

Lost Wax Casting: An Ancient and Innovative Metal Casting Technique

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Abstract:- Lost wax process also called *cire perdue* (French: [sɪʁ pæʁdy]; borrowed from French)—In the lost wax casting method, a wax model is first made. A coating of clay or plaster of paris is applied over this model. It is fired into a mold. Casting is done by pouring molten liquid metal (such as: copper, brass, iron, bronze, aluminum) into the void created by the burning of the wax.

Keywords:- Wax, Metal, Model, Molding, Burnout, Pouring, Finishing, Docra, Technique.

I. INTRODUCTION

Lost wax technique is an ancient and world famous method in metal casting process. Many factories use this method to cast metal. The lost wax casting method is an expensive and time-consuming casting technique. In terms of time, this metal casting method that is about 5,000 years old. This ancient method is used today to create various sculptures and objects. Currently, various educational institutions, especially sculpture and sculpture practice centers, use the lost wax technique to create sculptures and useful objects. The exact origin of the lost wax method is not known. Perhaps the method evolved independently in different regions. However, archaeological evidence suggests that this method was first used sometime in the fourth millennium BC.

II. TYPES OF THE LOST WAX PROCESS

There are three methods of lost wax process are widely known. Such as-

- Italian lost wax process (Hollow Casting)
- Docra casting and
- Dhamrai casting.

Below are the steps of the "Italian Lost Wax Process" and "Dokra" casting process sequentially.

III. PROCESS OF ITALIAN LOST WAX CASTING (HOLLOW CASTING)

Below are the steps of the "Italian Lost Wax Process"--

➤ Model-making

In the beginning, an artist made a model of the sculpture. The model can be made directly from wax or from clay. In the case of hollow casting, a model is usually

made with clay. A model should be created in such a way that it is not too complicated.

➤ Mold making

After making the model of the sculpture, its mold is made. Usually the mold of the model is made with Plaster of Paris. Molds are made in at least two parts. But there may be more. After the mold is made, each part is removed from the model. The molds separated from the model are thoroughly cleaned and prepared for the next step.

➤ Wax

Now it's time to wax the inside of the molds. Molds are tied together and liquid wax is poured inside. The mold is then rotated and a wax coating is applied to the inside of the mold to a certain thickness. However, there may be a problem in this case, that is, the wax coating may not be uniform in all parts of the mold. Another method can be adopted to eliminate this problem, that is to keep the molds separately and apply liquid wax between them with the help of a brush. The wax coating on the mold is usually 3 mm. (1/8 inch) thick. Once the mold is coated with wax, wait for the wax to cool.

➤ Core Casting

After wax coating the molds are reattached. Then the core should be cast in the empty space next to the wax coating. Plaster of Paris and brick powder are used in this case. The ratio of these two elements will be 1:1. Plaster of Paris and brick powder should be mixed in that proportion with water in quantity and the mixture should be poured on the voids of the wax coating on the mold. This casting is called core casting. A structure with GI wire as armature should be inserted at the site before core casting.

➤ Forming the casting channel

After casting the core, the next step is to remove the mold when the casting is sufficiently hardened. After the mold is removed, a wax-coated model, which was previously made of clay, can be seen. A few iron nail should be embedded in the wax core model at various points before the casting channel - to form a connection between the inner core and the outer core cast. Now we have to create a casting channel on the wax model. In this case, this channel is made with wax like a long stick made of wax. In many cases casting channels are also made of thermocol instead of wax. Two/four air channels are made with wax at the bottom of the wax model through which the air generated inside the mold during metal casting will escape. Cast channel construction consists of a main cast channel and several

branch channels on the sides. The main casting channel is called runner and the branch casting channel is called riser. After making the casting channel and air channel the next step will start.

➤ *Outer Core Casting*

Once the casting channel has been placed on the wax model, another core cast should be cast. This will serve as the mold for the original model. For outer core casting plaster of paris and brick powder in 1:1 ratio should be taken with small amount of ordinary sand. Then put the original model in a certain place and surround it with a solid object (tin or thick pipe) and mix the core mixed with water. The cast is reinforced with wire mesh between the casts. After casting the outer core, the tin or pipe is opened.

➤ *Burnout procedure/Removal of wax*

In this step, the metal mold is placed in a high temperature furnace and heating it. At high heat the wax melts and the wax coating, welding channels and air channels all become hollow. The empty spaces will occupy the metal space in the next step. After melting the wax, the mold is carefully taken out of the mold.

➤ *Pouring*

The metal mold is prepared for pouring and placed in certain place. In this case the metal mold should be placed with the casting face upwards. If the metal mold is too cold before pouring the liquid metal, it should be heated with some heat. Then the molten liquid metal (brass, bronze, aluminum, others) should be poured into the casting face of the metal mold. When the metal is poured, it will exit through the air channels of the mold. Then stop pouring the molten liquid metal.

➤ *Release*

The metal will harden shortly after casting. Then the metal mold should be broken with an iron hammer. Break the mold and bring out the cast sculpture or object from inside.

➤ *Metal-chasing*

Casting channels and air channels should be cut from the body of the sculpture after the mold is broken. Also, if there is anything unnecessary on the casting, it should be cut off. The core cast from inside the casting should be dug out with the help of an iron pick.

➤ *Cleaning the cast*

The casting is then taken for cleaning. Various wire brushes, polishing brushes etc. are used for cleaning. After cleaning is taken for the next and last step.

➤ *Patina*

The cleaned metal sculpture or object is dipped in various acids to change some of its external colors. This process is called patina. After sufficient patina it is usable.

Thus the hollow casting process is completed through several complex steps. It is a time consuming and expensive metal casting technique.

IV. DOCRA CASTING

Dokra art is also a lost wax casting technique that has been passed down from one generation to the next and this art form is a unique example of metalworking. The “Dancing Girl” or “Dancing Woman Sculpture” found in the Indus valley Civilization city of Mohenjo-Daro is an ancient example of Dokra art. Metalworking is a widely used term that relates to the manufacture of a particular metal.



Fig 1: Dancing Girl

Metal is a chemical element and industry is a professional job that requires expertise in specific types of work. Historically, especially in the middle ages or earlier, the term was used to refer to a specific group of people who made various useful items by hand out of metal. The art of metal engraving has been in practice since ancient times. The use of metals in Bengal began in the Copper Age around 1500 BC. However, the use of iron was well underway by 1000 BC. Copper and its alloys and iron were widely used and gold and silver were used to a limited extent in Bengal during ancient times. Copper has been used since the beginning of the Copper Age. Evidence of metal alloying has been found in the analyzed objects from the Late Copper Age as well. Small copper articles were made by casting and later beating. At that time alloys were made by mixing copper with tin.

V. HISTORICAL CONTEXT

It is not known for sure when, how and where humans first discovered/invented this method of wax dressing in the world. However, what is known so far shows that this method was prevalent in Mesopotamia around 3000 BC. This technique is believed to have been introduced in Egypt around 2500 BC. Also in the ancient Harappan civilization (3000-1500 BC) wax decoration was practiced. The famous Dancing Girl from Mohenjo-Daro and other small animal figurines are believed to have been made in this manner. In China, Egypt, Malaysia, Nigeria and Central America, the “Lost wax casting” method of early humans is also practiced among the indigenous communities of our country.

This primitive art style survives in the Dokra industry in West Bengal. Today the Dokra artists of Dariyapur are part of this tradition. Imagination, diversity and craftsmanship - these three have come together in this folk art of rural Bengal. These artworks of indigenous and socially marginalized people have now settled in the

drawing rooms and exhibitions of the elites of the country and abroad. Dokra artists have received state and national level awards in recognition of their artistic achievements. Besides, this method was practiced in ancient China at least during the Shang Dynasty (Shang-Yin Dynasty 1525-1028 BC). In fact, there is evidence that this method was practiced in some parts of Africa and South America in the near future.

Dokra art originated about four thousand years ago. According to researchers, the word “Dokra” originates from the Dokra-Damar tribe, who were skilled in various handicrafts. This age-old industry is believed to have first developed in India in the wetlands of Bastar in Madhya Pradesh. It is said that 3000 years ago, the King of Bastar had Dokra jewelry made for his Queen.

This art is believed to have originated in Bastar and Chhattisgarh of Madhya Pradesh. Much later it spread across Jharkhand Bihar to West Bengal and Orissa. Dokra work can be seen at Mayurbhanj, Lohakani in Orissa and Lohardi in Ranchi, Bihar. In Bankura of West Bengal, in Guskara of Burdwan, in rural areas of Medinipur and Malda, Dokra industry is practiced. Currently West Bengal is one of the names in Dokra industry. Hundreds of years ago, Dokra industry flourished in West Bengal. Mainly from Jharkhand, this industry spread through Purulia to various districts in the western part of the state. Among them the districts are---

Bankura, Burdwan, Purulia and West Mednipore. West Bengal's Bankura district-Bikna, Khatra's Lakshmi Sagar, Ladna, Chatna, Shabberia. Major centers of Dokra industry are located at Daryapur in Burdwan Guskara and Nahida in Purulia. Among these, Bikna in Bankura and Daryapur in Burdwan are notable. The fame of Dokra industry in these two places is world-wide.

Dokra artists are seasonal nomads. Initially, Dokra artists had no permanent residence. They do not belong to the artisan caste of West Bengal. Also not tribal or lower caste or tribal category of Hindu society. The unchained nomadic artist group are these Dokra artists. At present, however, they have left the nomadic life and started living permanently in West Bengal. A sculpture of a dancing girl found in the Indus city of Mohenjo-Daro is an example of Dokra art. From this sculpture to this art, there is evidence of antiquity.

VI. CONSTRUCTION METHOD OF DOKRA CASTING

The very ancient method of making gods and goddesses, people or animals and birds etc. through metal in a special process by making a model with wax is called “Lost Wax”. This method is known to French archaeologists as “Cire-Perdue.” In Sanskrit language it is described as “Madhuchishtavidhan.” It is called “Dokra” in Burdwan, Bankura, Birbhum regions of West Bengal, India. There are slight differences in production materials and construction techniques depending on the region, but in fact there is no significant difference except the difference in naming.

Dokra art is a lost wax casting technique that has been passed down from one generation to the next. However, the Dokra method is very different from the old metal casting method. Usually in five to seven steps each Dokra artwork is completed by the artist.

The list of raw materials required for the construction of Dokra industry is given---

- Dhuno (incense), 2. Wax, 3. Brass, 4. Mustard oil, 5. Color, 6. Zinc, 7. Lead.

Instrument and Vessel---

- Crucible, 2. Chisel, 3. Hammer, 4. Ukho, 5. Fire Irons, 6. Narrow shank, 7. Blower.

Dokras are still made in the same way as they were made since ancient times.

Mainly two types of Dokra are available---

- Blank Dokra
- Filled Dokra
- The hollow Dokra mold is made of clay, over which a coating of natural wax is applied. It is again covered with soil. It is then heated. In the heat, the wax melts through a narrow passage and the liquid metal mixture is poured into it.
- Filled Dokra molds are made with natural wax. Soil is placed on it. The rest of the work is done in the same manner. Although Dokra art is a folk art, it is now recognized as a handicraft.

This art is prepared with the help of water, earth and fire. The raw materials required for manufacturing the industry are procured from the market. Following are the details of Dokra industry construction method---

Dokra art method is a complex and time consuming, delicate art form. First, artists collect red or white clay from ponds and make earthen mounds. Then make a shape by hand with clay. The body is coated with wax, mustard oil. At the end soft soil coating is given. It is then burned. As a result, the wax melts and comes out through a hole. Then the molten brass through that hole and the sculpture is collected when poured and hardened. The sculpture is then polished by rubbing with sandpaper.

In about five-seven steps, various items of Dokra are made completely by hand. The main ingredients for this are finely powdered clay, dhuno (incense) and oil, wax broken from beehives, brass, wood-coal etc.

- In the first step, the soil is ground and sieved very fine. After that, sand is mixed with rice bran and sand. The sculpture or object to be made is given an initial shape, in the shape of the clay. It is coated with cow-dung mixed with powdered earth so that it does not crack when heated in fire. Then they are dried well.

- In the second step, the bee wax is heated in a vessel and mixed well with some incense powder and mustard oil to form a sticky paste and then filled and coated on the dry sculpture.
- After that, a part of the melted wax is cooled and cut into thin strips various sculptured limbs are made. Cut into long, thin thread-like pieces it is used in making various decorations and handicrafts.
- After making the limbs and decorations of the sculptures in this way, thin clay, rice bran and sand are used.
- Smear together and cover completely. After being covered with a coating of clay, channels are made on the sculptures with large needles or knives through which molten brass is inserted.
- When the sculptures are fired, the wax coating melts away and creates voids. And molten brass fills those spaces. When completely filled, the clay coating is carefully removed by submerging it in a container of water and cooling it.
- Then comes the finishing work which these artists do with their skill and expertise.

After going through so many steps, these Dokras are made completely by their own hands with the help of wonderful art. No matter how attractive the sculptures made by so much effort are at home and abroad, the market in our country is not very profitable. The financial status of the family of these artists can be understood.



Fig 2: Docra Art

The main reason for this is the continuous increase in the cost of raw materials.

➤ *Necessary things:*

For example, rice measuring kunka or pie, money coin, Lakshmi jhampi, bucket, vase, flower tub etc.

➤ *Religious objects:*

For example, Ganesha, Lakshmi, Manasa, Mansara Ghat, Dashamatha Ravana, Shri Krishna etc. Various materials - what is not? Everything remains.

VII. LOST WAX PROCESS IN BANGLADESH

Metal industry flourished in different regions of Bangladesh as well as in different regions of India. However, we have not yet found any clear evidence about whether any factories/centers for making idols or other things were established in this land of Bangladesh or not. Different types of bronze idols and various metal products

have been found from different regions of Bangladesh. Whether they were built in the region or brought from elsewhere is still an unsettled debate. For example, Nihar Ranjan Roy, describing the metal-idol art in his History of Bengali, writes, “It is difficult, almost impossible, to give proof, but, I suppose, these small artifacts were made in the Nalanda workshops and carried from there by devout Buddhist pilgrims. Went to the temple of Bhavan-Mahabihara to offer.”

On the other hand, Debala Mitra writes, “Though the possibility of a few portable images hailing from other regions cannot be ruled out, most of these images belong to the art-school of Chittagong revealing distinctiveness in form and style.” He also said, “In any case it is apparent that most of these metal image were cast within this district itself in view of fact that a group of images of Buddha (some of which are fairly large in dimensions) presents a distinctive art form and style.”

Obtained from Kewari of Chittagong district he made the above comments while discussing the bronze idols. However, many bronze idols or products have been found from other archaeological sites in Bangladesh. Among them, Paharpur in Naogaon district, Mahasthangarh in Bogura district, Mainamati in Comilla district, King Harishchandra's mound in Savar etc. The idols of the gods and goddesses are believed to have been made using the wax method.

VIII. LOST WAX PROCESS IN MODERN CRAFTS

In India, the tradition of wax decoration is ancient, but its influence on modern art is not extensive. However, the names of Meera Mukhopadhyay and Somnath Hore are particularly notable among the sculptors who applied and used the wax decoration method (especially Dokra). To teach the technique of wax decoration in the sculpture department of Institute of Fine Arts (DU) in Bangladesh institutionally.

Recently a Dokra from Burdwan, West Bengal at the initiative of “Britto Art Trust” a workshop on Dokra was organized in Dhaka by bringing the artist. Many of the young artists are interested in “Dokras.”

IX. CONCLUSION

In conclusion, lost wax casting process is a very important technique in metal casting industry. Many Artist make a living by casting metal with this technique. The lost wax casting process is also a widely used technique for making sculptures and objects. Widespread use of this technique has been observed since ancient times which continues equally in the present day. If current generation lost wax casting techniques are mastered well, the future will be more fruitful.

ACKNOWLEDGEMENT

First of all express my gratitude to the almighty creator for conducting this research paper. Sincere thanks to relevant person for continued support and help. Special thanks to my well-wishers for their cooperation and support in bringing this research to light. Finally, I would like to thanks the researcher's for complete this paper.

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