Making a Simple Tool

Bronze Casting for Personal Use in the Latter Part of the Scandinavian Bronze Age

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Abstract

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The prevailing perception of the Bronze Age bronze artisans is that the craftsmen must have been very specialized to be able to make the sometimes quite amazing objects produced during the Bronze Age in Scandinavia. After careful artefact studies, however, especially on ferrule axes from periods three to six, I feel that some artefact types were not manufactured by craftsmen who were experts or specialists in casting bronze, but more likely amateurs. There are clear signs that many ferrule axes were manufactured by people who certainly could mould bronze but were not experts in the field. Some of the Bronze Age bronze objects should be classified as everyday objects, such as certain axes, needles, etc. My theory is that these artefacts were not necessarily produced by experts but in some cases by farmers or amateurs in villages and on farms all around Scandinavia. Through experimental archaeology, artefact studies and habitat analysis, I shall test whether the theory holds water.
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Introduction

Was there farm production of bronze objects in the Bronze Age? This has been previously discussed, and several researchers suggest that there may have been some kind of self-production on the farm or the village during the latter part of the Scandinavian Bronze Age (Kaul 2004; Goldhahn 2007). On the other hand, many scholars believe that bronze craftsmanship is an art form and that there was a special section of society that performed these tasks (Jensen 1979; Rønne 1993, pp. 85–86).

Through experimental archaeology, artefact studies and habitat analysis, I intend in this article discuss whether there may have been farm crafts or production of bronze tools on a small scale and/or for personal use. There is no doubt in my mind that there was a highly specialized artisans who did both casting and mould making at particular production sites, but I believe there were also amateurs who could make objects for their own use, such as sickles or celt axes, and were thus able to satisfy the needs of their own farm or possibly a small number of farms in the vicinity. Bronze has the advantage that it can be cast several times; if a celt axe breaks during usage or is just considered to be old and worn out, if you have a mould you can cast a new one quite easily and in a relatively short time.

Fig.1 A prefabricated soapstone mold found in Brunnby in 1881. LUHM 19308

Fig.2 A celt axe with serious casting defects. LUHM 14083

Fig.3 A very well used axe, with a casting defects on the ear LHUM 28240:2

Fig.4 One of the mold fragments from Sandeplan. LUHM 32060:1119

Casting techniques

Copper has a melting point of 1086 degrees Celsius, but the molten copper is difficult to manage and sometimes becomes just a rubbery mass. Moreover, the resulting object becomes hard and inflexible and therefore quite fragile. Adding tin to copper solves many problems. First, it lowers the melting point radically; with the addition of just 8 per cent tin, the melting point dropped to about 1,000 degrees Celsius (Jensen 2002, p. 129). The most common amount of tin is 10–12 per cent, which brings the melting point down to 900–850 degrees Celsius. The molten metal also becomes much easier to handle, more fluid, so to speak. The main advantage of mixing copper with tin to make the bronze for the finished object is that it is much more durable as the tin makes the metal more flexible. It need not be tin; there are examples of lead and arsenic also occurring in copper alloys (Oldeberg 1942; Nilsson 2008). Two types of moulds were primarily used: soapstone moulds and the lost-wax method, or *cire perdue* as it is known. *Cire perdue* requires that you first make a wax model of the desired object. This model is then enclosed in clay and the clay mould is heated to about 600 degrees Celsius after the clay has been allowed to dry

for several days. The wax melts and flows out of the mould, leaving a cavity in the now-fired clay that can be filled with bronze. After casting you remove the clay from the bronze and the finished object emerges.

Mould types

Casting technology itself is basically the same no matter what type of mould you are using. It is not difficult to cast bronze. If you have a good forge and a good mould you do not need much experience to succeed. The difficulty with bronze casting is rather to produce the moulds. Producing a wax model of an object as required by lost-wax technique is not easy; producing wax models of such complex objects as belt plates or various types of fibulae makes the artisan an artist rather than a bronze caster. The production of soapstone moulds is also an art. Soapstone is a good material to work with because, as the Swedish name *täljsten* (carving stone) suggests, it is actually possible to cut into the stone with a knife or a piece of sharpened flint. Furthermore, the shape may be used several times, which is impossible with the lost-wax moulds. Trials have shown that a soapstone mould can be used more than 50 times (Nilsson 2008). However, it is very difficult to get the two sides completely equal. This is something that requires experience, and there are also examples of objects that appear to have had a mould where the two halves are not completely consistent.

Soapstone and the soapstone trade

One of the artisans involved in bronze craftsmanship that is rarely or never mentioned in the academic discussion is the mould maker. In cases where the mould maker used the *cire perdue* technique, he probably was a specialist and in most cases part of a casting team. In the case of casting in soapstone moulds, however, I am not certain that the same degree of specialization was required. Soapstone and moulds made out of soapstone was obviously a large commodity during the later periods of the Bronze Age. There are several places in Scandinavia where soapstone is visible on the surface. In Sweden there are soapstone in Halland, Bohuslän, Jämtland and Värmland. There are also large deposits of soapstone in Norway (Oldeberg 1943, p. 144; Goldhahn 2007, p. 126). However, there is no soapstone in Scania or in Denmark despite the fact that many Scandinavian soapstone moulds from the Bronze Age have been found there.

Since there is no copper in Scandinavia that was accessible to the Bronze Age bronze casters and no tin at all, both metals had to be imported, either alone or in already mixed alloys. And what were the northerners able to offer in exchange for bronze? Leather and amber were two articles that could certainly have been used in trade. It has also been discussed whether soapstone could have been used as a commodity in exchange for bronze (Goldhahn 2007, p. 126; Rønne 1996). At several places in Sweden, Joakim Goldhahn has identified soapstone quarries that were used in prehistoric times. Several of these soapstone quarries were close to casting places and rock art. There are also indications that quartz was quarried in the vicinity of a couple of these sites. Quartz can be mixed with the clay when making moulds, crucibles and ceramics (Goldhahn 2007; Weiler 1994), a useful material for the bronze smith but not necessary. The broken quartz can be replaced with sand found in southern Sweden and in several places in Denmark, or crushed granite.

In Brunnby Parish in Kullaberg in southwestern Sweden, a find was made in 1881 which strengthens the idea that people traded, not only in soapstone, but also in prefabricated soapstone moulds. Twelve square soapstone

blocks were found in a closed archaeological find under a stone wall; unfortunately, only three of the blocks were preserved (Oldeberg 1943, p. 143; Goldhahn 2007, p. 128; Weiler 1994, p. 130). These types of finds occur only in Halland, Scania and Zealand in Denmark in southern Scandinavia. These findings indicate that there have been talented soapstone mould makers elsewhere than at the soapstone quarries.

Casting defects

There are several celt axes which show serious casting defects but nevertheless were used for a long time. Often there are big holes in the side of the axe, or the ear is missing, and the celt entrance frequently has casting defects. Could it be that the craftsmen who made these objects were not bothered about the aesthetics, but only viewed them functionally? An amateur caster who needed an operational tool to manage his daily work on the farm might not have cared about the symbolic value of a perfectly made object, accepting the less aesthetic features as long as the function was the same (Nilsson 2008). After having experimented with bronze casting, I found that my casting defects were in roughly the same places as you find them on the original artefacts. Casting defects have approximately the same shape when a soapstone mould is used (Nilsson 2008).

Casting sites

After trying to cast various objects, I found that the really hard part of the bronze casting process is producing a functional mould. Learning how to build a forge that brings up the heat to the temperatures required for bronze casting, whether it is a forge heated with bellows or a bronze oven with natural ventilation, is not difficult. It is not hard to melt metal in a well-constructed forge. One may assume that on each farm or in each village there were several people who could handle clay and ceramics; crucible manufacturing should not have been a problem for the average farm during the Bronze Age. The only thing required of a crucible compared to conventional ceramics is to add more sand or quartz for it to withstand higher temperatures (Nilsson 2008).

What is difficult, however, is to produce a functional mould, but if the farm could purchase a soapstone mould they could produce a new axe as soon as the old one was worn out. I know of no celt axe find where one can say that the axe is completely worn out. Most axes have been used and some are worn and show damage caused, for example, by having struck the edge against stone or something else that is harder than bronze. However, these axes could be sharpened by cold-hammering and grindstone and used again. Discarded axes would thus have been cast into new axes or other objects.

The problem of proving it archaeologically is that a bronze forge that was used only a few times looks like an ordinary fireplace. In addition, it may be difficult to find the traces you often find at larger bronze casting sites. Calcined clay from *cire perdue* is often found in large quantities at larger bronze-casting locations (Bodin 1998). These traces should not be found on smaller bronze-casting sites for reasons outlined above. It is therefore necessary to look for fragments of crucibles to reveal a smaller bronze-casting site. Crucibles are often mixed with up to 60% sand or quartz (see example Goldhahn 2007, p. 128; Weiler 1994, p. 49). If these pots are not completely burned through during the melting process, they will often disappear in the soil. The crucibles were most likely often thrown on the trash heap and mixed with all the other ceramics. However, the crucibles and/or the presence of bronze are the only traces left of

a small bronze-casting site. Even if one finds traces of fragmented crucibles, it often requires a costly and time-consuming thin-section analysis (Stilborg 2008, pp. 209–220). And it would not be surprising if you find bronze fragments in a Bronze Age settlement. However, I think I have found just such a place that can be described as a settlement from the Bronze Age with small-scale bronze artefact production

Sandeplan as an example

In 1983 a kitchen midden from the Bronze Age was excavated at Sandeplan in Kämpinge Parish in southern Sweden. Much of the kitchen midden was examined by Monica Rasch in a research excavation of the Archaeological Department at Lund University. A few features were examined but no direct settlement remains were among these. A relatively large amount of material was retrieved and was put in storage. The material shows that the kitchen midden was used for several generations. A large ceramic assembly, approximately 14,000 shards of broken pottery, often well-worn with traces of food on the inside and very grimy exterior, was retrieved. Through analysis of the pottery the site was site dated to the Late Bronze Age and ceramics suggest that the site was used for a few hundred years (Nilsson & Hedlund 2010). A very large amount of bone, about 40 kg, was examined. Since all the dirt was water-sieved, about 11,000 fish bones were recovered and these were analysed by Annie Cardell (1997). The approximately 20 kg of mammalian bones and approximately 10 kg of bird bones have been studied and reported by Therese Hedlund (Nilsson & Hedlund 2010).

Among all the debris excavated in the kitchen midden, four pieces of fragmented crucibles were found and I interpret this as two different crucibles. There were also three fragmented bronze pieces. One crucible was sintered, which may indicate that it was not sufficiently mixed with sand or quartz. Two of the three bronze fragments were bronze wire, often used as feedstock. The third was so fragmented that no direct conclusions can be drawn without detailed analysis. No other traces of bronze craftsmanship were found in the rather extensive material.

Summary and concluding remarks

After having experimented with bronze casting and mould making and having analysed original artefacts, I have been able to see several different skill levels of craftsmanship. There is no doubt in my mind that there have been specialists in bronze casting during the bronze Age, otherwise we would not have objects like the Trundholm sun chariot, now exhibited at the National Museum in Copenhagen, or objects such as bronze lurs and belt plates (see e.g. Montelius 1917; Oldeberg 1943; Oldeberg 1974). But would simpler objects such as celt axes and sickles have required a specialist to produce them? I think it might have taken a specialist to produce the mould, but once a mould has been made it can be used for casting up to 50 times. One is not even required to purchase large quantities of bronze; instead, old objects can be reused to make new ones. There are often casting defects or defects that affect the function of the celt axes. The casters in this context simply did not worry if the axe was not perfectly cast; they were more interested in whether the object was usable or not.

One might add that there are several other indications that there were amateur casters during the Bronze Age. It is difficult to find the less frequently used bronze-casting places during archaeological investigations. But if you know what to look for, it is possible

to discover places like Sandeplan. The waste pile or kitchen midden that was investigated in 1983 revealed a number of crucible fragments and a few bronze fragments, showing that there was casting in Sandeplan, but not on a large scale because we probably would have found many more crucible fragments and parts from crushed moulds.

All these indications show that there were other types of founders than the specialized or full-time craftsmen. There were casters whose objects did not turn out perfect. These casters most likely used stone moulds as it is much easier to cast in these than with the *cire perdue* technique. A farm, a village or a small area could have purchased and shared a mould and then cast their own tool. Another possible explanation would be that there were itinerant craftsmen who, despite extensive experience, did not make perfect objects. It could thus be a kind of guild system we have discovered. The less knowledgeable craftsmen were not initiated into the small group of highly skilled craftsmen and therefore had only their own experience to rely on.

Further investigation is needed in this area. Can one, for example, see regional differences in basic bronze crafts? In further experiments it may be possible to establish a typology of casting defect and thereby gain greater insight into the skill of the caster and the usability of the objects.

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