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Wax Recovery Technique in *Cire Perdue*: An Analytical Studio Report on Approaches to Retrieve Wax During the Burnout Process

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Abstract

Lost-wax casting, or Cire Perdue, is an ancient technique of metal casting employed by many civilizations and remains of both cultural and technical relevance today. In the traditional process, wax is typically lost during the firing of the mould (dewaxing). However, in contemporary Benin City, Nigeria, economic constraints have compelled bronze casters to develop innovative techniques for recovering wax during the burnout phase. This article documents these innovations through practice-led studio-based research methodology, integrating experiential involvement with local techniques and critical analysis of material processes. Data was obtained through direct observation, practical experimentation, and semi-structured interviews with artisans at the Vincent-Uhunamure Emofonwan Foundry. Considerable emphasis is placed on localized adaptations, improvised equipment, and techniques that enable the retrieval of wax without sacrificing mould integrity or compromising the final cast. The case study illustrates how these techniques enhance efficiency, reduce costs, and promote environmental sustainability within traditional bronze casting practice in Benin City.

Background to the Study

The lost-wax casting, or cire perdue, is among the oldest and most enduring metallurgical techniques of human history. It dates as early as the 4th millennium BCE and involves wax-modelling of an object, covering it with refractory materials, melting out the wax, and pouring molten metal into the mould. Its ancient presence stretches from the early civilizations of Mesopotamia, Egypt, China, the Indus Valley, and the Greco-Roman period (Peng, 2018; Needham, 1959). It enables the creation of highly complex metalwork and is a key interface between the disciplines of archaeology, art history, and materials science. In the Shang dynasty of China (c. 1600–1046 BCE), foundries employed cire perdue in conjunction with piece-mould techniques to produce enormous ritual bronzes (Needham, 1959). In South Asia, the Chola dynasty (9th–13th centuries CE) cast devotional bronzes such as the iconic Shiva Nataraja, revered for both religious iconography and technical expertise (Srinivasan, 2001;). Pre-Columbian cultures, such as Colombia's Muisca, employed the method to cast gold objects for religious offerings, such as the renowned Muisca raft (Bruhns, 1994).

Lost-wax casting in West Africa, particularly in Benin and the Ashanti, was incorporated in statecraft and ritual. Benin is highly established in traditional bronze casting as court plaques, commemorative heads, and ritual objects that was fostered by hereditary guilds like the Iguneronmwon under the Oba's patronage (Ben-Amos, 1995; Plankensteiner, 2007). The living tradition still exists on Igun Street in Benin City, which is now a national heritage site of significance (National Commission for Museums & Monuments, 2023). Nonetheless, the current practices are confronted by grave challenges. Economic instability, competitions from industrial reproductions, and inflated prices of the required materials, particularly beeswax and bronze scrabs, undermine the sustainability of the traditional practices (Ebohon, 2017). Environmental degradation and the shortage of modern apiculture facilities to produce beeswax worsen the scarcity of beeswax. Notwithstanding its significant contribution to modelling, the supply of wax has become unreliable and expensive. Some Benin casters have responded to these issues by instituting innovative wax recovery systems. These include the vertical container placement method and the double-container collection system. Funnel-mould designs and basin-trap systems also enable practitioners to salvage about 50% of the wax used, reducing material expenses (ResearchGate, 2023; Field documentation, 2024). This pragmatic orientation is also consistent with Nwauche's (2020) formulation of "dynamic tradition," in which traditional knowledge frameworks make room for evolving socio-economic circumstances. In the same vein, Oriakhogba and Fenemigho (2019) place Benin's casting tradition at the intersection of cultural expression, intellectual property rights, and gender relations. These innovations do not only safeguard technical processes but also foster social transformation.

In addition, the recovery of wax ensures sustainability. By minimizing waste and reliance on finite natural resources, these innovations enable environmentally sustainable craft practice. They also respond to cultural heritage controversies. As restitution movements around the world gain momentum, as encapsulated by European museums' efforts at repatriating looted Benin bronzes (Hicks, 2020; Savoy, 2018), the need to maintain and innovate on historic processes within the communities of origin becomes more urgent. This research presents a studio-based report and examination of the innovations in wax recovery techniques now being carried out in local Benin City foundries. It places these innovations within the long technical and historical past of the lost wax casting process, highlighting how prevailing systems of knowledge are being actively renegotiated to address contemporary challenges. The research posits that wax recovery is not only a material innovation but also a cultural tactic, resistance through adaptation.

The research was conducted as part of a targeted case study with data collected from the Vincent-Uhunamure Emofonwan Foundry using a multi-method qualitative approach involving on-site observation of wax retrieval procedures, informal and semi-structured interviews with the master caster and assistants, photographic recordings, and hands-on studio-based experimentation. This allowed for an in-depth understanding of the technical adaptations and contextual considerations informing these modern innovations in wax recovery. This article documents these innovations through practice-led studio-based research methodology, integrating experiential involvement with local techniques and critical analysis of material processes. Data was obtained through direct observation, practical experimentation, and semi-structured interviews with artisans at the Vincent-Uhunamure Emofonwan Foundry. Considerable emphasis is placed on localized adaptations, improvised equipment, and techniques that enable the retrieval of wax without sacrificing mould integrity or compromising the final cast. The case study illustrates how these techniques enhance efficiency, reduce costs, and promote environmental sustainability within traditional bronze casting practice in Benin City. By placing the wax extraction methods used in Benin in a long historical and socio-technical context, this research demonstrates the long-standing existence and validity of African metallurgical knowledge. In addition, it offers insightful outlooks for building sustainable craft-based economies in the Global South by showing how low-cost innovations rooted in local knowledge systems can enhance artisanal livelihoods and preserve cultural heritage.

Innovations in Wax Recovery Techniques

This studio report is derived from observational research supplemented by informal interviews in Benin City, specifically targeting the Vincent-Uhunamure Emofonwan Foundry. The innovations introduced by the foundry are indicative of wider changes in the domestic casting industry and are an effective approach to wax recovery.

Documenting Wax Recovery Techniques

The economic challenges in Nigeria have stimulated innovations among the casters in order to minimize material losses. Wax is one of the costlier constituents in the casting process, and recovery can induce substantial reduction in material costs, potentially in double-digit percentages.

The Vincent-Uhunamure Emofonwan Foundry

Located in the centre of Benin's traditional casting business at #31 Oghobaghase Street, off Siloko Road, Ogida Quarters, the Emofonwan Foundry is an excellent illustration of innovation in a traditional art. Run by members of the Emofonwan family, the foundry has become renowned for the intentional integration of modern materials and tools into the very ancient cire perdue technique. In the face of increasing costs of production and raw material shortage, this foundry illustrates an innovative solution that makes bronze casting in Nigeria both more efficient and sustainable. (Field documentation, 2024) These innovations illustrate the following adaptive solution.

Utilization of Electric Bellows as Substitutes for Manual Ones

Traditional Benin casting furnaces prefer to burn charcoal or firewood as a source of fuel, with air admission by manually driven animal skin and wooden bellows. Although the process has cultural significance, it is characterized by high labour intensity and frequently fails to deliver a uniform airflow that is needed to develop and maintain the high temperatures needed for metal melting, usually more than 1000°C for bronze. At the Emofonwan Foundry, (as well as many other modified foundries in Benin city), the traditional bellow system (Plate 1) is now replaced with electric bellows (Plate 2) driven by electric motors. The electric bellows provides consistent and adjustable airflow, enabling better accuracy in furnace temperature control.

Plate 1: Craftsmen in Benin demonstrate the traditional method of, using home-made bellow.
Source: https://asabamemorial.wordpress.com/wp-content/uploads/2012/10/benin2.jpg retrieved June 13, 2025.

Plate 2: The electric bellow system.
Source: Njk studio Ugbighoko Benin city, 2023.

Replacement of Laterite by Plaster of Paris (POP) in Mould Investment

Moulds for casting in Benin are traditionally invested from locally available laterite clay, which is a readily available but partially limiting material in the areas of surface finish and heat resistance. Laterite also has long drying times, making it less compatible with rapid production techniques. The Emofonwan Foundry (other foundries) now use plaster of Paris (POP, a commercially sourced gypsum-based material) to invest moulds. POP has several advantages: it captures more surface details, dries more quickly, and is more uniform. Its smoothness allows for more accurate duplication of the wax models, which is critical for high-relief paintings and delicate sculptural details. Although POP is more expensive than locally sourced laterite, the time saved and reduced failure rate when utilizing POP in moulds justify the investment. In addition, POP moulds are more receptive to wax recovery, since they are better able to endure repeated heating than the laterite moulds (Plate 4).

Use of Pins and Poultry Netting Instead of Binding Wires

In traditional mould reinforcement, metal binding wires are wound around the mould to prevent cracking or splitting upon firing**.** (Plate 5) Binding wires, however, have the tendency to need replacement after each use and do not provide uniform reinforcement. The foundry has developed the use of metal pins in the mould layers, together with chicken mesh (hexagonal wire netting that can be adjusted) to serve as an alternative to binding wires. Chicken mesh provides a structurally strong yet lightweight framework that adds to the mould's integrity without interfering with the firing or casting process **(**Plates 3 and 4). The use of pins in the incorporation also keeps the wax model secured in the mould throughout the investment process to allow for less possibility of distortion. These modifications minimize material expenses over time and enhance structural stability during metal pouring as well as dewaxing.

Plate 3: The chicken mesh (hexagonal wire) netting. The Emofonwan studio, Ogida, Benin city, May 2021.

Plate 4: The chicken mesh (hexagonal wire) netting. The Emofonwan studio, Ogida, Benin city, May 2021.

Plate 5: The traditional mould reinforcement, with metal binding wires.
Source: https://www.youtube.com/watch?app=desktop&v=gOrzwBiXGkc. Retrieved June 13, 2025.

Use of Metal-Based Improvised Crucibles (Refrigerator Compressors and Gas Cylinders)

Traditional crucibles used in Benin foundries are made of fire-hardened clay, shaped and heat-hardened to sustain high temperatures. This efficient clay crucibles crack after repeated use and can be difficult to make in a uniform manner. (Plate 6) To counter these limitations, the Emofonwan Foundry has championed the use of metal-based improvised crucibles made from recycled industrial scrap, such as refrigerator compressors and used gas cylinders. (Plates 7 and 8). The improvised crucibles are noted for their affordability and greater resistance to repeated heating cycles.

Plate 6: Benin traditional crucible.
Source: https://www.penn.museum/collections/objectimages.php?irn=525570. Retrieved June 2025

Plate7: Gas Cylinder cut to size.
Source: Njk foundry, Benin city, 2023.

Plate 8: Refrigerator compressor cut to size.
Source: Njk foundry, Benin city, 2023

They can withstand direct flame contact and achieve greater volume melting, making them well-suited for the casting of larger or multiple pieces at a time. Their application is part of a larger trend of sustainability and material reuse in artisanal production, a requirement in economically strained environments. In addition, these crucibles can be adapted to have pouring spouts or handles, which provide greater control during metal transfer and minimize workplace accidents. By fusing traditional knowledge and technological advancements, Emofonwan's Foundry offers a viable model for sustainable artisanal practice in altered global conditions. Such innovations not only decrease operational expenditure and limit material wastage but also place the foundry at the forefront of the modernization of traditional craft, marrying cultural heritage with business efficiency.

Wax Recovery Processes

Wax recovery, although not conventionally emphasized in the cire perdue process, has become a local innovation in Benin City foundries, spurred by increasing expenses of beeswax and imported materials. Based on field documentation at Vincent Uhunamure Emofonwan Foundry (2024), artisans estimate to recover about 60–70% of original wax using two containers-based methods, internally referred to as the Vertical Container Placement Method and the Double Container Collection System. These locally devised adaptations of standard firing equipment allow for wax melt collection without sacrificing mould investment integrity. No academic literature has yet formally documented or tested these percentages or nomenclature; empirical research is warranted.

Method 1: Vertical Container Placement

This technique involves the deliberate positioning of one high-temperature-resistant metal container, typically a reused refrigerator compressor or cut-off gas cylinder, immediately beneath the firing point. (Plate 4).

Methodology:

i. The metal -can is vertically embedded, directly beneath the firing zone. It is equipped with a perforated metal lid, modified to act like a funnel, with a central hole through which melted wax can drip.

ii. Wax-invested moulds are placed upright over this container in a manner that the gates or sprues align with the funnel hole. The setup is then covered with vertically piled up firewood. Once the fire is lit, popularly known as the "first fire," the application of heat slowly melts the wax contained within the mould so that it flows through the gating system into the perforated lid and thereafter into the receptacle positioned below. Once the firewood has been burnt and the dewaxing is done, the container is painstakingly dug up and opened after some time of cooling to find a mass of wax that has solidified at the bottom (Plates 9 - 12).

Advantages:

1. This method allows for a relatively high rate of recovery of wax, which is especially beneficial for foundries that operate under limited resources.
2. The arrangement utilizes gravity-fed flow and is easy to design using readily available materials.
3. The moulds can be reused for subsequent firing once the initial stage of wax removal is done.

Limitations:

i. It needs proper alignment of the moulds for efficient drainage of wax.

ii. Excavation of the container adds a labour factor and can lengthen the overall production cycle if not well-coordinated.

Plate 9: Burying the metal lids for wax collection. Emofonwan's Foundry, Benin city, May 2020.

Plate 10: Vertically placed moulds on the metal container for wax collection. Emofonwan's Foundry, Benin May 2020.

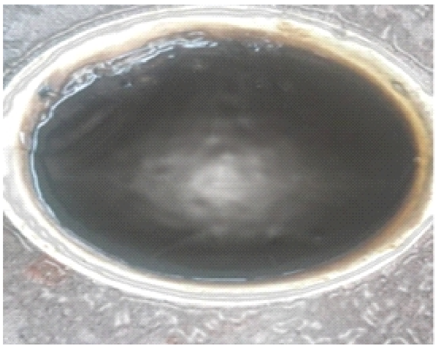

Plate 11: Recovered wax from the process
Source: Emofonwan's Foundry, Benin city, May 2020

Plate 12: Recovered wax
Source: Emofonwan's Foundry, Benin city, May 2020

Method 2: Double-Container Collection System
This improved technique uses a double-container setup designed to collect melted wax without disturbing the moulds after dewaxing. It is particularly suited to foundries that prioritize mould integrity or batch-processing consistency. (Plates 13 and 14).

Methodology

i. A metal paint can, or other cylindrical container is altered by cutting a large opening along one side, used as a later point of access for retrieving wax.
ii. Inside the bucket, a small metal cup or crucible is put in a position to collect the melted wax. The top part of the large container is perforated or simply left open to allow the passage of molten wax.
iii. The entire assembly is then buried vertically or with a slight angle, as per the plan of moulding placement.

Wax-invested moulds are positioned directly atop the large container, ensuring that the sprue or gating face is accurately aligned with the perforated upper surface. During the first stage of firing, when the moulds have attained high temperatures, wax flows down through the channels and into the large receptacle and eventually collects within the inner cup. Upon the cooling process, wax is extracted by entering the inner cavity through the lateral opening, employing instruments like pliers or tongs, while ensuring that the mould remains undisturbed for the following firing phases (Plates 13 - 18).

Advantages:

1. It allows for the recovery of wax without moving or removing the mould from the firing setup
2. The inner cup allows for neater wax collection with minimal ash or debris contamination.
3. The lateral entry facilitates quick and easy access, thereby minimizing effort needed in demolition or excavation.

Limitations:

i. Production of the double-container system requires greater precision in alteration and placement.
ii. Vertical angle configuration demands precise placement of the moulds for optimal distribution of wax inside the inner cup.

Plate 13: Perforated metal lids (stage one)

Plate 14: Perforated metal lids (stage two)

Plate 15: The buried metal lid; (stage three).
Source: Njk Foundry, May 2024, Benin city.

Plate 16: Moulds on the cans ready for dewaxing (stage four).
Source: Njk Foundry, May 2024 Benin city.

Plate 17: First fire/burning out (stage five)
Source: Njk Foundry, May 2024 Benin City

Plate 18: Collected wax.
Source: Njk Foundry, May 2024 Benin City

Table 1: Comparative Analysis

Feature	Method 1: Vertical Container	Method 2: Double Container System
Mould Movement Required?	Yes (after dewaxing)	No (mould remains stationary)
Ease of Wax Retrieval	Requires digging	Side-access aperture
Wax Purity	May include char residue	Cleaner, less contaminated
Setup Complexity	Simpler, fewer parts	More complex, requires fabrication
Suitability for Batch Casting	Moderate	High

Conclusion

This essay has confirmed that wax elimination in the cire perdue (lost-wax) casting technique is not a technical requirement alone but a dynamic aspect of metallurgical expertise, firmly embedded in centuries-old craft practice. With its origin traceable to ancient cultures of Mesopotamia, China, and Africa, the method has evolved repeatedly through the ages and across societies. In the present-day Nigerian situation, particularly in Benin City, economic and material constraints on artisans have spurred ingenious wax recovery methods like controlled heating, steaming, and container-based systems that drastically minimize the cost of production and ensure sustainability. The main findings of the study show that such innovations are not merely pragmatic solutions to economic problems but also cultural strategies that help keep indigenous casting techniques relevant. The incorporation of waste materials and altered firing systems illustrates a synthesis of traditional knowledge and modern problem-solving strategies, increasing the efficiency and environmental sustainability of foundry operations.

Looking forward, future research might systematically measure the economic effects of wax recovery across several foundries, record the environmental gains of curbing wax waste, and investigate the spread of these innovations through artisanal networks. Comparative analysis between regions or casting communities might also provide insight into the ways localized responses might inform global discussions around sustainable craft and heritage conservation. In the end, this strand of inquiry emphasizes the value of considering traditional art forms as less a static inheritance, but rather as dynamic systems.

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