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LEARNING THE TECHNOLOGIES OF MAKING BEADED WIRE

The article discusses the process and results of experimental archaeology carried out in Tallinn in 2008/2009 to learn about and revive the technologies of making beaded wire. Such technologies that were once commonly known have by now been forgotten at least in Europe. Several experiments led to the recognition that beaded wire can be made with the aid of two iron knives. Knowing the material properties of gold and silver implementing specific working methods guarantees the making of beaded wire with the aid of two knives – the technology was easily understood, the result was effective and the quality constant. The use of beaded wire was closely connected with the filigree and granulation techniques and it may be possible that beaded wire was abandoned in favour of filigree wire that required less specific skills.

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Introduction

Blacksmithing and the art of goldsmith belong to traditional crafts. Therefore a comparison of archaeological and ethnographic material is used to learn about the making of ancient blacksmithing and goldsmith items (e.g. Rybakov 1948; Oldeberg 1966; Evans 1970; Untracht 1987; Ogden 1992; Eniosova & Saracheva 1997; Peets 2003). Such research method is often supplemented with experimental archaeology (e.g. Svarāne 1994; Stemann Petersen 1998; Armbruster et al. 2003; Tamla et al. 2004). This research method realizes that most of the specific knowledge, crafts and working tools required for traditional craftsmanship are so archaic that they may originate from prehistoric times.

Experimental archaeology is especially necessary when ethnographic material for comparison is absent and the researcher is in doubt about the technology and tools used for making the ancient item. In such cases it is recommended to turn to a professional who masters the specific craft and whose experience and skills provide a basis for the practical side of the experiment that either supports or disproves the hypothesis based on archaeological source material and/or the validity of the interpretation based on the external observation of the item.

The international conference on experimental archaeology held in 1999 in Chicago concluded that only experiments with scientific value may be regarded as experimental archaeology. Such an opinion was based on mixing up separate concepts of experimental archaeology as a research method: 'experiment', 'experience' and 'education'. J. R. Mathieu (2002a; 2002b) suggests that the following circumstances are necessary for experimental archaeology to be considered serious research: the experiment either supports or disproves a hypothesis offered by archaeological source material; the experiment must be repeatable; the results of the experiment must be assessable. Regardless of the critical attitude towards experimental archaeology and the scientific credibility of the objects made during the experiments (see Reynolds 1999), it is still admitted that experience is the best teacher: the experience gained through the practical experiment has an important role from the educational and cognitive point. At the same time it is agreed that an experiment can never convey the motives or emotions of the prehistoric person crafting the objects. For example, it is futile to measure the time required for making a replica of a prehistoric object, since the time depends on a number of reasons, including the material, tools, skills, etc., and hence it may only express the prejudices, skills or ineptitude of the person involved in the experiment (Coles 1973). Yet, experimental archaeology may be an invaluable source for reviving forgotten crafts.

In 2008/2009 experimental archaeology was practised in Tallinn by a jeweller and engineer Harvi Varkki. The experiments were motivated by a wish to study more profoundly one of the ancient crafts that was once commonly practised, but which by now has been forgotten (at least in Europe) in the goldsmiths' profession – the making of beaded wire and questions about the technology.

Beaded wire (*Perldraht* in German) was probably named after its similarity to round pearls on a wire. The earliest examples of beaded wire date from Egypt of the 14th–13th centuries BC. In Europe ornaments decorated with beaded wire were more common in the jewellery of the 8th–6th centuries BC Greece and especially in the high quality art of the Hellenistic period. In northern Europe beaded wire ornaments can be found already from the early Iron Age, but the technique really flourished during the Migration Period and the Viking Age, when beaded wire was mainly used to decorate gold and silver ornaments crafted in filigree and granulation techniques (Duczko 1985, 19; Andersson 1995, 128 ff. and references cited therein; Whitfield 2002). The only prehistoric items decorated with beaded wire found in Estonia are the five gold pendants from the Essu hoard (Fig. 1; Hansen 1875, 16; RK, pl. 27: 3–5). These pendants[1] have been crafted by one and the same very skilful master and dated to the second half of the 9th century (Leimus 2006, 26). Technologically similar but different in pattern, gold disc-shaped pendants are known from the 9th century Hoen Hoard from Norway (see Fuglesang & Wilson 2006, nos 31–33, pl. 15) and from the 10th–11th century

[1] One of the Essu pendants (AM 87: 2) has been lost. Photo of this pendant is published in RK, pl. 27: 4.

Fig. 1. Gold pendants decorated with beaded wire from the Essu hoard (AM 87: 1, 3, 6, 5).

hoard found from Gnjozdovo hill fort, Russia (Put´ iz varjag v greki 1996, 57, nos 334–336). Various scholars have come to different conclusions regarding the origin of these ornaments (Carolingian, Anglo-Saxon, Scandinavian or Russian) but they all emphasize a high quality of the craftsmanship.

There is only one suspected special tool for making beaded wire, which has been preserved in archaeological material,[2] but more information to solve the problem may be found in the Latin book *De diversis artibus* (*Schedula diversarum artium*) by the monk Theophilus who worked in the 12th century. This book contains a description of two tools that were necessary to make beaded wire – an *organarium* and *lima inferius fossa* in Latin (the first can be translated as “little organ” and the second as “beading file”; see Hawthorne & Smith 1979, 88 ff.;

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[2] According to Ilkjær (2000, 117 ff.) the file for making bead-ornamentation survives in the Roman Iron Age bog find from Illerup Ådal, Denmark. This implement consists of a curved piece of iron, with a groove in it, set into a wooden handle.

Brepohl 1987, 69 ff.). Relying on the information given in the book a number of researchers and goldsmiths have tried to reconstruct similar tools and make beaded wire with them (see Hawthorne & Smith 1979, 89 and references cited therein; Duczko 1985, 18 ff.; Brepohl 1987, 69 ff.). These experiments have been based on the hypothesis that the craftsmen of the time required the special instruments mentioned by Theophilus in order to make beaded wire. We suspected that in addition to the *organarium* and the beading file the jeweller must have also used simpler tools. Hence we did not concentrate on the instruments described by Theophilus.

Theophilus' tutorial on how to make beaded wire: *organarium* and *lima inferius fossa* and their work principle

Theophilus was a monk with encyclopaedic knowledge who lived in the 12th century Germany. In his secular life he had been a professional craftsman with versatile skills, possibly a smith or a jeweller. His book *De diversis artibus*, which he probably wrote between 1110 and 1140, contains several useful recommendations for various working methods, including a jeweller's work (see Lynn 1965; Hawthorne & Smith 1979, xvi; Brepohl 1987, III; Ramsay 2001, xvii ff.). The description of how to make beaded wire with two instruments – *organarium* and *lima inferius fossa* is given in chapters nine and ten of the III part, devoted to the crafts of the blacksmith and goldsmith. The *organarium* and ways to work with it are described as follows: '*There is also an iron implement called the organarium which consists of two pieces of iron, a lower and an upper one. The lower one has the width and length of the middle finger and is slightly thin, with two spikes which fit into a piece of wood below it. On the upper side above these spikes there project two thick pins which hold the upper piece. The latter is of the same width and length as the lower one and has two holes, one at each end, through which the upper parts of the two pins should pass so that the two pieces will fit together. They must be fitted exactly to each other with a file, and [a series of] small grooves should be cut out in both pieces in such a way that holes appear right through the middle. Then, a long [rod] of gold or silver, hammered evenly round, is pushed into the larger hole and the upper part of the tool is struck hard with a horn hammer while the piece of silver or gold is turned with the other hand. Round beads like beans will then be made; in the second hole they become like peas; in the third, like lentils; and so on smaller.*' (Translation from Latin into English: Hawthorne & Smith 1979, 88 ff.)

It appears that *organarium* works as a two-part form, where a wire with a round crosscut is pressed so that it gets a relief, i.e. into beaded wire. Erhard Brepohl (1987), who presents an image of his reconstruction of the *organarium* (Fig. 2), drew our attention to the fact that other researchers before him have interpreted the description of the instrument by Theophilus slightly differently and therefore different results have been achieved in making beaded wire

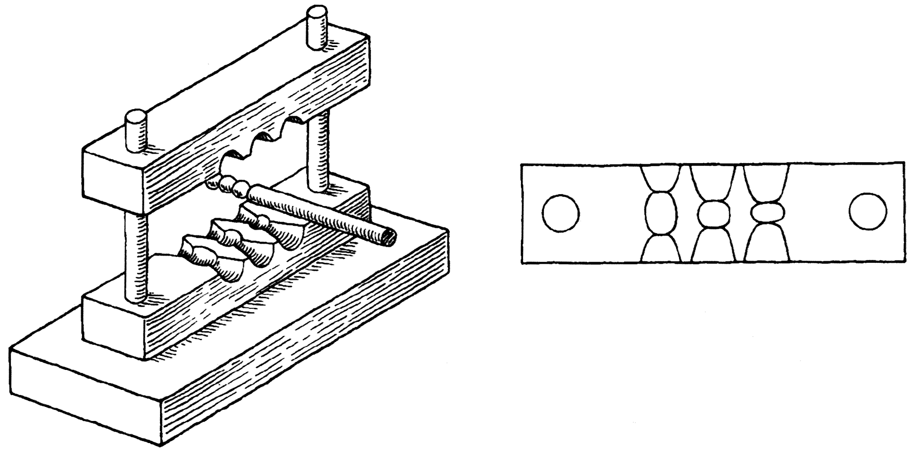

Fig. 2. *Organarium* for making beaded wires, as described by Theophilus. Reconstruction by Erhard Brepohl 1987.

(Brepohl 1987, 69 ff.). Wladislaw Duczko supports the opinion, and considers Theophilus' description of the *organarium* to be detailed, but also notes that the shape of the concavities between the beads of the beaded wire remains unclear: in addition to grooves also dimples were made into the wire and therefore it is not certain whether the instrument was used to press the grooves one by one, i.e. whether the beads were created to the wire one at a time, or whether the instrument pressed the grooves as a series and a longer row of beads was attached to the wire at a time (Duczko 1985, 21).

Theophilus describes the other instrument for making beaded wire, the so-called beading file (Theophilus's '*lima inferius fossa*') and gives instructions how to use it briefly and concisely: '*There is also tools, as thin as a straw, a finger-long, and nearly square, but wider on one side. Their tangs, on which handles are put, curve upwards. On the underside a longitudinal strip is dug out and filed like a furrow, and the faces on both sides of this are filed sharp. With these tools both thick and thin wires of gold and silver are filed so that beads appear on them.*' (Translation from Latin into English: Hawthorne & Smith 1979, 90.)

This description shows that the instrument was a two-part tool, the lower part being a flat working space and the other was a file with two handles and a longitudinal strip on its underside. Researchers agree that this tool has nothing in common with the classical file, yet the move that the craftsman had to make in order to make the beaded wire resembled most classical grooving. W. Duczko (1985, 19, figs 3–6), who reconstructed a beading file in the 1980s according to the instructions given by Theophilus and carried out practical experiments with it, added that the wire placed on a hard wooden surface first has to be filed from side to side and then forward and backwards, bearing in mind that pressure on the wire should not be too hard and filing should not be excessive. With such method a globular bead appears on the wire with a round crosscut. Next, the file is moved along the wire in such a way that its one side is placed in the groove of the first bead, filing it the same way until the next bead appears. Moving on step-by-step and filing each groove of the next bead, work is continued until a beaded wire of a required length has been created.

Description of the experiment of making beaded wire in 2008/2009, development of ideas during the experiment and interpretation of the results

Having studied the illustrative material published about goldsmith articles from various periods and different parts of the world, we realized that the different beaded wires always demonstrate minor peculiarities or divergences both in the shape of the beads and in the rhythm of the grooves between the beads. These characteristics are contributed to the different 'signature' of craftsmen in the traseological study and interpretation of archaeological items. The large number of different variants and divergences from regular beaded wires is so great that it is not possible to explain that only by the possibilities of using the two above-described tools. Therefore we decided to try and solve the issue from the point of metal treatment technologies. We attempted to work out technological stages and find suitable tools and working methods for the different stages.

The characteristic features of deformations on beaded wires suggested that analogical bruising could be left on the wire alternately by the blade of a sharp and a rounded knife. Experiments with the deformed wire showed that higher pressure on the wire made it brake, when the strength limit of the metal was exceeded. In order to obtain historical analogues a bigger deformation was needed. Hence the necessity to use a support or a counter knife emerged that could be firmly fixed to the working space.

Therefore the technology of making beaded wire with the help of two knives developed, which allowed to produce an endless number of different wires. The use of two knives was also supported by the fact that knives have been used by mankind from the earliest times.

During the experiment we attempted to make beaded wire from round silver wire with the diameters of 0.5 mm, 0.6 mm, 0.9 mm, 1.5 mm, 2.0 mm and 3.5 mm with the help of two iron knives. We called the first knife a working knife and the second one an auxiliary knife. First we used 20-cm long knives with a rounded back or with a so-called U-shape. The blade of the working knife thickened evenly towards the handle for approximately 4 times, the sharpening angle of the V-shaped blade increased smoothly to the handle up to 30–100 degrees. We pressed the V-shaped back side of the auxiliary knife into a slightly hollowed timber brick and checked that the knife should be firmly fixed in the brick (Figs 3 and 4). With the aid of such simple and convenient tools we made the beaded wire in three stages.

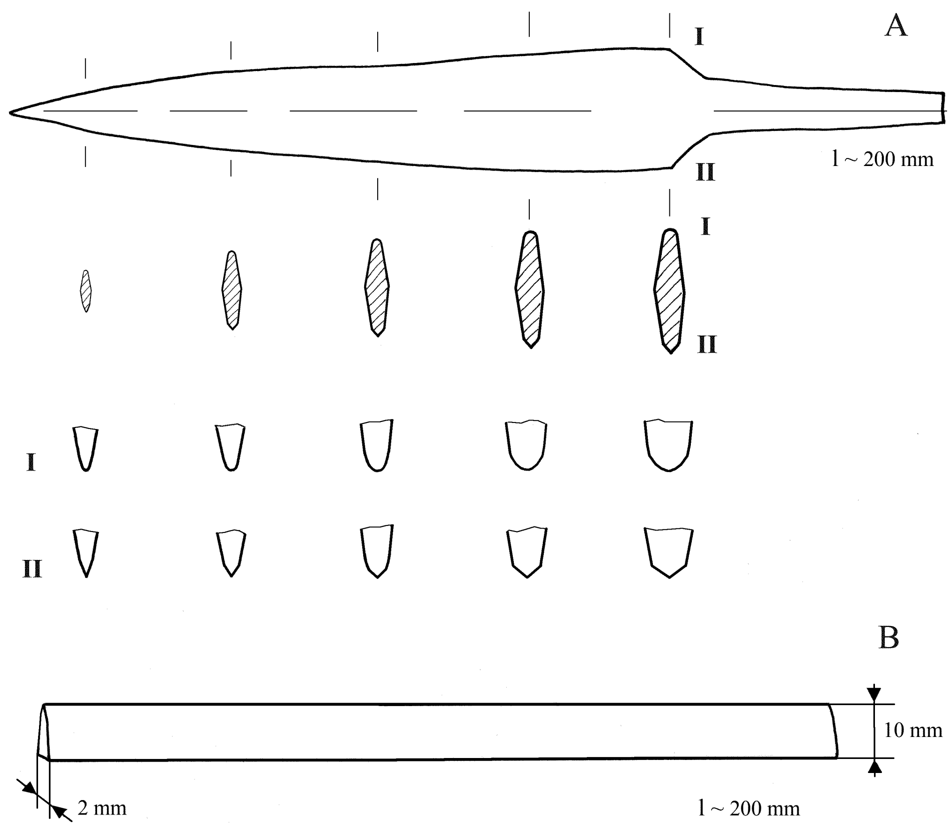

Fig. 3. Working knife (A) and an auxiliary knife (B).

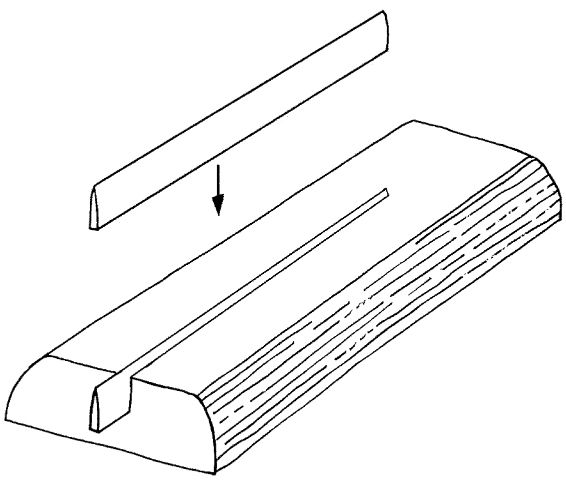

Fig. 4. Auxiliary knife pressed into a timber brick.

First, a wire with a round crosscut was placed on a hard surface, in our case a polished antler. An antler was picked for the reason that it was harder than any timber and retains its smooth surface during the work process. With the V-shaped blade of the knife we cut parallel strips in the wire, crosswise with the wire (Fig. 5). Due to the profile of the working tool's blade and the moves made with it the bottoms of the strips cut in the wire were sharp, i.e. V-shaped, bruising the soft wire made the edges of the cuts rise above the wire surface. At the same time cutting strips into the wire made the wire itself longer, because the knife pushed the edges of the cuts away from one another (a fine example of two different stages of making beaded wire, see Andersson 1995, fig. 98).

Next follows modelling the V-shaped strips with two knives. The wire that has previously been heated to 650 °C is placed on the back of the auxiliary knife, the round back of the working knife is used for making rolling moves in the sharp strips described above (Fig. 6). This makes the strips deform flatter;

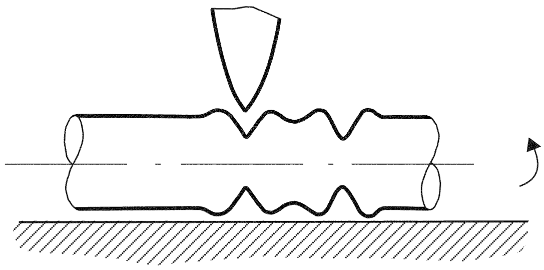

Fig. 5. The first stage of making beaded wire: with the V-shaped blade of the working knife parallel strips in the wire were cut crosswise with the wire.

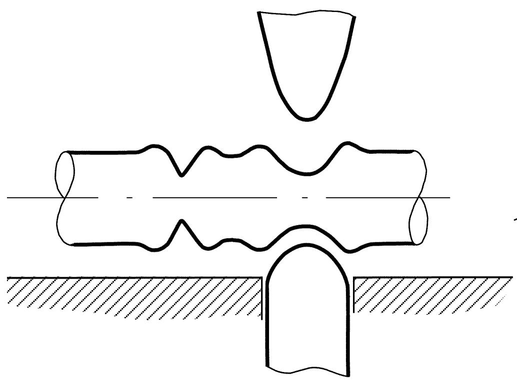

Fig. 6. The second stage: modelling the V-shaped strips with two knives. The wire is placed on the back of the auxiliary knife, the round back of the working knife is used for making rolling moves in the sharp strips.

simultaneously material is pressed upwards from the bottom of the strips to the edges and to the upper surface of the wire. Then the wire has to be heated again to release the pressure.

The last procedure was to model the spherical surface of the 'beads' that had risen up. For this the wider end of the V-shaped back of the working knife near the handle was used (ca 100 degrees), rolling the beaded wire on top of the strips. While rolling the wire, the position of the tool was tilted both to the right and to the left, the V-shaped tip of the blade touching the beads on both sides of the strips and forcing them into a spherical surface (Fig. 7).

After the beaded wire has been completed, it is recommended to heat it once again. The described experiment proved that in the first stage, which could provisionally be called the marking and cutting of beaded wire (Fig. 5), the craftsman's knowledge of material was essential: excessive force on the wire could cut it through, i.e. exceed its cutting strength. The distance between the strips depended entirely on the sharpness and aesthetic taste of the craftsman. Yet, from the point of the wire's strength this has no relevance.

In addition, it appeared that the sharpening angle of the working knife might not be strictly defined, and each master may have chosen it according to his working habits and character of the work. However, we determined that making beaded wire with the help of two knives is effective and universal, since changing the thickness of the blade gives the craftsman the possibility to apply one and the same tool for treating wires of different thickness. Also, the craftsman could change or combine the two last stages of making beaded wire according to his wish and aim. In order to achieve greater spherical surface of the beads the second and the third operation should be repeated several times.

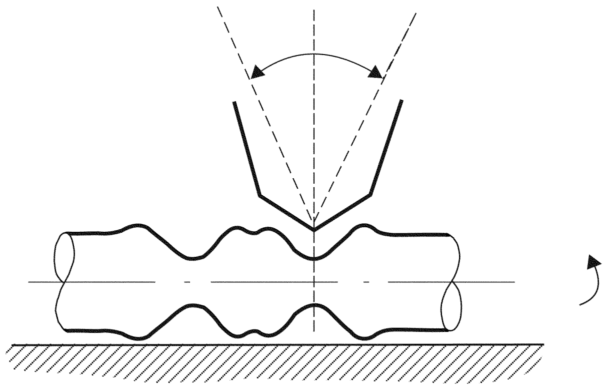

Fig. 7. The third stage: modelling the spherical surface of the 'beads' that had risen up. For this the wider end of the V-shaped back of the working knife near the handle is used (ca 100 degrees), rolling the beaded wire on top of the strips. While rolling the wire, the position of the tool is tilted both to the right and to the left, the V-shaped tip of the blade touching the beads on both sides of the strips and forcing them into a spherical surface.

A number of experiments proved that the length of the working knife could also be relatively small in case of treating thinner wires, i.e. ca. 5 cm. The work became more effective when the moving directions of both knives were changed in relation to each other, provided the rolling direction remained the same. Special attention and concentration was required to make the knife for treating thin wire (e.g. diameter of 0.5 and 0.6 mm). It was necessary to 'tune' the instrument – checking it out in practice and rectify the shape.

Interesting results were obtained while searching different deformation possibilities of the wire. For example, a spiral threaded wire was obtained by rolling the wire on the antler and changing the angle of the working knife in relation to the wire (Fig. 8).

Enlarging the strip on the wire proved to be effective while using two knives with a cutting angle of 50°–70°, when the direction of the working knife was changed in relation to the auxiliary knife (Fig. 9). The strip on the beaded wire can be enlarged, the extent of deformation may be bigger when heating the wire and repeating the process for several times. It is recommended to keep the rolling direction the same, e.g. rolling outwards.

In order to model the spherical surface of the beads another working knife was tried, with a vein goofed in its round back. It appeared that this particular

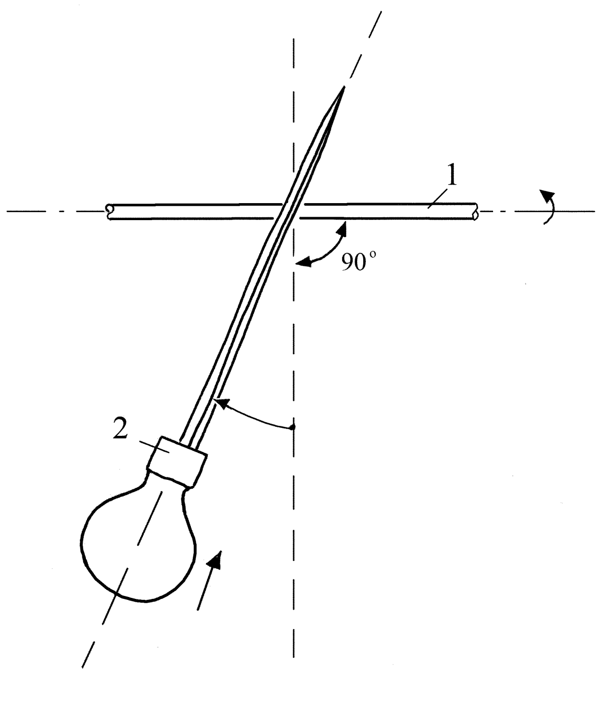

Fig. 8. Spiral threaded wire was obtained by rolling the wire (1) on the antler and changing the angle of the working knife (2) in relation to the wire.

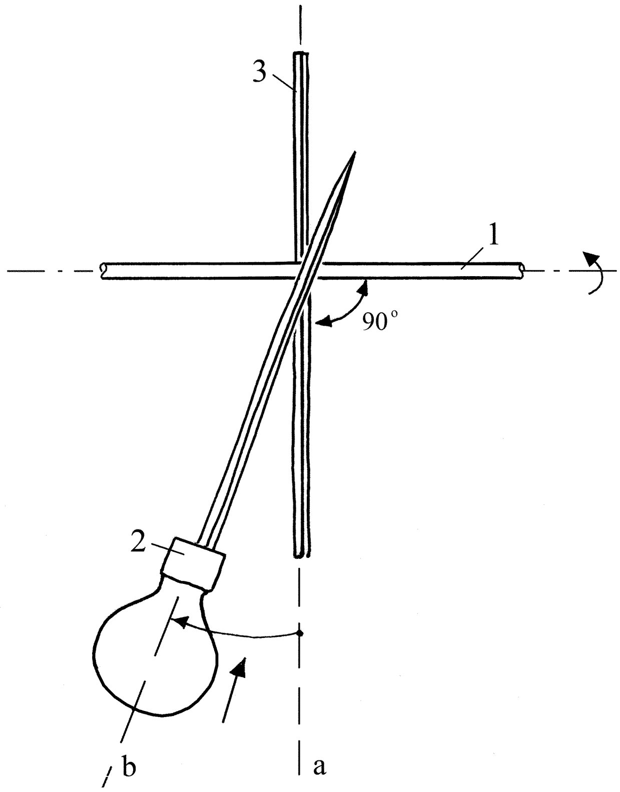

Fig. 9. Enlarging the strip on the beaded wire (1) was effective while using two knives, when the direction of the working knife (2) was changed in relation to the auxiliary knife (3). a rolling direction of the wire, b moving direction of the working knife.

working method was the most effective. The deepness of the vein, the proportions and the sharpening edges were essential (the sharpening edges must be slightly rounded to cut into the material, the depth of the vein has to be minimal). As an option, a test was carried out to model the spherical surface with the help of two knives with a vein grooved into both of them (Fig. 10: A) or where the working surface of the working knife was flat (Fig. 10: B).

All these experiments demonstrated that a number of variations were possible and supported our opinion, which we had got while studying the photos of ornaments, weapons, regalia, etc. from different periods and different countries, incl. Egypt, India, Tibet, Hungary, Italy, Ireland, Sweden, Norway, Denmark and Russia (Vilímkova 1969; Evans 1970; Duczko 1985; Wolters 1986; Untracht 1987; Whitfield 1987; Ogden 1992; Batley et al. 1994; Andersson 1995; Ilkjær 2000; Fuglesang & Wilson 2006) that the final stage of making a beaded wire depends and also depended in the past largely on the imagination and skills of the craftsman to combine different tools.

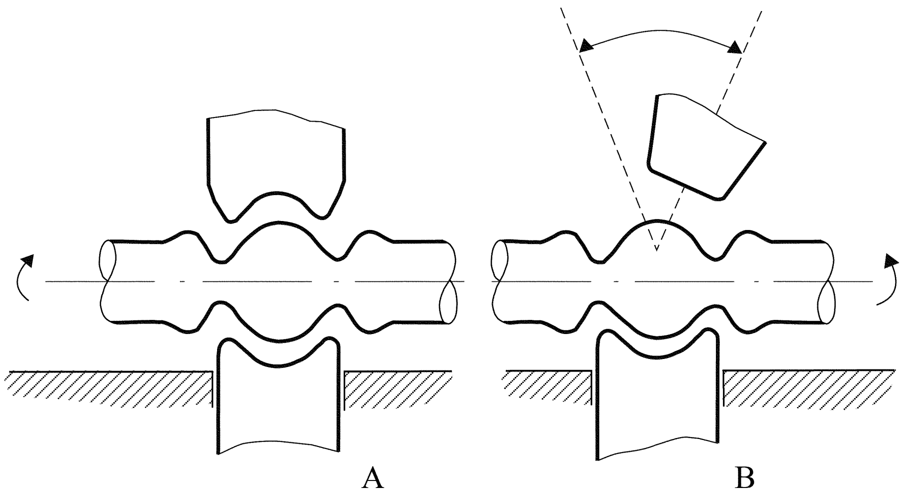

Fig. 10. Modelling the spherical surface of the beaded wire with the help of two knives with a vein grooved into both of them (A) or where the working surface of the working knife is flat (B).

Discussion and conclusion

The analyses of Theophilus' description of the *organarium* and the beading file concluded that they are appropriate measures and manual for making beaded wire. Without any doubt the *organarium* was a masterpiece among tools of the time and an exceptional instrument. Such a tool could only be made or possessed by very wealthy workshops. And also vice versa – a definite sign of using an *organarium* refers to a possible place of production.

The beading file, also described in the same book, is contrary to the *organarium* a universal tool, since its application was not limited by the diameter of the wire. Yet, this tool had its drawbacks as well: the shape of the bead's sphere had a fixed size. For the craftsman it meant that whenever he wanted to change the diameter of the beaded wire, he would have had to make a new tool for a different size strip as well. Our experiments proved that making a beaded wire allowed to choose combinations of technologies and working methods, where the regularity of the result may have mistakenly led to the belief that an *organarium* was used. We also established that the existence of an equator in the bead implies the use of a beading file.

The experiment of making beaded wire in 2008/2009 in Tallinn was motivated by an interest to find the most suitable and simple tools for making beaded wire, with a clear working principle, an effective result and stable quality. Several experiments finally led us to the realization that the best outcome was achieved with two knives (a working knife and an auxiliary knife). The production of such knives was within the powers of every smith.

Knowing the material properties of silver and gold it is possible to make beaded wire with the help of two knives, but it requires specific working methods and the use of remarkable force. For example, in case the diameter of the wire enlarged, it was essential to find the right combination of working methods. The enlargement of the diameter of the wire conditioned also bigger force on the wire. This explains also the technologies of the beading file with two handles described by Theophilus (see Hawthorne & Smith 1979, 90 and the reconstruction of the beading file by Duczko 1985, figs 3, 4). Similar reasons would justify the making and use of an *organarium.*

The experience gained during the experiments allows us to conclude: there are several possibilities that may lead to a required result; the appearance of the beaded wire depends largely on the master's choice of tools and on how much energy and time are foreseen to be spent on the production. For example, enlarging one element of the beaded wire, the spherical surface of the bead, increases considerably the volume of work. Good eyesight of the craftsman is also essential (e.g. a beaded wire with a diameter of 0.3 mm was used on the pendants of the Hoen hoard, see Fuglesang & Wilson 2006, tab. 59: C), and a skill to make a tool required for such miniature work.

Naturally the making of beaded wire starts with making a common wire with a round crosscut. In addition to following the right technology through the process, the right content of the metal is also important: the fewer additives there are, the more plastic, homogeneous and treatable the metal is. The most suitable metals for making beaded wire are gold and silver with a high hallmark. Even a small amount of additives makes the material considerably harder and consequently the making of beaded wire becomes more difficult.

Considering the metal for beaded wire, the most important thing is to realize the plasticity and deformation of the material and heating it several times, in order to balance the inner structure of the metal that was tensioned during cutting and rolling. If we fail to release the tensions that emerged during treating the metal by heating, we shall end up with several small wire strips instead of beaded wire.

The reason why the making of beaded wire has been forgotten, may lie in the overall decrease of craftsmanship. The use of beaded wire was closely connected with filigree and granulation techniques, it may be possible that beaded wire was abandoned in favour of filigree wire that required considerably less specific skills.

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Ülle Tamla ja Harvi Varkki

PÄRLTRAADI VALMISTAMISVÕTETE TUNDMAÕPPIMINE

Resümee

2008. ja 2009. aastal viidi Tallinnas läbi eksperimentaalarheoloogilised katsed, kus praktilise töö tegija oli ehtekunstnik ning insener Harvi Varkki. Need eksperimendid olid ajendatud soovist uurida lähemalt üht iidset ja vanasti üsna laialt levinud, kuid nüüdisaegses kullassepakunstis unustatud (vähemalt Euroopas) tehnoloogiat: pärltraadi valmistamist ning sellega seonduvat küsimuste ringi.

Pärltraat sai arvatavasti oma nimetuse välisest sarnasusest ümmargustest helmestest keega. Varasemad teated pärltraadi valmistamisest pärinevad Egiptusest 14.–13. sajandist eKr. Euroopas oli pärltraatidega kaunistatud esemeid rohkem Kreekas (8.–6. sajandil eKr) ja eriti kõrgetasemelises hellenismiajastu kunstis. Põhjapoolses Euroopas esines pärltraadiga ehteid vanemal rooma rauaajal, kuid selle tehnika õitseaeg jäi siiski viikingiaega, mil seda kasutati põhiliselt filigraan- ja granulatsioontehnikas teostatud kuld- ning hõbeesemete kaunistuselemendina. Ainsad Eestist leitud pärltraadiga kaunistatud muinasaegsed ehted on Essu aardes sisalduvad kuldripatsid (joon 1). Need on võõramaist päritolu ja valmistatud kõige tõenäolisemalt 9. sajandi teisel poolel.

Kuna Illerupi (Taani) rooma rauaaegses sooleius sisalduv puust käepidemega kumer viil on ainus arheoloogiline tööriist, mille kohta on arvatud, et seda võidi kasutada pärltraadi meisterdamiseks, pakub probleemi lahendamisel mõttepinget 12. sajandil Saksamaal tegutsenud munk Theophiluse ladinakeelne õpetusraamat "De diversis artibus" ("Schedula diversarum artium"), kus on üsna detailselt kirjeldatud pärltraadi valmistamiseks mõeldud kaht tööriista: *organarium*'i ja *lima inferius fossa*'t (*väike orel* ning *pärliviil*). Nimetatud allikale toetudes on mitmed uurijad proovinud rekonstrueerida samasuguseid tööriistu (joon 2) ja püüdnud nendega pärltraati valmistada. Nende katsete läbiviimise lähtekohaks on olnud hüpotees, et pärltraadi tegemiseks olid toonaste ehtemeistrite tööriistade arsenalis Theophiluse kirjeldatud vahendid. Meie oletasime, et lisaks *organarium*'ile ja pärliviilile pidi muistsete juveliiride käsutuses olema ka oluliselt lihtsamaid tööriistu.

Tutvunud kirjanduses eri ajastute ja maailma eri piirkondade kullassepatoodete pildimaterjaliga, veendusime, et pärltraadivariandid paistavad silma oma pisi-

keste eripärade ehk hälvetega nii pärlite kujus ning rütmis kui ka pärlitevahelistes vagudes. Need on tunnused, mida arheoloogiliste esemete traseoloogilisel uurimisel ja tõlgendamisel on seostatud eri meistrite "käekirjaga". Lahendusvariantide suur mitmekesisus ja paljud kõrvalekalded korrapärastest ei luba pärltraadi valmistamisvõtteid seletada ainult Theophiluse kirjeldatud kahe tööriista kasutamise võimalusega. Seetõttu ei keskendunud me Theophiluse kirjeldatud vahenditele, vaid lähenesime küsimusele metallitöötlemise tehnoloogia seisukohast. Püüdsime välja töötada pärltraadi valmistamise tehnoloogilised etapid ja leida nende sooritamiseks vajalikud tööriistad ning vastavad töövõtted.

Deformatsioonide iseloomulikud tunnused ajaloolistel pärltraatidel lubavad oletada, et analoogseid muljumisjälgi saab tekitada kohati terava, kohati ümardatud noateramikuga. Katsetused traadi deformeerimisel näitasid, et traadi suuremal muljumisel hakkas see metalli tugevuspiiri ületamisel katkema. Siit tekkis vajadus toe ehk abinoa kasutamiseks, mis kinnitati stabiilselt tööalusele (joon 3, 4). Nii kujunes pärltraadi valmistamise "kahe noa" tehnoloogia, millega oli võimalik saada lõpmatu hulk eri lahendeid. Selliste lihtsate ja käepäraste tööriistade abil, mille valmistamine on jõukohane igale sepale, toimub pärltraadi valmistamine tinglikult kolmes etapis (joon 5–7).

Kirjeldatud eksperimendi käigus tõdesime, et esimesel tööetapil (nn pärltraadi märkimine ja lõikamine, vt joon 5) on tähtis meistri materjalitunnetus: liiga suure jõu rakendamisel võib traadi läbi lõigata, st ületada metalli lõiketugevuse. Vagudevaheline kaugus sõltub aga üksnes meistri silmatäpsusest ja ilumeelest, kuid traadi tugevuse seisukohalt pole sel tähtsust. Samas veendusime, et kahe noa abil toimuv pärltraadi valmistamine on efektiivne ja universaalne, kuna noateramiku paksuse muutmine tagab meistrile võimaluse kasutada üht ning sama tööriista erineva läbimõõduga traatide pärltraadiks töötlemisel.

Mitme katse tulemusel jõudsime järeldusele, et töönoa pikkus võib peenema läbimõõduga traatide puhul olla ka suhteliselt lühike: umbes 5 cm. Tööle lisas efektiivsust töö- ja abinoa omavahelise liikumissihi muutmine, kui rullimissuund jäeti samaks. Erilist tähelepanu ja kontsentratsiooni nõudis peene (läbimõõduga 0,5 ning 0,6 mm) traadi töötlemiseks vajaliku töönoa valmistamine: vajalik oli tööriista "häälestamine" – kontrollimine praktikas ja kuju korrigeerimine.

Huvitavaid tulemusi andis traadi eri deformeerimisvõimaluste otsimine. Näiteks saadi spiraalse keermestusega traat nii, kui seda põdrasarvel rullides muudeti töönoa nurka traadi suhtes (joon 8). Traadi vao laiendamine oli efektiivne 50–70-kraadise lõikenurgaga kahe noa vahel siis, kui töönoa liikumissuunda muudeti klotsi kinnitatud abinoa suhtes (joon 9).

Pärltraadi pärlite sfäärilise pinna modelleerimiseks katsetati ka sellist töönuga, mille kumerale seljale oli sisse viilitud soon. Just see meetod oli kõige efektiivsem. Ühe võimaliku variandina katsetati sfääri modelleerimist ka kahe niisuguse noa vahel, kus mõlemal oli soon sisse viilitud (joon 10: A) või kus töönoa tööpind oli lame (joon 10: B). Kõik need katsetused osutasid suurtele varieerimisvõimalustele, kinnitades ühtlasi meie arvamust, mille olime saanud eri ajastute ja maade (sh Egiptuse, India, Tiibeti, Ungari, Itaalia, Skandinaavia, Venemaa) pärltraatidega kaunistatud ehetest, relvadest, regaaliatest jt kullassepatoodetest tehtud ülesvõtetega tutvumisel, et pärltraadi valmistamise lõppfaasi teostamine sõltub ning sõltus ka minevikus suuresti meistri fantaasiast ja oskusest tööriistu kombineerida.

Eksperimentide käigus saadud kogemusele toetudes võime väita: tulemuseni viivaid teid on mitu; pärltraadi välimus sõltub suuresti meistri tööriistavalikust ja sellest, kui palju taheti pärltraadi valmistamisele aega ning energiat kulutada. Näiteks pärltraadi ühe elemendi – pärli sfäärilisuse – suurendamisega kasvab töömaht oluliselt. Loomulikult algab pärltraadi tegemine ühtlaselt ümmarguse ristlõikega traadi valmistamisest. Lisaks õige tehnoloogia järgimisele on olulise tähtsusega ka traadi tegemiseks kasutatava metalli koostis: mida vähem on lisandeid, seda plastilisem ja ühtlasem on ka töödeldav metall. Pärltraadi valmistamiseks sobivad kõrge prooviga kuld ja hõbe (tänapäeval võib peale nende kasutada ka punast vaske).

Pärltraadi valmistamiseks valitud metalli seisukohalt on kõige olulisem materjali plastilisuse ja deformeerimise tunnetamine ning korduv lõõmutamine, et normaliseeruks lõikamise ja rullimisega pingestatud metalli sisestruktuur. Juhul kui traadi töötlemisel tekkivaid pingeid lõõmutamisega ei vabastata, saame mingil hetkel pika pärltraadi asemel hulga pisikesi traadijuppe.

Otsides vastust küsimusele, miks kullassepad enam tänapäeval pärltraati ei valmista, võib vaid oletada, et selle oskuse unarusse jäämine on olnud üheks lüliks üleüldise käsitööoskuse kahanemise protsessis. Kuna pärltraadi kasutamine oli tihedalt seotud filigraan- ja granulatsioontehnikaga, siis pole võimatu, et pärltraadist loobuti oluliselt vähem spetsiifilisi oskusi nõudva filigraantraadi kasuks.