10th Century Danish Necklace Hooks

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Summary

On a trip to Denmark in 2001, I saw two pairs of necklace hooks in the Danish National Museum. These hooks answered a question I had pondered for some time, which was how Norse women attached their necklaces between their brooches. I decided to make some necklace hooks, and learned a lot about fire-polishing wax and casting bronze in the process. The result is a beautiful and practical form of jewelry.

Historical Documentation

Norse Hanging Necklace

Norse researchers generally agree that Norse women often wore a pair of brooches to pin the dress and/or apron together. The photo to the right shows a reconstruction of a Norse female costume with brooches and hanging necklace.

The theory that wealthy Norse women wore necklace segments strung between their brooches is based on physical placement of beads, brooches, chains, and tools in many grave finds, because the strings on which the necklaces were hung have not survived. During my visit to the Danish National Museum, I saw many necklace artifacts, many of which only had enough beads and pendants to be 10-14 inches long. This would be the right distance to dangle between the brooches. My own research has also found many examples of brooches with loops near their bottom edge, which further supports this theory.

Shown to the right is WOV 2013, the back of a bronze brooch found at the Nygaarden site at Nord-Troendelag, Norway. It shows the structure of the pin, though the decoration on the pin holders is a rare thing for brooches. Such decoration would not be visible when the brooch was in use, and may have been some kind of artist's signature.

At the bottom of the brooch can be seen a small loop that may have been used for hanging necklaces. However, as with many museum photos and displays, the brooch is shown upside down, so the loop is at the top of the photo.

My assertion deserves some explanation. The brooch pin is attached at the top of the photo, with the pin end and its keeper at the bottom of the photo. Anyone who has worn Norse female garb, such as my lady, can attest that the brooch is much easier to put on and take off with the pin pointed upward. Thus, I conclude that the museum has the brooch upside down in the photo, and the loop shown could be used to hang a necklace. It is not uncommon to find such errors in museum photos and reconstructions, where information gathered later supersedes an earlier interpretation.

Shown to the near right is WOV 2015, a pair of composite brooches from Viking Age Norway. They have animal-head lugs at the bottom, which could be loops for the attachment of a hook. It is difficult to be certain in this photo. The far right shows WOV 2882, a brooch from Lindholm, which has a large loop.

To the right is WOV 4118, a brooch set from Viking Age Finland, which has twin round brooches, a single bar brooch (used to pin the shawl, worn over the dress), and some tools, all permanently joined by bronze chains. This sort of arrangement was undoubtedly more expensive than using hooks, which are more versatile to meet the needs of changing fashions.

Necklace Hooks

While I took photos of two pairs of necklace hooks in the Danish National Museum, they did not come out well, so I must describe them from memory and the poor-quality photos shown to the right. The hooks are bronze but may once have been gilded. As with all the Norse jewelry pairs (brooches, hooks, etc.) that I have seen, the left is identical to the right, rather than the mirror image that the modern artistic eye expects.

Each hook is shaped vaguely like a tall triangle, covered with a zoomorphic animal design. The design used on both the museum artifacts was the Jelling style,

though this is difficult to tell, even with the enhanced close-up shown here. Each had a hook at the apex of the triangle, and four or five necklace strands were tied to the back, probably to loops or hooks, though the museum display make this impossible to see. The hook with five strands also had a small "spreader" bar at each end of the necklace, with holes through which the strands went to keep them spaced apart and orderly.

Clearly, the archeologist's interpretation of these objects as necklace hooks is speculation. I have seen other similar hooks interpreted as garter hooks. It is also possible that these hooks were chatelaines to hold the small tools that Norse women suspended from their brooches. However, the museum artifacts interpreted as hooks were found in pairs, each with a quantity of beads, and one pair of hooks had spacers (small bits of wire with holes in them). The presence of beads and spacers suggests these objects were hooks for a necklace set.

I was not able to accurately pinpoint these hook artifacts to a date and location, though the Danish National Museum included them in the Viking Age section, and the Jelling art style dates them to the late 10^{th} Century or early 11^{th} Century.

Jelling Style Art

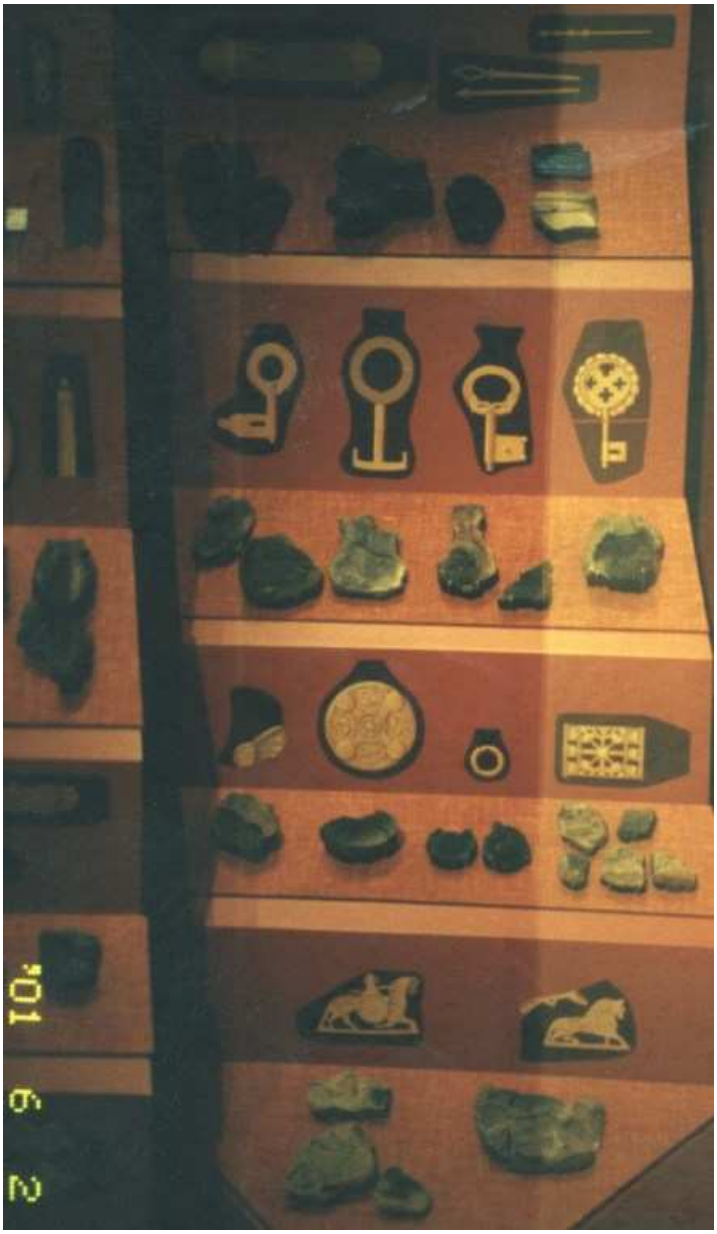
The Norse art known as the Jelling style, named after the Jelling cup, is characterized by ribbon-like animals knotted together, with different body parts of varying thickness. The thicker body parts are generally covered with stylized patterns that may represent scales, fur, or feathers. The animals usually have round eyes, with or without a pupil, and curls or spirals on the nose and sometimes at hip and shoulder joints. The overall animal is difficult to identify as to its intended species. The shape of the ears and jaws and the number of limbs are the only clues to the type of animal. Unlike Celtic knotwork or the zoomorphic designs seen in the Lindisfarne Gospel or the Book of Kells, the knotted pattern of a Jelling style animal is not usually symmetrical, but flows gracefully and generally fills the available space. When more than one animal is used to fill a space, the overall pattern could have radial symmetry, bilateral symmetry, or no symmetry at all.

Here are two examples of the Jelling style of art used on brooches. To the lower left is WOV 2836, a bronze brooch found in Hedeby. To the lower right is WOV 71323, a bronze brooch found in Iceland. Each has 4 intertwined beasts in a radially symmetrical pattern, surrounded by a simple border. These are composite brooches. The cutouts in the decorated top layer of metal give the pattern great depth.

These brooches not only illustrate the Jelling style very well, but are exciting because they are so identical in their artistic design that they must have been made by the same craftsman, despite the geographical distance between where they were found.

Copper-Alloy Casting

The archeological evidence for metal casting in 10th Century Denmark is extensive. However, some question remains as to whether the Norse craftsmen employed sand casting, or exclusively used fired clay molds.



Evidence of casting in hard-clay molds is widespread. At the museum in Ribe, I saw hundreds of clay molds that had been pieced back together, some of which are shown in the photo to the right. These reassembled mold fragments showed that the craftsmen of Ribe could cast metal in many types of tools and jewelry, including brooches. Traces of metal in clay crucibles found there show traces of bronze, brass, lead, silver, and gold (Jensen 31). Furthermore, the mold fragments found in any one location show that craftsmen routinely cast the entire variety of objects, rather than specializing in keys, brooches, and so on (Jensen 33).

The archeological digs at the Coppergate site in York, England, dated to Viking Age, also provide information about clay casting. These included many crucibles, ingot molds, and cupels (Bayley, 799). The crucibles show evidence of being used to melt all manner of copper alloys (Bayley 803), including brass and bronze, as well as silver (Bayley 799). Likewise, a wide variety of copper-alloy items were found in York, including strap-ends, buckles, brooches, and finger-rings (Hall 103-105).

The process of clay casting is, in theory, simple. A "master," or original, is carved from wax, including a wax sprue or gate to pour the metal, lugs to hold pins, or other hardware features. This master is carefully packed in clay, which is fired to pour out the melted wax and harden the clay. While the molds are hot, the metal can be melted and poured in. Finally, when the casting has cooled, the clay mold can be broken apart to free the metal item for finishing (Theophilus, 106). Clay mold casting can create nearly any shape including intricate shapes with undercuts, but requires one wax master for each item cast. However, my experiments with this technique have been only marginally successful, and I am still seeking to find the correct clay mixture.

The use of the sand casting technique is more difficult to document, because a mix of fine sand and clay would not be recognizable in an archeological dig as a casting component. However, sand casting produces a rougher surface on an unfinished piece than clay mold casting. A sand-cast piece has tiny pits and bumps which, in my own experiments with clay versus sand casting, do not occur with a fired clay mold. Some artifacts

show this type of bumpy surface and could, therefore, have been cast in sand. Sand casting is documented by Biringuccio in the 16th Century (324-328), but Theophilus in the 12th Century makes no mention of it. It is possible that it was available to 10th Century Danish metalsmiths, but I have not been able to prove it.

Sand casting is different from clay casting, in that the mold is made from two halves of packed sand, mounted in frames that fit together. One half of the mold is packed and dusted with powder to prevent it from sticking to the master or the other half of the mold. The original is pressed into the mold and dusted again. Then, the second frame is set in place and the second half of the mold is packed down, around the master model. Finally, the two halves are pulled apart to extract the master and cut sprue, gates, and vents. Sand casting can create any shape that does not have undercuts, can make many castings from the same master model, and usually requires more finishing work because of the parting line left between the mold halves. However, the effort of packing the sand can gradually damage a master made from soft material, like wax.

In either case, it is believed that the mold masters were usually made from wax originals, because beeswax was readily available, easy to carve, and has an advantage over wood or bone in that its lack of grain makes detailed carving easier. A copy of the wax master, of clay, lead alloy, or other durable material, was usually made as a basis for future castings (Jensen 33). Such a lead master could be used with clay to mold wax masters for clay molds, or directly in sand-casting.

Metal Working

At the Danish National Museum we saw an assortment of tongs, pliers, hammers, chisels, files, gravers, and other tools that were likely to have been used in carpentry but some of which could also be used in metalworking. The museum display did not provide any information as to where these tools were found, but the display was in the Viking Age wing of the museum. The Mästermyr find, from Sweden, also has similar tools (Arwidsson 12-17).

Works from later time periods, such as the writings of Theophilus and Biringuccio, can fill these gaps in our knowledge. The technology of metalworking is believed to have changed little during the Middle Ages. The main advances during that time were in the use of chemicals for parting, assaying, and pigments (Agricola 354), so it is likely that most tools and techniques from later periods could be applied to the Viking Age.

Forming, or bending, is an important step in many types of jewelry, including the pin holder on brooches and the hook portion of a necklace hook. The craftsmen had various types of pliers to accomplish this. Working metal this way causes it to become hard and brittle. The hardening varies with the type of metal. To restore malleability and ductility to the metal, a metalworker can conduct a process called annealing. Theophilus mentions annealing as being done at each stage of working silver (102, 138). His failure to define or describe the annealing process in a work that is otherwise very detailed is evidence that the concept of annealing was commonly known to metalworkers in the 12th Century. Biringuccio describes the process of annealing copper-silver alloy using a charcoal fire (362), and reiterates the importance of annealing after hammering (367). Alloys of gold, silver, and copper are quite different from ferrous metal in their reaction to heat. Annealing consists of heating the metal to a faint orange glow and quenching it to cool quickly, which softens the metal, allowing it to be further worked.

Finishing jewelry consists of shaping, smoothing, and polishing. There were many abrasives available in period, chosen by their availability and relative effectiveness on the material being worked. Theophilus describes the process of shaping with a flat hone (102) or flat sandstone (189). He describes a variety of files (93) and wire brushes (86) for shaping and smoothing harder metals such as brass and bronze. He describes smoothing as done with a piece of oak covered in ground charcoal (102) or fine sand and cloth (152). He describes polishing with a cloth covered in chalk (102) or powdered clay tiles and water (128), or saliva-moistened shale followed by ear wax (115). Biringuccio describes shaping as done with files, smoothing with cane dipped in powdered pumice (366) or sand and water (390), and polishing using tripoli powder (366, 374), or a wheel of copper or lead coated with powdered gems (122), emery (123), or lime (372).

Materials and Tools

I used brass for this project, because it is affordable and has a beautiful appearance. Its hardness and casting properties that make it just as challenging as silver or bronze. I purchased the brass from a jewelry supply outlet, because I lack the necessary experience to safely alloy my own. I carved the original necklace hook from beeswax, which is cheaper than modern carving wax, and is likely to be the wax used in period. I carved the brooch pattern from a sheet of carving wax, because I needed a stable, hard, thin sheet of wax for the brooch design.

The tools needed are:

- Carving tools to carve the original or "master" model (I made some from 10-guage wire and also used some small (1 mm wide) woodcarving tools)
- Casting sand, talcum powder, mold frame, and palette knife, to make the molds
- Crucible with tongs and a heat source that can keep the crucible at 2000° F
- Brass, bronze, pewter, or silver to cast, and flux (boric acid crystals)
- Graphite spoon and/or rod for stirring molten metal in the crucible
- Oven or kiln with controllable temperature capable of 300° F
- Fire extinguisher, fire-resistant apron, and safety glasses
- Dapping block (piece of 2x6 wood with an oval depression carved into it)
- Ball-peen hammer for dapping the brooch master on the dapping block
- Small bolt cutters or jeweler's saw to remove the sprue, wire cutters to remove the vents
- Drill with 1/32nd and larger drill bits; a drill press is the safest form of drill for this

- Tools to file and polish the cast piece
- Carved wooden jig to hold the hook for drilling
- Round-nose pliers to bend the hooks and pin holder
- Dust filter mask and light leather gloves for polishing
- Heavy welding-type insulated gloves for handling crucible tongs, hot molds, and metal

Method of Construction

Designing and Carving the Master Model

The design for the necklace hooks is one of the first free-form designs I have made. That is, I drew it on paper once and then proceeded to carve it. The design is that of a dog, in Jelling style. The only deviation from Jelling style is that I did not put decorative patterns on the animal's body, because I wanted a clean and simple design that did not distract from the necklace it would display or any brooch with which it was worn.

I carved an original model of the hook from a thin slab of beeswax, made by pouring melted wax onto a tin plate. For ease of casting, I left the hook portion as a long thin straight bar. The lugs on the back, used to make the loops, were also cut from beeswax and melted into place. I made the lugs slightly tapered to make it easier to get them out of the sand mold.

The final step in making a wax original is to fire-polish it. This is done over a small heat source, such as an alcohol lamp, and requires great care. Hold the model over the flame, always moving it to keep the temperature under control. To do this properly, it helps to be able to see the underside where the heat is acting on the wax. The idea is to melt the wax enough that its surface becomes smooth, and gravity pulls it into a nice rounded form. Fire-polishing takes a great deal of practice, because overheating the wax or holding it at the wrong angle can ruin the design. Beeswax in particular is difficult to fire-polish, because it goes from solid to liquid in an instant, and is thus much less forgiving of fire-polishing errors than the modern carving waxes. If the fire-polishing goes poorly, however, you can get out your carving tools, solder on more wax, and repair the design.

I then sand-cast a pewter master from the wax one. A mold original made from wax is very soft and flexible. This means that when the sand is packed down, the wax will not break, but it will gradually be compressed and lose its shape. A period solution is to cast a master from the wax original using a base metal such as pewter or bronze, with a hard-packed mold to capture maximum detail, then using the metal master for future castings.

Preparing the Mold for the Master

Put the flat side of the mold frame on the bench, fill it with sand, and pack it down. The master is fairly flat and would not have to push far into the sand, so pack the sand down hard. Then, turn the frame over, powder it, and press the master, non-detailed side down, into the sand. Powder the master a bit, put the other mold frame on, and sift the sand over it. Once the master is covered with a layer of finely crumbled sand half an inch thick, fill the frame with sand and pack it down. Separate the halves, carefully remove the original, and with a palette knife carve a sprue channel into the sand. The sprue is the cone-shaped piece of metal where you poured into the mold, and will be cut off the casting after it is poured. Put the mold halves together and set the mold up to pour. Depending on the type of mold frame, you should loosely clamp or weight the mold shut, to keep the frames from being forced apart by the momentum of the metal when you pour.

Melting and Pouring the Master

Heat the metal in the crucible, using a kiln, oven, or torch. Silver, brass, or bronze should be heated to about 2000° F; it will have a "sheen" on the top and glow bright orange when the metal is above its "flow" point. Pewter can be heated to about 600° F; it may have a thin gray oxide coating which you should scrape off, and it will be as shiny as a mirror beneath the oxide layer. With either metal, it should "flow," that is, it should be as liquid as water or mercury. If the temperature is too low, the metal will not flow properly and may not enter all the recesses of the mold. If the temperature is too high, or the sprue too thin, the metal may not cool evenly and may create smooth "implosion" pits in the finished casting. When the metal is slightly above flow temperature, pour it into the mold. Pour it all in one smooth motion into the sprue channel, taking only about one second to do so. This also takes practice to do well.

After the visible top of the sprue cools to a dark color, carefully separate the mold halves, take out the casting (it will still be hot), and tap the sprue on the bench to remove the burned sand. Then, polish the casting a bit to see if the pattern came out well. If it did not, you can melt it down and try again. Any sand that is burned black should be thrown away, but the rest can be sifted and reused.

Casting the Hooks

Cast the hook in the same sand-casting process as described above. Again, it is wise to make a master from which all future castings are made. There is no need to bake the mold as you did with the brooch. The casting is smaller and is less likely to cause the metal to solidify before it can reach the end of the hook, though vents are still important, particularly with bronze.

Finishing

Cut off the sprue, grind off any excess metal (flash) around the edges, and smooth all the parts down. I was able to do most of the smoothing with the 600-grit belt sander, though certain detailed areas of the edge required me to use hand files. Smooth the front and back, and polish the front and the back of the hook portion (which will become the front when it is bent) to your satisfaction. Due to the small size of the hooks, I used the white, black, blue, and pink polishing wheels (rubber wheels impregnated with graded abrasive) for this.

Then, anneal the metal by heating it to a dull red and quenching it in water. With the round nose pliers, form the hooks into shape while the metal is still warm. My experiments have shown that it is easiest to put on a necklace hook when the hooks bend forward, toward the decorated side, particularly when the brooch loop is attached to the pin behind the brooch and is not visible, so you should bend the hook in that direction. If the hook hardens as you bend it to the point that it becomes difficult to bend, STOP and anneal the hook again, or it will break. With brass or silver, one annealing is enough, but bronze requires two.

Put the hook in your homemade wooden jig to hold it firmly, and drill the string holes in the lugs. I tried using my hand-powered reciprocating push drill, but I lack sufficient practice with it and the bit kept binding. I had to use the drill press.

File away any sharp edges left by the drill, and polish out the marks left by the pliers. If desired, you can fill the recesses of the design with niello or enamel, use vinegar or muratic acid to darken it, or use a flame to age the metal and then surface-polish the hooks. I preferred to let the pattern remain subtle and become more visible over time through a natural aging process.

Lessons Learned

The hooks took about 2 hours to carve the original, 2 hours to cast both hooks (not counting a metal original for future castings), and 3 hours to form and finish the hooks. I broke one or two hooks before I got the annealing temperature correct.

I have used the same hook design to experiment with casting in hard clay molds, which will be the topic of another paper some time next year.

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Various museums in Denmark. In the summer of 2000, my lady and I traveled to Denmark and visited the National Museum in Copenhagen, the Viking Ship Museum in Roskilde, the Viking Museum in Ribe, and the research/reconstruction sites at Fyrkat, Trelleborg, Jelling, and Lehre. We took many photos, saw many artifacts, and spoke to an archeologist or two. What we saw on this trip gave us ideas and research for years of arts and sciences projects. Our only complaint is that we had to take our own photos, which did not always come out well when taken through the glass that protected the artifacts. None of the museums sold information or photos of individual artifacts.

York Archaeological Trust and the National Museum of Denmark, The World of the Vikings (CD-ROM), Past Forward Limited, undated. This CD contains thousands of photos of artifacts, but the historical information about each artifact is quite limited. The CD is still quite useful because it often shows the same artifact from different angles, detail photos, etc. I eagerly anticipate the 10-year anniversary edition that is coming soon.


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