for 0.14 m² in the previous year a remarkable gain. Parallel to this work a comparable tree was cut with a copy of a Roman steel axe, which took a bit more than an hour. This agrees well with the figure given for a similar test carried out in New Guinea by Papuas skilled in the handling of stone adzes as well as steel tools (GODELER & GARANGER 1973). The major difference was that on our tree cut with stone adzes up to three persons had been working simultaneously, whereas the steel axe was swung by only one man used to such work. This gives an interesting insight how much learning and experience matters. For more reference material a thinner tree was felled with a parallel hafted flint axe. Here the notch was clearly

Fig. 7 a and b: Chisel made out of a moose metatarsal and its use for cutting a mortice in an oaken plank. Scale bar 3 cm.
lower on the trunk, just above the point where the root wood started and was less wide as compared to those produced with the adzes, thus giving a larger yield of timber.

Much time was devoted to finer woodwork during the 2012 edition of the experiments. To this end a large oak was felled some days before with a chainsaw. This gives the wood enough time to develop first drying cracks, showing where it can be split best. These initial cracks were widened with antler wedges. For the splitting itself large hardwood wedges as commonly found in Neolithic lake-side settlements (e. g. DE CAPITANI et al. 2002) but also from the LBK-well from Erkelenz-Kückhoven (pers. comm. J. WEINER) and large wooden mallets were used. The resulting long planks were cut to length using the heavy-hafted miniature adze-blade, resulting in identical forms and toolmarks as found on the ends of the original timbers (fig. 4). The aim was to reproduce the basal frame from the well from Altscherbitz, consisting of four timbers connected with tusked mortice-and-tenon joints and one layer of logs with interlocking recesses as in log cabin construction, like the rest of the wooden lining is constructed (TEGEL et al. 2012, figs. 4 & 5). Several tools were tested for the cutting of the recesses. For this work all adzes performed poorly as it is nearly impossible to work against the grain of the wood with the relatively blunt edges of stone tools. The depth up to which can be worked is limited by the length of the blade protruding from the haft. Best results were obtained with bone chisels.

The toolmarks which occurred on the worked wood are identical to the traces which had been found on the mortices and the cogged joints of the wood lining of the Altscherbitz well. This strongly suggests that bone chisels had been used for carpentry. Next to stone and antler, bone is one of the most important materials for crafting tools in the Neolithic. The different shapes of the bone tools are technically mature so that they don’t vary during the Neolithic. For example the massive bone chisels had been found in the LBK settlement of Müddersheim (SCHIETZEL 1965, Taf. 15) and in the settlement of Sipplingen-Osthafen of the Horgen Culture (2925-2855 den BC PROBST in prep.). Both chisels are made of the metatarsal of cow-sized animal. In spite of the high number of bone tools, they are still underestimated within the archaeological research. By the Ergersheim Experiments we are able to prove, that bone tools are much more durable than anyone thought before. For example 2012 we started to work with a bone chisel made of a moose metatarsal. Because of the sub-zero temperatures in 2013 two cracks appeared at the side, but it didn’t break. Thus, 2014 we could continue to work with this tool. Over that weekend some part of the edge cracked apart, but it is still good to handle and work with (Fig. 7). Until now it has lasted about 32 hours of work including 15 working hours with the two cracks at the side. In 2015 we will still keep on working with that moose chisel and hope it will finally break apart irreparably. Without freezing temperatures in 2013 the moose chisel probably would have lasted at least two or three times longer.

Most surprising were the results of the trials with the obtuse-hafted flat-broad blades. As no parallels are known for such tools, their function and handling was a complete mystery. Several suggestions were made ranging from a specialised
tool for overhead work, a kind of plane that was used in a shoving manner, throwing axe or, inevitably, an Early Neolithic golf club. All methods of use, be it for cutting the recesses or use as a plane were very ineffective and can be performed much more effectively with other types of tools. Finding an answer required quite some rethinking. As the hafting was for a flat-broad blade found in a well where the timbers showed toolmarks most probably left by such a blade, it must clearly have been used for surface work. Trying to find the most effortless way to handle such a tool and bringing the blade in a position in which it could have left such marks, we laid a split plank on the ground, stood astride over it and swung the tool between our legs (fig. 8).

This worked remarkably well with the cutting edge grazing the surface, removing thin slivers of wood, not unlike the shavings produced by a plane and leaving a clean surface with very shallow toolmarks perfectly replicating those on the Neolithic planks. Within the team the tool is colloquially know as the ‘115’, after the obtuse angle between the handle and the blade, but should functionally be called a planing adze. Judging by the large number of type 2 adze blades found in LBK settlements and the fact that all known haftings are of the obtuse variety, it can be concluded that this kind work must have been very common during the Early Neolithic. In all we concentrated more on the work and spent less time on elaborate documentation, although the stumps and planks produced were, like the year before, transported to the laboratory and recorded with a 3D-laser-scanner to compare the toolmarks with the original timbers.

On the 2013 edition of the experiments we were met by freezing conditions, seriously impeding the work. As the wood froze and the bone tools became brittle by the cold, we had to discontinue the finer woodworking and concentrated on the felling. This year saw the introduction of a new piece of equipment: the Middle Neolithic broad wedge (fig. 3). Several previous experiments had been carried out with this type of tool, with mixed outcomes. ŠTELCL & MALINA (1970, 50–52; Taf. 31–33) successfully felled 100 trees with an average diameter of 16 cm using ‘hammeraxes’ as they described them. Recently an experiment on a much smaller scale was carried out in the Netherlands, which gave less convincing results (RAEMAEKERS et al. 2011). Often these axes are seen as wedges for splitting

Fig. 8: The handling of an obtuse angled stone adze in smoothing the surface of a timber.
wood, as the traditional name indicates. But as hard as we tried, it was impossible to drive the blunt edge into wood, neither by swinging nor by keeping the blade in place with the relatively thin handle and hitting the heel with a heavy wooden mallet. This matches the Dutch results (ibid.) and stands in strong contrast to our own experience using antler chisels and wooden wedges to split even very large trees. Slightly better results were obtained when using the ‘wedge’ to dress a beam. To this end notches were cut at approx. 60 cm intervals in the trunk of a felled oak with a diameter of 25 cm. Subsequently the wood between the notches was removed by cleaving it tangentially. Getting an even surface would have demanded a lot of reworking as the broad head of the axe makes it impossible to split off the wood at the base of the notches, leaving deep grooves in the face of the beam. Cutting the notches showed that it should be possible to fell a tree without much problems, which was then done. As the broad wedge can be handled like a modern axe despite its blunt edge, the movements were much more familiar than the overhead cutting with an adze. After a cautious start, afraid the relatively thin handle would break under the hammering blows with a one-kilo head on solid oak, we soon drove the axe with full swing into the tree. Although it felt more like hammering than woodcutting, it was possible to keep the felling notch much narrower than with the adzes, greatly reducing the amount of wood that had to be removed (fig. 9). Instead of producing chips, the broad wedge creates a kind of coarse sawdust as the cuttings are relatively thin and more or less disintegrate on detachment. This seems typical when cutting perpendicular to the grain of the wood with stone blades (ARNOLD 2003, 44). The first tree with a diameter of 25 cm fell after a bit more than an hour, a second tree with a diameter of 35 cm took nearly two hours. The thin handle made of elmwood and the perforated head easily withstood this prolonged ‘tree bashing’ and the cutting edge hardly showed any traces of wear. Again all work was recorded in detail with photos and on film and the resulting stumps were laser scanned in the 3D-laboratory for later reference.
During the fieldwork in 2014 we concentrated on the documentation of the toolmarks and the development of the felling notches on the one hand and finer woodworking, predominantly using bone chisels, on the other. To compare the traces left by different tools four oaks were cut down. On one of these flint axes of the Northern European type were used (fig. 10), another two were felled with broad wedges and one was cut down again using adzes. For the documentation of the notches we had a portable Artec EVA 3D-scanner at our disposal, provided by the Archaeological Heritage Office of Saxony in Dresden. After an initial scan of each tree before the work started, recordings of the developing notch were made in regular intervals, thus documenting the change in size and shape and the volume of material removed. After some problems due to the strong sunlight a work-flow was established which only minimally impeded the work and resulted in detailed 3D-models of all stages of the work. Also representative samples of the chips produced by the different tools were collected for later analysis and comparison with archaeological finds.

To broaden the experience gathered with the ‘broad wedge’ a second copy was produced. This one was substantially larger and heavier (length 24 cm, weight 2.5 kg), made after the example of the largest and slightly more slender archaeological specimens. Due to its length and weight it was considerably harder to handle. This resulted after only a short time in an ill-directed blow, which took off a larger part of the cutting edge, again demonstrating that stone tools are anything but indestructible when improperly used.

As the cold weather of the previous year rendered the work impossible, a major part of the team again concentrated on the finer woodworking. A large oak, felled a few days earlier, was split into long planks using wooden wedges. From these a copy of the basal frame of the Altscherbitz well was produced including the tusked tenon joints, showing toolmarks identical to the original.

**Conclusions and perspectives**

What initially started as a quite spontaneous action to answer a basic set of questions developed into a ongoing series of experiments with a much broader scope which have resulted in a large body of data. After four field experiments we can conclude that it is perfectly feasible to fell even large hardwood trees with copies of Early Neolithic adzes as well as other Neolithic stone tools. Even so experiments such as these have to be regarded critically, as is made clear by the use of the different types of haftings. In absence of archaeological examples we adapted the type of handle for the heavy adzes of types 3 and 4 to our way of working. This resulted in a functioning tool but this can’t be used to prove anything about Early Neolithic woodworking. Here we have to wait for the find of an original handle before we can draw any definitive conclusions. With the idiosyncratic 115° degree haftings for the flat-broad type 2 adzes it is just the other way around. Here we had possible handles without any parallels in the ethnographic or archaeological record and no idea of how they might have been used. The light, effortless
movement of its use as a planing adze, replicating the original marks on the ar-
chaeological timbers, is a very strong indication that this is actually the way these
tools were hafted and employed. The case for the narrow type 1 blades is still
somewhat inconclusive. The hammer-headed hafting makes for a surprisingly ef-
ficient tool which, when used for the same kind of work as in the Early Neolithic,
leaves exactly the same marks on the wood. We take this as a strong indication
that blades of this type have been hafted in a similar way and it certainly proves
they are functional tools and not some kind of toy or amulet.
As for the comparison of the effectiveness of the various tools and the time need-
ed for the execution of different tasks another caveat is in order. The reduction of
time spent on the felling of comparable trees with adzes over the years shows
clearly that learning how to handle such a tool is the single most important factor.
By clocking the work, you mostly measure the skill (and fitness) of the worker and
little else. Although by now we are getting some practice in the use of stone
woodworking tools, we can never hope to attain the proficiency of native Early
Neolithic lumberjacks. This renders futile any attempts based on experiments like
these to calculate the actual amount of time necessary for the construction of
e. g. Neolithic houses; at the best it gives a broad indication of energy invested.
Despite these critical notes, the experiments have brought new light into the ob-
scurity of prehistoric woodworking. For the coming years the main focus of our
work will be the analysis of the large volume of data gathered. Here it is planned
to do a detailed study of the experimental chips in relation to those from archae-
ological contexts (cf. MÜLLER-BECK 1965, 134–135) as well as a comparison of
the toolmarks left by the individual tools using the 3D-scans. Another topic will be
the study of ethnographic films on woodcutting to find out if evidence for the han-
dling of stone tools similar to those used in European prehistory can be found.
And of course we will continue the fieldwork as only practice makes perfect.

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(In addition, several films on the experiments can be found on the YouTube-channel of ulfr23.)

**Figure credits**

**Figure 1**: Replicas Wulf Hein, 3D-models and rendering Thomas Reuter/Archaeological Heritage Office Saxony

**Figure 2**: Graphic Rengert Elburg

**Figure 3**: Replica Wulf Hein, 3D-model and rendering Thomas Reuter/Archaeological Heritage Office Saxony

**Figure 4**: 3D-scans and rendering Thomas Reuter/Archaeological Heritage Office Saxony

**Figure 5**: Replicas and photo Wulf Hein

**Figure 6**: Photo Petra Schweizer-Strobel

**Figure 7**: Replica Anja Probst, Photo Sebastian Böhm

**Figure 8**: Photo Rengert Elburg

**Figure 9**: Photo Andreas Franzkowiak

**Figure 10**: Replica Kai Martens, Photo Klemens Niesen