Het inpakken van wasfiguren in klei

Bronsgieten in Nederland in de Bronstijd

Vereniging voor Archeologische Experimenten en Educatie

Ervaringen met prehistorische bronsgiettechnieken in Nederland

Ernest Mols

Ook hebben we enige experimenten gedaan met het invormen van wasmodellen in leem, waarbij de eerste leemlaagjes een mengsel bevatten van fijne leem met houtskoolpoeder. Een papje van leem, houtskool en water wordt met een veertje over het wasmodel aangebracht; na droging volgt de tweede laa en daarna natte leem gemengd met schapenwol. Na droging kan de was bij het vuur voorzichtig worden uitgesmolten en de vorm in het vuur verder gebakken. De gietresultaten geven een mooi oppervlak te zien waarin ook fijne details mooi worden weergegeven.

Bronsgieten door de Vikings

Scandinavian bronzecasting in the Viking Age and the Early Middle Ages

http://web.comhem.se/vikingbronze/casting.htm

The moulds

Since the Bronze Age, a common type is a mould of clay tempered with fine sand and some organic material; cattle- or horse spilling is excellent as the fibres in such material are cut into ideal lengths of 1-5 mm.

Bronsgieten in Italië in de Renaissance

Direct versus Indirect Casting of Small Bronzes in the Italian Renaissance

http://www.metmuseum.org/toah/hd/bron/hd_bron.htm

In this, the simplest of methods, the statuette was first carefully modeled in beeswax and then rods of wax were attached to convenient positions such as the underside of the feet. Next, both the statuette and the attached rods, excluding their tips, **were covered—or "invested," to use the proper foundry term—with a refractory material such as potter's clay and the clay was allowed to dry. The whole assembly was heated in a furnace which both fired the clay and burned out the wax (hence the**

term “lost wax”). The investment was now a hollow ceramic mold pierced with the holes—”sprues”—left in the clay by the wax rods. The mold was then filled with molten metal through one of the tubular sprues, while the other sprue released the suddenly heated air inside the mold, thus ensuring that the mold fully filled with metal. After cooling, the clay mold was broken away, revealing the original wax model as well as the sprues, now transformed into metal. The sprues were cut away and the bronze surface worked with tools (“chased”) to the desired degree of finish.

The Bell Maker at Notre Dame University, U.S.A. Benjamin Sunderlin
De enige Amerikaanse klokkenmaker volgens de traditionele methode.

https://www.sunderlinfoundry.com/

Uit een artikel in:
http://magazine.nd.edu/news/bell-maker/
There amid piles of brick sits a plastic bucket of horse manure and a flowerpot full of human hair, much of it clipped from Sunderlin’s own dark blond locks. Another pail gives off the earthy smell that emanates from the mud alongside streams and lakes. This is Sunderlin’s loam, and while he’ll joke that it’s dirt cheap, to him it is the most valuable material of all. It took him three years to find it and to work out the precise mixture of loam, dung, hair, clay and silica sand he uses to make molds. “I’ve never tried so hard to make something work and failed so many times,” he says.
https://www.youtube.com/watch?v=UzQc5mzCWHY

Rijksmuseum voor Oudheden in Leiden

http://www.rmo.nl/onderwijs/museumkennis/verhalen/inleiding-brons-uit-de-oudheid

1.6 Cire perdue
Van geheel andere aard is echter de zogenaamde "verloren was" techniek ("à cire perdue"). Hierbij wordt het te gieten voorwerp allereerst in was gemodelleerd. Vervolgens omgeeft men dit wasmodel met een gietmantel van klei, voorzien van giet- en luchtkanalen. De kleimantel wordt voorzichtig gebakken, waarbij de was smelt en door een gat wegloopt. De zo ontstane holte, in de vorm van het wasmodel, wordt met vloeibaar brons gevuld. Na stolling kan men de gietvorm stukslaan en het bronzen gietstuk, een unicum, uit zijn mantel bevrijden. Deze methode is vooral van nut bij de vervaardiging van voorwerpen van ingewikkeld ontwerp en veel detail.

Bronsgieterij Archeon

https://www.archeon.nl/nl/ontdek-archeon/wandel-door-ons-park/bronsgieterij.html

De schuur die op hetzelfde erf is aangetroffen als de boerderij, doet dienst als werkplaats voor het bronsgieten. Beide bouwwerken zijn op een houten skelet geconstrueerd, met muren van grijze leem. Brons wordt gesmolten bij een temperatuur rond de 1150 o C. Het vloeibare metaal wordt in een mal van steen of klei gegoten. Na afkoeling wordt het voorwerp mooi afgewerkt en eventueel voorzien van mesheften of handgrepen.

Medieval bronze casting of an aquamanile in a lost wax loam mould - by Dr. Bastian Asmus

https://www.youtube.com/watch?v=i-IOZpLbm1w

The mould was prepared from loam and made three days before the casting. The wax model was molten from the loam mould over embers. The mould was subsequently fired with charcoal. The charcoal was allowed to burn down to the top of the mould and before it was charged again with fresh charcoal. This was repeated three time s, just as Theophilus tells us (Hawthorne and Smith, 1979, 136). The casting was accomplished through the feet; so the mould is placed upside down for the casting. It was cast with a quaternary alloy of copper, zinc, tin and lead. The alloy is CuZn13Sn8Pb2 and was prepared for the casting.


De mal is gemaakt van leem

Prehistoric Bronze Casting - Making of an Iron Age ring - by Dr. Bastian Asmus

https://www.youtube.com/watch?v=iBAyEy3FBB0

For more information visit:
http://en.archaeometallurgie.de/casting-medieval-aquamanile/

Ring van was

Ring van was wordt in leem gepakt.

Ring van was wordt in leem gepakt.

Giettrechter van leem

Mengen van klei met kaf van rijst in Engeland

http://www.instituteofmaking.org.uk/blog/2014/07/luted-crucible-bronze-casting

Luted Crucible Bronze Casting

Day 1: Using 10g of bees wax we made our objects, bearing in mind the technique may not work with complex forms. Once we had made our objects which ranged from a detailed brain, animal figures and a hammer and sickle to more experimental objects with embedded mica, it was time to add the first layer of clay. It incorporated very fine sand to catch all the detail of the wax models.

Day 2: Today’s layer involved a mix of coarse yellow and fine white clay with rice husks. After much mixing (the rice husks were pretty vicious on the hands!) and a dash of water we carefully layered the clay around our objects. In addition we had to form a funnel shape around the top of the object. This would enable the molten metal to flow into the cavity where the wax model had been. These extra layers of clay help to protect the inner detailed layer from the intense heat inside the furnace. We also made our crucible cups, where our metals would be contained. These were left to dry overnight.

Day 3: To make bronze you can use a few different 'recipes', some include arsenic or lead to modify the properties. For obvious safety reasons, we used plain copper and tin. We used 10 times the weight of the wax in copper, and we could choose to either use 10% or 20% of tin (20% would give make your object harder). Once measured and weighed with great accuracy, we joined the crucibles to the objects using another layer of the clay and rice husk mix. These were then left to dry overnight.

Day 4: This was a shorter day, where we built the finally clay layer over the entire object to ensure it was fully sealed and ready to be fired the following day. They were left to dry overnight for the final time.

Day 5: The big day, the moment of truth. Will our objects come out how we wanted them to? After an early start, Piers homemade furnace was roaring and the first objects were in. They didn't spend that long in the furnace, around 20 minutes, some took longer about 1hour max. Piers, master of the furnace, pulled them out and gave them a gentle shake to see if all the metals had melted - something you can only tell by experience. Once he was happy that they were all fully molten it was time to pull it out, tip it upside down which allowed for the metal to flow into where the wax once was (the wax burns away in the heat leaving an empty mould for the melts to flow into). After the crucible had cooled, we cracked it open to reveal our objects.

Wynn Danzur Marketing

Loam Molding

http://www.wynndanzur.com/loam-molding.html

Loam is soil, that is composed of sand, silt, and clay in relatively even concentration (about 40-40-20% concentration respectively). Loam soils generally contain more nutrients and humus than sandy soils, have better infiltration and drainage than silty soils, and are easier to till than clay soils. Loams are gritty, moist, and retain water easily.
Loam molds, can be made of loose loam mud, loam bricks, loam gutters, loam retainers etc. all formed from loam soils.

The Lost-Wax Casting of Icons, Utensils, Bells, and Other Items in South India

http://www.tms.org/pubs/journals/JOM/0210/Pillai-0210.html

Mold making involves coating the wax pattern with layers of clay, known as investment—three layers for small icons and more layers for larger icons. A different clay is used for each layer. The first coat, about 3 mm thick, is made when fine loam or alluvial soil collected from the Cauvery river bed (called "vandal mann" in Tamil) is finely ground with charred paddy husk and mixed with cow dung, forming a thick mixture. This first coat performs two important functions: protection of the wax model and reproduction of the minute contours of the model. Thus, no portion of the wax model should be left uncovered except the wax sprue top surface, which is the outlet for the melted wax while dewaxing and the inlet for molten metal during casting. Further, no air bubbles should be allowed on the surface of this first coat, since they can spoil the mold cavity surface finish, and, in turn, that of the icon. During the clay-coating application, the wax model is kept on a piece of paper or cloth on the floor or a table, depending upon the size of the model, to avoid its deformation. The coating is applied to half the model, allowed to dry, and then the model is turned to coat the other half. It is crucial that the clay coating is dried either in mild sunlight or in the shade to prevent the wax model from melting.

The second coat or investment is made with a paste obtained by thoroughly mixing clay from paddy fields and sand, and combining that mixture with water in a 1:2 ratio. The thickness of this coat varies from 12.5–50 mm depending upon the size of the icon. The third coating is a paste containing a mix of coarse sand and clay. The mixture is applied after the second coating is dried. A fourth coat is applied only if necessary, based on the size of the icon. Especially with large icons, the mold must be reinforced with iron

rods and wires to prevent the mold from giving way during handling and liquid metal pouring. When the last coat dries, one half of the mold is ready to withstand the pressure and heat of liquid metal. The same investment application procedure is repeated on the other half of the pattern, resulting in a completed mold with a wax model inside

Figure 1. A completed individual wax pattern/model of the child Krishna and a banyan tree leaf.

Figure 2. Completed mold halves with patterns after sun drying readied them for
mold halves.

Figure 3. Completed molds for an icon of the child Krishna and banyan tree leaf.

Medieval alchemy, chemistry related technology and random things distilled from books and artefacts

Trying out different mould materials for bronze casting – it's amazing what works

Guthrie Stewart in Copper alloy casting, Medieval stuff
https://distillatio.wordpress.com/category/copper-alloy-casting/

Vannochio Birringucio, the late 15th/ early 16th century foundryman, wrote a book about all forms of casting and related work he had done and how to do them. It is important as one of the earliest comprehensive works left by an actual artisan, a real practitioner, rather than by some over educated alchemist. Biringuccio doesn't like alchemists, and spends many pages excoriating them.
Anyway, amongst much important and useful information, he mentions a number of different recipes for making moulds for casting copper alloys into.

From these recipes, I have tried clay and horse dung, clay, dung and sand, clay and chopped wool, and they all worked very well, withstanding the heat when being baked, and the molten metal when it is poured into them. But he also writes, on page 219 of the Dover paperback, "There are some others who mix various earths with it; others, wash ashes; and some, coarse sand."

So I wanted to try wash ashes and clay, although it has to be said that Biringuccio is not very keen on the use of pure clay, preferring clay that has organic matter in it. Nevertheless I thought it would be interesting to see what pure clay and ash does. Fortunately I had a great deal of ash that had been washed already, in order to get the lye from it. What was left is a mix of calcium carbonate, various metal oxides, tiny bits of unburnt charcoal and anything else that isn't water soluble, which means no potassium or sodium oxides. Mixing it all together was quite hard, but I ended up with a surprisingly smooth paste. When squashed flat, it held its shape well, the only problem was it's lack of stickiness, so it was a little hard glueing the two halves together.

I pressed a buckle into it to see how well it took the impression, the answer is that it does hold it rather well. I hoped it would leave a nice smooth surface on the finished product, since I want to try and match the very well finished medieval artefacts.
In the end though, the casting didn't work properly because the metal wasn't hot enough to flow well. The small bit of metal that did get inside was at least quite smooth, but that was probably less to do with the mould material and more the fact it was so small it had frozen without touching the walls.
So here it is, note the layers of white stuff that is ash which isn't properly mixed with the clay. The inside is grey, due to lack of

oxygen, and the outside is red, due to the iron in the clay. The larger piece shows the inside of the mould, with the curve of buckle at the top left; the piece at the top right is a through section of it. ash and clay mould for casting

It worked, and I think in the future I'll try using more organic rich clay and see what sort of result that gives. In fact I need to experiment with the sort of clay you find in rivers anyway, fortunately there's a good source not far from me. Stay tuned for more secrets of the medieval foundryman.

The Ancient Secret of Pre-Hispanic Jewellery

http://www.mexicolore.co.uk/aztecs/home/ancient-secret-of-pre-hispanic-jewellery

a) Mixing of beeswax with copal incense. According to the Florentine Codex, the raw material for jewellery-making in pre-Hispanic times was beeswax and white copal (incense). We found in earlier tests in our workshop that the addition of just 1% of white copal to the beeswax was sufficient to give the latter the key properties of malleability (able to be hammered into sheets), stretchability and compression needed for successful jewellery design. (Concentrations of 5% or more render the wax too soft to be worked into models). We used the 1% formula in the current research.
b) Forming the core in clay and charcoal. In order for the figures to be hollow and not solid after casting, a clay and charcoal core has to be created, the same size and shape as the final object. The cores used in our work comprised 40% coal dust and 60% clay.
c) Creating the design in wax. After preparing the beeswax and copal incense mix, the designs were created based on archaeological examples from different pre-Hispanic regions of Mexico. In such cases the wax thread was wound round the clay and charcoal core.
d) Making the clay mold. Step 1: a semi-liquid mixture of coal dust (50%) and clay (50%) was applied to the surface of the finished wax designs. Step 2: a semi-solid mix of the same composition was applied on top to form the mold. Step 3: the molds were left to dry for two to four days. The molds were made following the copa style of original molds found in a tomb at Monte Negro, Quindío, central Colombia and described by Dr. Olsen in her 1972 study Two Prehispanic Cire Perdue Casting Molds from Colombia.
e) Inserting the casting channel. Once the molds had dried, the cylindrical shaped wax casting channels were added to each design. Ventilation channels were not used.

f) Forming the casting funnel. The mold's funnel was then made of charcoal and clay and placed around each design's casting channel, to direct the metal inside (Pic 9).
g) Removing the wax and firing the cast. Once dried, the molds were placed in an oven for two hours, for the wax inside to melt and for the clay to be fired.
h) Casting and pouring of the metal. The metal used to form the designs was pure copper and bronze (copper with 5% tin). The metal was melted in a spoon-shaped crucible made of the same materials as the molds. The crucible and metal were placed in a clay brazier, into which air from the lungs was blown through several reed tubes with a nozzle at one end, allowing the air to be introduced in amongst the coals, and so raising the temperature of the brazier. Once the metal had melted, it was poured inside the mold, which could subsequently be opened to determine the quality of the jewellery piece.

Dhokra shilp - Traditional Process of making

https://www.youtube.com/watch?v=ZDwLBIasMuo

http://www.dsource.in/resource/dhokra-shilp/video/traditional-process

Dhokra Shilp
The Bell Metal Craft of Bastar
by
Palash Vaswani
IDC, IIT Bombay
Raw Materials and Tools

1. A basic model is prepared by using black soil mixed with rice husk in appropriate ratio. Soft pliable dough is made by adding water in it. A basic model of craft is made and dried in the sun. Black Soil: The black soil is collected from beds of the fields.

Rice Husk: Rice husk is procured from mill. It is mixed with soil as clay tends to break while drying. It also prevents the cracking of mould during firing.

2. For second layer, cleaned riverside soil is used. A powder of dung and water is added and mixed thoroughly for smooth dough. It applied all over the dry model & again left to dry in the sun.

3. The hard & dry model is filed & shaped with metal files to achieve a proper shape. When the model is ready, it is scrubbed all over with hands to remove dust. A very thin semi liquid layer of black soil is applied over the model and is left to dry.

Cow-Dung (Gobar): It is mixed with river soil, which allows the wax to melt out of the cast.

4. The bean leaves are then crushed by rubbing them between the hands and applied over the model until it looks green. The purpose of applying green liquid to model is to prevent the soil from sticking to the model. The model is left to dry again in the sun.
Bean Lleaves: Lima bean (sem patta) leaves picked up from the plants due to their water content.

5. Thin wax threads are then wrapped closely around the model. The wax threads are made using hand-held press, which is also known as phichki-pharni in Bastar.

6. A layer of riverside soil & powdered wood coal is applied over the model. A chamber is made at the bottom of the model, where the liquid metal has to be poured for casting.

7. Final layer of termite soil is applied by adding bigger channel. This channel is added to the earlier chamber made at the bottom & covered with termite soil mixture to make the passage ready & dried.

8. The casting process starts with the preparation of furnace for firing & casting. The model is made wet with liquid mud and kept on the burning coals for firing. It is kept erect by giving support with wooden sticks.

9. Another furnace is made for melting metal pieces which are then placed in a vessel. This vessel is placed over burning coal. The fire is blown continuously. When the model in the first furnace turns red, it is ready for casting.

10. The ready-fired model is lifted gently & brought near the vessel. The liquid bell metal starts emitting green blue flames, which is an indicator of the ideal temperature of its liquid state.

11. It is then poured in the channel, which is made at the bottom by keeping model upside down. The wax inside the model is replaced by molten metal poured through funnel. Then model is left to cool.

12. After cooling, the outer model is broken gently with a wooden mallet or small hammer. The actual shape of the craft is then rubbed & cleaned.