METAL SCULPTURES:
MAKING AND PATINATION TECHNIQUE

(AN ANALYTICAL STUDY BASED ON INDIAN CONTEMPORARY SCULPTORS)

Thesis Submitted for the Award of the Degree of

DOCTOR OF PHILOSOPHY
in

Fine Arts

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2024

To My Mother

DECLARATION

I declare that the thesis "METALSCULPTURES: MAKING AND PATINATION TECHNIQUE" (An analytical study based on Indian contemporary sculptors) submitted in the fulfilment of the requirement of a Doctor of Philosophy in the School of Journalism, Film and Creative Arts, Lovely Professional University, is based on the results of the research work carried out by me under the Supervisor **Dr. Vishweshwari Tiwari** and Co-supervisor **Prof. (Dr) Sanjeev Kumar**. The manuscript has been subjected to plagiarism by the software Turnitin. And no part of this thesis has previously formed the basis for the award of any degree of fellowship.

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CERTIFICATE

This is to ce1tify that the thesis titled "METAL SCULPTURES: MAKING AND PATIONATION TECHNIQUE" (An analytical study based on Indian contemporary sculptors), submitted to the Department of Fine Arts, Lovely Professional University, Phagwara in fulfilment of the requirements for the award of the degree of Doctor of Philosophy in Fine Arts is a record of original and independent research work conducted by Pulkit Jawa (41600149) under our supervision and guidance. The candidate has pursued the prescribed coursework of research and has incorporated all the suggestions given by the Department Doctoral Board of the University during his annual presentations.

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Date: 21-06-2024

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ABSTRACT

For many readers of this research, one of the main reasons for using it will be to understand the technical aspects of metal casting and its surface treatment techniques. This research is an analytical study based on Indian contemporary sculptors by investigating different metal casting methods, including tribal, traditional, and modern methods of casting non-ferrous metals for making sculptures in contemporary times. Along with the patination process through chemicals to achieve different colours on different metals, using the reactive nature of metals gives a natural ageing or antique look to the art piece. So, this is experimental (technical approach) research for the field of visual art (sculpture) with the support of science (chemistry), one more example of the relationship between Art and Science.

There are many reasons behind choosing this topic. Making of metal sculpture through the lost wax process, continues the history, the origin of which has generally been traced to 3rd-millennium Mesopotamia (Penniman 1975:144), and the technical process of sculpture making, which is being used to date. This technique is also prevalent in Contemporary art scenarios due to different reasons, one is because its strength and ductility (lack of brittleness) is an advantage when figures in action are to be created, especially compared to various ceramic or stone materials such as marble sculpture.

The lost wax casting process of metal sculpture follows the basic principle, which is the same from the beginning till date, in which a mould is made over a wax model to create a negative impression of the desired model, which is filled later on by the molten metal to get the required shape of the metal cast. The basic principle is still the same, but there are many changes made in terms of materials and techniques due to change in time and place, which can also said to be the evolution of metal casting. From this research, the following questions have been answered.

• How metal casting techniques evolve in respect of material and technique?

• Why and how different Indian contemporary artists are using different metal casting materials and techniques?

• Problematizing the process of metal casting and patination adopted by the contemporary Indian sculptors.

• Lab experimentation to find new patina recipes for non- ferrous metals.

There are significant discrepancies between the metal casting procedures used in various Indian locations. Middle Indian tribal metal casting, South Indian traditional metal casting, and North Indian modern metal casting.

Another strong point is that India is recognized for its investment casting skills across the world, notably for the "South Indian bronze" and "Dhokra" art castings that are still produced by hundreds of skilled artisans around the country. The foundry industry should thus pay greater attention to this procedure. India may benefit from a hybrid strategy built on the foundation of antiquated investment casting and modified for industrial purposes utilizing appropriate, efficient, and eco-friendly technologies.

In contrast to the South Indian lost-wax technique, which is codified the Dhokra tradition, is complicated and unstructured, and it is practised by groups that are more or less independent. Discussions include motifs and topics as well as the method's finer features.

In India, sculpting practices have a variety of cutting-edge techniques to cast bronze art while upholding its long-standing customs. Thanks to the persistence of traditional practices, we can investigate the variances in how these techniques evolved beginning with the Indus Valley Civilization and continuing through the Pallava and Chola periods. From 10th and 13th centuries, when artisans started to relocate under royal support, from the 9th century. Today's sculptors continue to employ the skills and techniques of the ancients. They include their own creativity and originality while adhering to the style and conventions outlined in the previous writings.

They uphold customs and put in a lot of effort to create metal forms with exceptional creative value and skill. Archaeological research on conventional bronze casting methods is essential because it enables the interpretation of these processes from artifacts and other features discovered in the archaeological record. It is essential for identifying certain types of production tools, variations in the types of furnaces used and waste created, etc.

Evaluation of contemporary metal casting methods covers the late 20th and early 21st centuries. It includes the non-ferrous metal sculpture casting process used by artists who cast their work themselves or by professional metal casters on commission, the methods used at institutional foundries and the commercial foundries where artists send their models for casting.

All of the great metalworking traditions include patination practices for metals. By using various metals or their alloys to create sculptures, we have maintained that surface treatment or patina plays a crucial part in an aesthetic sense. The goal of this study is to provide sculptors and fine metalworkers with formulas and useful approaches that relate to readily available materials.

Every recipe has been tried using a variety of cast and sheet materials after being gathered from as many different sources as possible. Repeat testing on test samples and larger-scale items has been conducted, and to the best of our ability, methods have been improved and new approaches have been created. This research presents the findings of patination experiments. Patination on metal surfaces is not a precise science; instead, it relies on the material and working style of the individual.

Modern terminology is utilized to overcome the ambiguity of antiquated chemical names and weights and measures systems. This compilation of methods and formulas, along with the test results depicted in the metal patinated plates, is intended to provide an artist-craftsman with an understanding of the possibilities of patination.

KEYWORDS: Metal casting, Indian contemporary sculptors, tribal dhokra casting, south Indian casting, modern metal casting, patina, techniques, patination, bronze, brass, gunmetal, sculpture, surface treatment, chemicals, reactions, chemicals recipes

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CHAPTER ONE

THE RESEARCH CONTEXT

1.1 Introduction

Sculpture and painting are the two main branches of Fine Art[1], both allied primarily, one having Scope limited to the surface only and the other giving Scope for the three dimensions. The sculpture is the art of forming representations of objects with expression in the three dimensions or round or in relief by additive or subtractive techniques that are modelling clay or wax, casting or carving stone or wood, etc, constructive techniques or similar processes.

Art is the manifestation or application of human creativity and imagination. Sculpture is one of the areas of art. A coin or a monument, portrait bust, statue, bas-relief or any other kind of sculpture can all be considered works of art that use three dimensions to express ideas, emote, analyze, and disclose perspectives that are representative of both individual and societal conditions.

In India, spirituality is communicated via sculpture by condensing its essence into tangible form. Sculpture is an immersive three-dimensional experience, which provides aesthetic enjoyment to those with an appreciation for the line, rhythm, texture, repetition, symmetry, balance, proportion, emphasis, movement, and value of form as well as the quality of form and space.

In the primary technique of sculpting, there are two working stages. One is modelling, and the other is the reproduction of the same into some durable material. Generally, both these stages are followed to give a durable and finished art- piece. However, the second stage of reproduction may not be followed if the model is not

[1] Fine art whose products are to be admired primarily or only for their imaginative, aesthetic, or intellectual value is referred to as creative art.

preserved or arrangements to keep the model duly prevented. The clay model may be preserved by baking or firing it directly.

In many cases, artists do not prepare any clay models and proceed to their sculptures directly. However, this shortcut way is possible only when the same is to be carved in wood and stone or welded and forged in metal. Sometimes the sculpture is directly done in concrete or plaster media, without a preparatory model. Now in Contemporary times, sculptures are also been created with the help of 3D software, in this process first the model in digital form is created on computer and then that model can be printed through 3D printers.

The word 'metal' appears to have been derived from the Latin Metalum, meaning metal or mine. Wood and stone are substantially older in sculpture use than metallic media, although all these substances as the material of sculpture date back to Antiquity. The discovery and early use of metal are shrouded in the obscurity of prehistory time. However, it appears that Neolithic man first discovered metal, and they kept on to find practical utilitarian and artistic uses for the crude varieties native to his immediate environment.

The word bronze comes from "Brindisi", the name of a small town and port on the Adriatic Coast of Italy, famous for its bronze images since Roman times (Kuppuram, 1989).

The mode of casting metal images is termed 'madhuchchhishta-vidhäna' or the lost-wax method, known as cire perdue in French. As the name itself suggests, the molten metal is poured into the hollow of the mould. There are two ways of casting metal images: the hollow method and the solid—sushira and ghana. Though the smaller images for household worship were usually cast solidly, the large ones were sometimes cast according to the hollow method. There are references to both the modes in early Chola inscriptions describing the images gifted by the emperors to the temple for worship- ghanamaga elundaruluvitta Chandisvaraprasadadevar, "the God

Chandisvaraprasadadeva cast solid and set up,” and ghanapollalaga chcheyda rishabham, “a bull cast hollow”

The lost wax casting process of metal sculpture follows the basic principle, which is the same from the beginning till date, in which a mould is made over a wax model to create a negative impression of the desired model, which is filled later on by the molten metal to get the required shape of the metal cast. The basic principle is still the same, but there are many changes made in terms of materials and techniques due to changes in time and place, which can also be said to the evolution of metal casting.

1.2 Significance and the Scope of the Study

By emphasizing concept and contextual interpretation in selected artists' works, this latest study contributes to bringing another dimension to sculpture by metal casting practice in the sphere of contemporary arts. Studying metal casting arts with motivational aspects and creating visual language by various artists from different parts of India.

1.2.1 Significance of the study

As the contemporary approaches, all the critical case studies of an artist are analyzed by close observation of their activities, interviews, and examination of primary and secondary literary sources moderated by their creative method. As a sculptor, sculpting in metal has inspired this thesis and teaching role in the area of visual arts in analyzing these developments and their thinking processes. As a result, the study challenge entails inquiries into cultural differences, identity, and motivational influences.

Using different materials and techniques in metal casting practices, an independent artist has used metal as a medium for creative activity. Nonetheless, artists are reinterpreting the metal casting techniques to shift them towards more demanding philosophical and artistic concerns; these techniques add a new dimension to the contemporary metal casting practices. This research will enable to understand the contemporary techniques used in India, in different regions, from different sculptors of a different style. This research also includes a discussion on the patinations technique, which is a part of the metal casting finishing process.

1.2.1. Scope of the study

From this research, the researcher has attempted to answer the following questions:

- How metal casting technique evolved in respect of material and technique.
- Why and how different Indian contemporary artists are using different metal casting materials and techniques.
- Problematizing the process of metal casting and patination adopted by contemporary Indian sculptors.
- Does the core pinhole spoil the surface texture of the metal sculpture? If yes, then what is the solution for that?
- Does welding on metal sculpture affect the patina colour, if yes, then what is the solution for that?
- Does the composition of metal have a vital role in the metal casting process? If yes, what are they?
- Does artificial patina change its colour over time? If yes, what is the reason behind it, and can we control it?

The following steps were followed to see the variables of this research.

a) Extensive literature survey

b) Data collection through primary and other sources

c) Analysis and interpretation of data through qualitative research tools

d) Observation and interpretation of data through the idea of formalism

e) Preparation of the thesis through APA research writing guidelines

The literature survey will be executed with relevant research reports, books, journals, textbooks, and articles published and unpublished documents. The collected information from the literature will be critically examined and analyzed. The researcher is going through the literature survey at present. A list of those books has been mentioned in the Bibliography. The investigator will be surveying the books in print, historical and theoretical on the concerned subject.

In a book titled "The Complete Guide to Sculpture, Modelling and Ceramics Techniques and Materials" by Barry Midgley, there are two separate chapters on metal casting. One is wax and another is casting metal, in this book, they showed the use of iron pins in the wax process to hold the inner core with investment mould, in which iron pins help to maintain the negative space in the investment mould, where molten metal takes its shape in the form of sculpture. In this process, iron pins get stuck in the bronze sculpture and become an unwanted part of it, if that not be appropriately removed from the sculpture, it makes rust spots on the metal sculpture, which spoils the surface finish of that sculpture. If a sculptor wants to resolve that rust issue, then the only way is to remove the iron pins from that sculpture. However, the removal of those pins causes holes, which can fill by the welding, and it spoils the texture finish of that sculpture, which a sculptor never wants, but still, this wrong technique is in practice.

In another chapter of the book titled "The Complete Guide to Sculpture, Modelling and Ceramics Techniques and Material" which is very beautifully written on the topic of metal casting, but as this book is a guidebook on many different materials used in the field of sculpture and so have minimal information on casting metal, and it's a surface treatment like patination process.

I observed the same case mentioned above in many other books, for example, a book named "Sculpture Inside and Out" by Malvina Hoffman. This book is technical and has aesthetic values, which is a great thing, but I aim to do research that will also work as a complete guide to the metal casting and patination process.

I got inspired by the book. That book pushed me to try chemical experimentations on bronze sculpture, as it has lots of different patination recipes that can be done on bronze sculptures. But when I tried to use that chemical composition, I faced many challenges like non-availability of those chemicals or difference in quality of chemicals, may be due to the difference in metal composition or its quality. Due to these reasons I was unable to achieve the same results as shown in the book. And that inspired me to do my experiments on different metal test plates, discussed in chapter five, which is on the patination techniques and includes different patina recipes.

1.3 Objectives of the research

Research objective means the thesis goals succinctly state what the study is attempting to accomplish. They summarize the goals that a researcher hopes to achieve through the experiment and provide the analysis guidance. A systematic and thorough analysis of a specific issue or question using experimental techniques is known as research. An in-depth study of data makes room for new problems, definitions, and understandings to emerge.

The primary goal of this research is to discover new possibilities and investigate the current scenario of lost wax metal sculpting in India.

The four main objectives are mentioned below:

- To trace the evolution of materials and techniques of metal casting
- To analyze the bronze sculpture-making process by Indian contemporary sculptors
- Problematizing the process of metal casting and patination adopted by contemporary Indian sculptors
- To explore different patination processes.

1.4 Research method

A study is legitimate when the result is correct or real, and analysis architecture is the methodological framework in which the study is carried out. When doing analysis, we must consider the types of facts needed to provide a fair response to the research query.

Time, society, and situations all influence the creation and evolution of every entity or creature. Research is critical to comprehending this trend and going in the correct direction in terms of explaining the phenomena. Science Methodology refers to the research instruments that the researcher employs to address the issue. The researcher constructs a framework using these analysis elements in order to get to the root cause of the problem and outlines the problem's current state as well as its potential solutions. As a result, Research method is a critical analysis phase in which the investigator shines light on the research's operation.

This study sheds the light on metal sculpture casting and patination techniques. It emphasises the background of contemporary Indian sculptors and the lost wax technique techniques that they used to create metal sculptures.

1.4.1. Research design

The research framework can be thought of as the "glue" that binds all of the elements in a research project together, in other words, it is a strategy for the future research work. According to Jahoda, Deutch & Cook “A research design is the arrangement of conditions for the collection and analysis of data in a manner that aims to combine relevance to the research purpose with economy and procedure”. (Innam, 2016)

The following flow chart represents the overall path of the research. It illustrates the process followed from problem identification to answering the research problem.

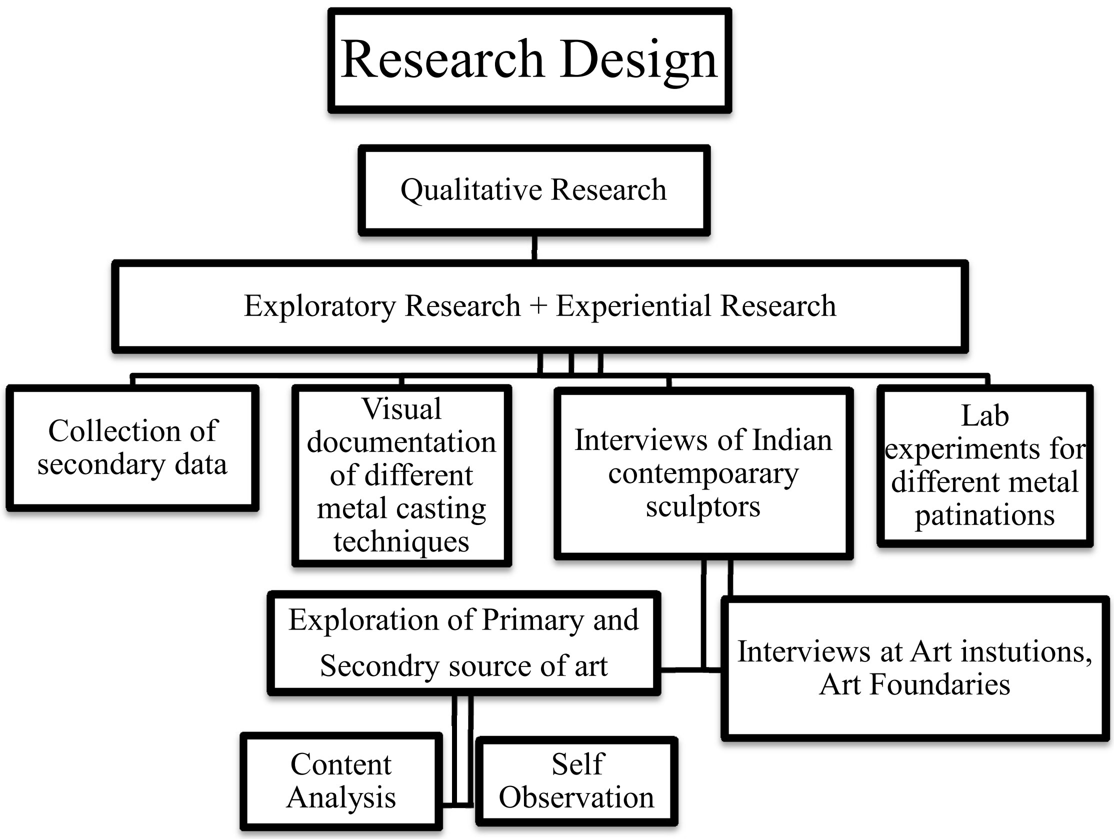

Figure 1.1 Flow chart of Research design

1.4.2. Methodological justification as per the objectives

Objective (A). To trace the evolution of materials and techniques of metal casting

Methodology:

- Unstructured interviews and visual documentation of the metal casting process
- The tribal metal casting of Bastar district, Chhattisgarh
- The traditional metal casting of Khunhimangalam village, Payyannur, Kerala
- Contemporary metal casting at studio Sukriti, Jaipur, Rajasthan

Objective (B). To analyse the bronze sculpture-making process by Indian contemporary sculptors.

Methodology:

Structured interviews with Indian contemporary sculptors.

Objective (C). Problematising the process of metal casting and patination adopted by contemporary Indian sculptors

Methodology:

Analytical study after collecting secondary data, through structured interviews.

Objective (D). Problematising the process of metal casting and patination adopted by contemporary Indian sculptors

Methodology:

Analytical study after collecting secondary data, through interviews.

1.5 Operational definitions

The terms mentioned below have been used in thesis discussions and arguments.

Sculpture- It is the art or practice of shaping a three-dimensional form. The designs could take freestanding pieces, reliefs on surfaces, or other forms of expression in three-dimensional form.

Sculptor-Those practitioners in the fine arts are concerned with the three-dimensional imagery, produced in round or relief, by carving, fashioning in malleable materials, casting or forming in metal, by assembling found objects or by combining all or some of these techniques.

Metal Casting- Metal casting is the method of pouring molten metal into a mould with a hollow cavity of the desired shape and allowing it to cool to form a solidified form in metal.

Furnaces- One of the essential items to the sculptor in the foundry intended to make the metal casting. It is enclosed equipment in which metal melts in a controlled atmosphere at a specific temperature.

Smelting- Process by which a metal is obtained, either as the element or by heating beyond the melting point.

Patina- The patina literal meaning is a film of oxide formed on the surface of a metal or patina is a thin layer of colour formed on the metal due to the oxidation process. That can be natural or artificially created.

Lost wax/Ceri perdu- It is one of the oldest metal-forming techniques known, dating back 6,000 years, and it is still commonly used in jewellery, dentistry, and sculpture. It is a metal casting process by creating a wax model, covering it with a refractory (as clay) to form a mould, heating until the wax melts and runs out of small holes left in the mould, and then pouring metal into the space left empty are the steps involved in metal casting**.** In its industrial nature, investment casting is a popular way to make precision metal parts in engineering and manufacturing.

Contemporary sculptors- Sculptors in the present day. Sculptors from the late twentieth and early twenty-first centuries have also been included in this category.

CHAPTER TWO

CONTEXTUAL RESEARCH OF LITERATURE

2.1 Review of Literature

Many studies have addressed metal casting techniques, some are related to sculpture metal casting, and some are of industrial product casting; for this research, few from both have been covered.

We know many different metal casting techniques, but when we talk about the metal casting of sculpture, we have two basic methods of casting that emerged in the Ancient World, the direct and the indirect methods. The direct method meant that the sculpture had to be modelled as a solid form in wax, over which a refractory material was formed. The wax was subsequently melted away, and molten bronze was poured into the resultant void to make a solid casting. Similarly, wax was modelled over a shaped refractory form, which in the process, became a core. The core wits then held in place by metal pins pressed through the wax, followed by the application of an external coating of refractory material. After the wax had been melted away, then the resultant space between the core and mould could be filled with molten metal to produce a hollow section casting. This Method, in both instances, result in the original modelled work being destroyed during the process. The indirect method, introduced by the Greeks, required the production of a piece mould from the original model in order to produce a wax casting which could, if necessary, be cored and could then follow the same process already described. The mould could then be used to repeat the process if necessary. Both these methods are still used today. The lost-wax technique is still the most satisfactory method of producing cast sculpture in bronze, although two critical alternative developments in metal casting emerged in the eighteenth and nineteenth centuries—sand casting and electrotyping, which prevents metal from oxidation and gives a surface finish. However, electroplating is very much different from patina which we see more in artworks.

Metal Casting and bronze casting have evolved over about 4000 years and have remained virtually unchanged in their principles to this day. The lost wax method of casting in bronze was known to the Sumerians in the Indus Valley around 2000 C. It continued to evolve in the Middle East and was used in China around 1500 C. Lost-wax casting (also called "investment casting," "precision casting," or cire perdue in French.

Nowadays, The term 'Patina' is most often connected with the attractive green corrosion sculptures that may be seen on some antique bronze that been retrieved from ground of an archaeological site or with colours that are purposefully added to metal sculptures using patina recipes.

Most modern sculptors in bronze believe in the romantic myth of a benevolent Nature that will in time provide their sculptures with a handsome patina, or example, Henry Moore has stated that bronze naturally in the open air particularly near the sea will turn with time and the action of the atmosphere to a beautiful green But sometimes one cannot wait for nature to have its go on the surface of bronze and you can speed it up by treating the bronze with different chemicals which will produce different effects. Some patina recipe will turn the bronze black others will turn it green or brown. I usually have an idea of the final outcome of sculpture, while modelling sculpture in plaster, whether I intend it to be a dark patina or a light bronze and what colour it is going to be when it comes back from the foundry. I do the patination and this sometimes comes off happily though sometimes you can't repeat what you have done previously. It is a very exciting but tricky and uncertain thing this patination of bronze. [Henry Moore Henry Moore on Sculpture Philip James Ed NY 1967 p 140]

Treatment of metal sculptures is made more difficult by the fact that patina, or oxidation, forms at the expense of the object's substance, sometimes to the point of complete mineralization. Once significant alteration or patina has occurred, physical evidence cannot be used to restore the original color or finish of the sculpture. Furthermore, these extremely significant historical details may be found in these patinated objects. For example, buried relics may include a little amount of dirt that can be used to determine origin and authenticity.

For this research, the researcher studied the extant literature.

2.1.1 History and evolution of metal casting of sculptures

In India, both home shrines and temples use metal iconography in unusual ways (Udayakumar 2011). Bronze sculpture has a long history that extends back to the Indus civilization (Bandyopadhyay 1987). However, it grows as a separate school of art throughout South India's classical era under the Pallavas, Cholas, and succeeding kingdoms (Udayakumar 2011). The Lost-Wax method was used to create the bull and dancing girl at Mohenjo-Daro, which is thought to have been created about 2500 B.C., provides the oldest evidence in South Asia for the casting process used to create metal figures (Bandyopadhyay 1987). The copper and lead-coated steel were used to create the dancing girl. This is important because even small levels of lead in a copper alloy might dramatically boost the molten metal's fluidity and, consequently, its capacity to flow, filling intricate and constrained places in a mould. Near Shahi-Tump, another site in Pakistan, lost wax casts were rediscovered at the end of the fifth millennium BC (Mille et al. 20). The Chola era in South India is primarily when Indian metal sculpture flourished. However, several examples from the Pallavas who ruled from Kanchi had a high level of artistic and technical quality. For instance, the Government Museum in Madras has a Nataraj sculpture dating to the eighth century A.D. that was found at Kuram, District Chinglepet (Sivaramamurti 1962; Mehta 1971).

Melting metal is an essential step in the production of semi-finished and final cast products. Between the manufacturing of the initial smelting ingot and the final fabricated or cast object, remelting of initial smelting ingots to make secondary or refined ingots is also a typical intermediate stage. Secondary ingot manufacturing is done for various purposes, including removing slaggy impurities left in the initial smelting ingots, breaking up massive smelting ingots into more useable or transportable ingots, forming metal alloys, and melting down metal scrap with a variety of compositions.

In the very first published investigation of Harappan Phase ingots (his "copper lumps"), SanaUllah (1931:484-485) noted that three of the four ingots were the "crude output of the smelting furnace" that were too high in sulphur to be formed. He proposed that such ingots be remelted for refining, as this metal could only be utilized for casting "heavy or plain items" otherwise.

As previously stated, most of the archaeological evidence for melting (and casting) mirrors that for smelting, including crucibles, kilns, slag, and metal ingots. However, a thorough examination of these items, particularly identifying the kinds of slags present, frequently permits the distinction of these processes (for a complete description and references, see Miller 1994b).

Copper melting in crucibles is first documented during Period III at Mehrgarh, between 4000 and 3500 B.c. Crucibles containing evidence of molten copper have been discovered in a Period III brick firing building (arrige 1983, 1985a).

The crucibles are similar in internal size and form to the ingot discovered at Lothal, according to J Arrige (1985a:289).

Despite the fact that only a small number of crucible pieces containing copper prills have been found at Harappan Phase sites, copper melting appears to be more frequent; future archaeometry studies may enable unambiguous differentiation between the two processes (see Miller 1994b).

Sana Ullah (1931:485 and pl. CXLII, 9) believes that a crucible rim piece discovered during excavations at Mohenjo-Daro demonstrates the re-melting of unrefined metal for refining. Although no analysis was ever published, the image of this rim reveals slagging. It seems to be quite similar to fragments discovered during the Aachen/ISMEO surveys at Mohenjo-Daro (below). Surface surveys and subsequent excavations at Harappa and Mohenjo-Daro provide considerably more favourable data. In surface surveys of the southern slope of E Mound at Harappa, half a dozen crucible rim pieces with slagging and copper prills were discovered, and several rims and base pieces of similarly slagged crucibles were discovered in nearby excavations (Miller 1994a, 1994b).Surface studies at Mohenjo-Daro revealed at least two crucible shards with slagging and copper prills, as well as a whole tiny ceramic cup (Pracchia et al. 1985; Tosi et al. 1984). This cup resembles the crucibles used by current South Asian goldsmiths. However, no visible signs of metal or slagging, and microprobe analyses revealed no metal residues (M. Vidale, pers. comm.).All of the Harappa crucible fragments and one of the two from Mohenjo-daro have a tiny diameter; the second piece from Mohenjo-Daro is significantly bigger. These appear to be melting crucibles, not smelting crucibles, based on the accompanying kinds of slags, though archaeological study is still needed.

On the other hand, Dokra artists continue to practise the ancient technique of metalworking. This population is located throughout India in states like Andhra Pradesh, Orissa, Chhattisgarh, Jharkhand, and West Bengal (Bhattacharya et al. 2011). Brass (Copper + Zinc) is a material that the Dhokra shilpis use frequently. In contrast to potters, where males are often the ones who turn the wheel, all Dhokra work can be done by either men or women. Children pick up the skill through instruction and imitation (Kochhar 2011). This craft's notable quality is its distinctive individuality. The Dhokra Shilpy manufactures items like lamps, necklaces, caskets, measuring bowls, figures of people and animals, and representations of gods like Durga, Lakshmi, etc.

2.1.2 Tribal lost wax metal casting

When we use the word "Tribal," it means something about the tribes or village. The tribal metal sculptures are the metal images of Hindu deities used for worship in

Indian villages and are enshrined in the village temple or household altar. They are fashioned by the local metal smith who belongs to the metal-workers community and has inherited the secrets of his trade and his skill from his forefathers. He is well-versed in the techniques of metal craft and the traditional repertoire of artistic motifs and Hindu mythology, legends, and traditional folk lore .It has preserved the age-old indigenous artistic and cultural traditions over the centuries till the present times and saved them from passing into oblivion for good. Despite his apparent illiteracy, he is far more learned than any of the so-called literate babus who contribute nothing to live, not to speak of arts and culture. (Agrawal, 2000)

One wonders how and when the casting of tribal bronzes came into being. Thousands of years ago, when the villagers were at the mercy of Nature, they channeled their desperate hopes and fears into magic rites and ceremonies which they believed would safeguard and improve their existence. The religion of the earliest village communities demanded the making of majestic images of the ancestors they worshipped. At the dawn of civilization, these images in folk style were the only tangible link between the various tribes when writing was as yet unknown. With time, the motifs used in this art form continued to change according to the changing needs of the various cults. In certain remote villages, on account of their geographical isolation, very many types of folk bronzes are still in existence, like other specimens of art. Some of them are still in a good state of preservation. These images and other folk art forms have proved to be the cultural backbone of the artistic development of the village communities. The history of art enables us to identify and track down elements of cultural continuity in the form of artistic motifs transmitted by one province to another and establish links that connect the people with their neighbors and predecessors. These interconnections both in time and space are an enthralling study.

The history of tribal metal sculptures is shrouded during hoary antiquity. Till now, it has not been possible to trace their origins or chronological development. What is certain is that, the prehistoric person created such images and symbols to pay homage to the Supreme Principle, which, he thought, governed his life and the entire Universe. Therefore, these images and symbols are the spontaneous expressions of his joys and sorrows, hopes and fears. From prehistoric caves in India, ancient relics, simple motifs, and emblems testify that folk images date back to very ancient times and have since then been continuing to develop along energized lines. (Bandyopadhyay, 1987)

These bronzes are certainly of ancient origin. This is evident from the bronze figurine of the dancing girl unearthed from Mohenjo-Daro, which can be regarded as the earliest specimen of folk bronzes. However, it was fashioned by the people belonging to one of the most sophisticated and advanced urban civilizations in the world. B.B has expressed the same views. Lai:

“The earliest known Indian bronze figurine was discovered at Mohenjo-Daro, where a highly developed urban civilization flourished in the 3rd millennium B.C. Mohenjo-Daro has yielded a large number of copper and bronze objects. The art of metal casting and metal working had reached a high level of technical excellence as demonstrated by the remarkable bronze statuette of the dancing girl. (Sivaramamurthi C. , 1962)

The tradition of making folk bronzes is as old as Indian civilization is evident from this bronze figurine discovered from the remains of Mohenjo-Daro. Heinrich Zimmer has interpreted the figure of the dancing girl as representing the devadasi, the female dancers institutionally attached to South Indian temples who dedicated their lives to the temple deities. No one can help from being attracted to its alert resilience and refined force. The statuette displays the graceful slender figure of a girl, full of the dynamism of life, some hidden energy welling from within that constituted.

Lai. B.B.'s note to A.K. Coomaraswamy, Encyclopedia Britannica, 1955, under ‘Bronze and Brass Ornamental Works,’ quoted by Ruth Reeves. Cire Perdue Casting in India, Crafts Museum, New Delhi, 1962.p. 19.

One of the most characteristic features of classical and folk style bronzes is the qualities that characterize the bronzes fashioned in later periods; this fact suggests a continuity of at least several thousand years. This figurine is undoubtedly the most ancient representation we possess, which probably served as the prototype of the Indian deity who was later worshipped as the Mother goddess , the Goddess Earth.

In ancient India, a variety of metals and alloys were used. “Not only was iron worked at an early date (being listed with gold, silver, lead, and tin in the Yajur Veda), but there existed (and maybe originated) in India a very early knowledge of the art of preparing steel,” said Dr. Coomaraswamy, a great Ceylonese writer on Indian art. The Greeks and Persians and the Egyptians were familiar with Indian steel, which was also the source of the famed Damascus blades.”

Since ancient times, copper has been commonly used in India for sculpture. Bronze, which is actually an alloy that is composition of copper and few other metals like zinc, tin and lead in lesser proportion to copper, was also used. The explanations for this remain a mystery. There is evidence that gold and silver were also used to create large sculpture pieces in ancient India. A history of the casting of gold and silver Buddha image studded with jewels during the reign of the great Gupta emperor Samudra Gupta in A.D. 360 survives.

It has already been stated that most of the examples of metal figures which exist today are of pure copper or copper-base alloys and brass. The scarcity of the bronze images (as the metal is commonly understood) may have been due to the fact that tin was not easy to get in the quantity required for the alloy. There may be another reason for not using the standard bronze; according to the Hindu religious ideas, this alloy was considered impure for divine rites. From very early periods, various metals were considered to symbolize different stars; and in the making of images, particular metals were selected in the amalgam to signify the cosmic relation of the idol. In the north, the amalgam of eight metals known as Astadhatu, which is composed of gold, silver, iron, tin, lead, mercury, copper, and zinc, was considered as the most perfect and prized alloy for the making of divine images. In South India, the ideal alloy for statuary has always been the " Pancha Lauha." This literally means the five irons but is in fact, an amalgam of copper, silver, gold, brass, and white lead. The casting of images in brass has been carried on both in North and South India since the 10th century A.D.

Almost all the images of the early periods show delicate modelling, and although the details of the bones and muscles were suppressed in the simplified forms, they have the grace of the natural human body. But in the works of the later periods, the figures were most diligently chiselled out, and this obliterated the tactile beauty of the sculptures. The modelling was entirely overpowered by the hammering and engraving of the craftsman. The images look like the hand work of the goldsmith rather than of the sculptor. Sometimes the figures were carved and engraved in wax and after the casting in metal, their details were emphasized by chasing.

The methods of casting metal figures in the Gupta period can be investigated by examining the colossal copper image of the Buddha from Sultanganj, which is now in the Museum and Art Gallery, Birmingham. This seems to have been made in two layers. The inner layer was moulded on a core made of a mixture of sand, clay, charcoal, and rice husks. The segments of the layer were supported by iron rods of nearly three-quarters of an inch thick. The outer layer of copper was cast on the inner one by the cire perdue process and was made in several sections.

There are various references to the process of cire perdue in some of the ancient religious manuscripts, and in Manasara, an old textbook on image-making, there is a reasonably detailed description of this process as it was practiced in the old times. This is worth quoting at some length.

“According to the navatala measurement as mentioned before, the expert should first prepare the image (i.e., the mould), complete with all the limbs, yellowish in colour, beautiful to look at and with weapons and arms as prescribed.

After placing the wax tubes of the length of a dhatura ' flower on the back, on the shoulders, and the neck or the crown (of the image), (the artist) should besmear the image with refined clay.

To clay should be added charred husk finely rubbed, cotton severed a hundred times, and a little salt finely powdered. All these (when mixed with clay) should be (finely) ground on a smooth stone, and (the paste) should be applied three times all over and round (the image).

The first layer (of clay) should be transparent (and thin) and dried up in the shade. After a couple of days, a second layer should again (be applied). When dry again, there should be the third coating thickly applied.

(One) should besmear the whole (image or model) with clay leaving the mouths of the tubes open, and the wise man should dry up (the clay coating) with care and judgment.

The expert should first (i.e., before beginning the process, just mentioned) measure the wax of the image, which has to be made either in brass, or copper, or silver, or gold.

Brass and copper should be taken ten times that of wax, silver twelve times, and gold sixteen.

(Then one) should encase the metal, either gold or one that is desired, with clay and coconut-shaped crucible (thus formed) should be dried up in an aforesaid manner.

Next (one) should melt away the wax (from the mould) by heating the (i.e., the mould) in fire and should afterwards heat the crucible in cinders.

Brass and copper melt surely with (the help of) cinders just kindled. Silver melts with (the help of) glowing cinders, while gold with (the help of) cinders flaming fivefold.

After making a hole with an iron on the top of the crucible and holding it tightly with a pair of tongs (one) should bring the heated crucible (out of the cinders).

(One) should place a burning wick in the mouth of the tube of the heated (mould of the) image.

After bending carefully the crucible, held tightly by the tongs, (one) should pour molten metal into the mouth of the tube in a continuous stream and stop when it is packed to the brim of the tube.

The adjacent fire should be put out for the purpose of cooling (the mould with the molten metal). When the image (i.e., the mould) gets naturally cool, the expert should break up the clay (mould) very carefully.

Then the metal image (thus prepared) verily resembles that in wax, endowed with similar limbs and other details.

When there is seen anything superfluous it should be put right with 'charana'; the tubes should also be cut away, and after that (the image) would have to be finished.

After making an image by this method, the king should install it on an auspicious day according to the usual rites and should offer daily worship to it."

The Manasara book suggests that wax models be constructed in yellowish hues as that is the closest to the colour of the metals often used for sculpting, with the exception of silver. Thus, it would guarantee accurate modelling and the presentation of light and shadow to the finished cast.

In Nepal and some regions of South India, metal casting is still done in the method described in Manasara. When it comes to tools, Indian professionals who work with metal statues hardly vary from those who work with wood or stone. An old book by

Sarasi Kumar Saraswati about the metal casting of metal pictures, Indian Society of Oriental Art Journal, 1936.

2.1.3 Traditional lost wax metal casting

The traditions and techniques of metal casting in India have been recorded in ancient Sanskrit religious texts. According to the Agni Purana, images made of gold and silver, yield the most significant religious merit. In the Manu Samhita, mention is made of "mining operations," metal manufacturers, guilds of metal craftsmen etc., which are enough to suggest that metal craft already had a highly developed tradition. Though fewer references to metal craft are found in the Ramayana, the Mahabharata abounds in such allusions. The Vishnudharmottara Purana, the Jain texts such as the Anuyogadvara Churni and the Acharanga Sutra, and numerous medieval texts also furnish helpful information on metalwork. The references in our ancient literature to metal objects cannot be dismissed as merely fanciful accounts of non-existent facts, as has been done by western scholars. No ancient specimens exist on account of heavy destruction by foreign invaders and the tropical climate of our country. "The climatic conditions in India being what they are." to quote Ruth Reeves, “innumerable works of art have perished; also, that many of the treasures mentioned in these texts were either plundered and taken to other countries or destroyed by iconoclastic zeal. The metal arts still extant and which by markings can be chronologically verified or those currently excavated by archaeologists reveal that the metal artisans of India of former times were capable of producing. Nevertheless, when mention of artifacts or craft techniques is made in the epic literature, an open mind must be kept, for not infrequently similar artifacts have been excavated by archaeologists, proving that to some extent these ancient texts can be relied upon.”

Reeves, Ruth: Cire Perdue Casting in India, op, cit., pp 24-25.

For centuries, the foreign invaders entered the country through this province and trampled down and destroyed whatever vestiges of arts and culture remained.

Despite so much destruction, political upheavals, and disturbances, people continued to live in the villages of Punjab and preserved whatever little they could of the traditional life patterns, age-old beliefs, and social customs, and religious practices. Whatever specimens had come down to us date from the periods when peace reigned over this province for a short while. It is impossible to piece together a consecutive chronology of any particular art form from this province. The sources are lamentably few and far between. This has been pointed out by all the scholars who were interested in this region. "Much is known of the art of bronze casting in North India and Pakistan," writes Douglas Barret," but this is true only of certain regions and specific periods. Significant gaps in our knowledge remain. From North-West India, however, comparatively little seems to have survived. This lack of material is particularly apparent in the Gandhara period from the 1st to the 7th century A.D., apart from a few small images from Taxila.

Whatever has come to light so far shows that the folk culture and artistic traditions have remained unchanged since the time of their origin. The cultural traits of the rural folks are unswerving and exceedingly tenacious, and they have survived from hoary antiquity until the present times. Wherever we do not come across actual specimens of art objects, we have no choice but to rely on allusions in our ancient literary texts.

After a long gap of a few thousand years, we have Panini, our great grammarian, informing us in his Ashtadhyayi that in his time (4th century B.C., according to some historians, and 8th century B.C., according to others), numerous cities and towns had come up in northern India where metal crafts were fervidly practiced. His works are a valuable record not only of arts and crafts that flourished contemporaneously but also of the social, political, and cultural life in pre-Mauryan times.

Another vital source that fills up this gap

Barret, Douglas's "Bronzes from North-Western India and Western Pakistan" in Lalit/Kala Akademi journal, No.11, April 1962, p. 35.

Here it suffices to say that the very existence of terracotta figurines at a particular period suggests that the folk bronzes must have been made contemporaneously, for both are allied crafts. The Mauryan period (322-184 B.C.) has yielded a large number of terracotta figurines. After the Mauryan period, The focus shifts on attention on the North-western frontier areas of India, which were ruled over by the Indo-Greek and Indo-Parthian dynasties (150 B,C. 60 A.D.), whose courts attracted many foreign metal smiths who brought with them imported styles, namely Hellenistic traits which, however, failed to make a deep impact on the indigenous artistic traditions and did little to promote the high promise of metal craft established by the bronze figurine of the dancing girl from the Indus Valley site of Mohenjo-Daro.

Based on these epigraphs and their stylistic characteristics, the scholars of Indian art have piece together a more or less consecutive chronology of Indian bronzes in classical style. Can we reconstruct a similar historical account of bronzes in folk style?

No, alas! There are several reasons. First of all, we do not come across ancient specimens of folk bronzes. Some bronzes have been dated to centuries preceding our own based on their style. Whenever we find identical stylistic features and treatment in other art forms in classical style such as painting, stone and metal sculptures, or other objects, we presume that our bronzes might have been executed contemporaneously or a few years later. Secondly, no written records or literary references exist to enable us to date them, for the artisan continued to work in style he was trained in unquestioningly over the centuries. This way, the original style did not undergo much change in centuries. The basic features have remained unchanged. The bronzes in folk style do not have chronology, but they certainly have a tradition that has persisted unaltered since the day of its inception till the present times. These observations can be summed up more concisely in the following manner:

The chronology is still uncertain, but stylistic features enable us to date quite a few folk bronzes. The timeless Nature of objects inhibits precise dating. Many derive from the great tradition but have been magically transformed by the ingenuity of artisans working predominantly with whatever materials were at hand. Some illustrate the tenacity of traditions that reach as far back as the Indus Valley civilization. Others have the distinctively brash character of tribal art or the unabashed naivete (lack of sophistication) typical to folk art throughout the world.

Archaeologist K.V. Soundra Rajan has expressed the same views:

“There is as yet no consecutive account avail-able of the centuries during which the transition from the prehistoric to the ancient and medieval world of Punjab took place. In the Sivalik and the snow ranges, we find the most numerous vestiges of ancient and later Hindu civilization from the Kushana and Gupta times up to the flourishing of Kangra art in the late 18th and early 19th centuries. Since no adequate archaeological excavations have been carried out in the Punjab, Rajasthan, or Gujarat, it is difficult to trace the history of bronzes of these areas."

"The Rajasthan area is, in many respects, the terra incognita of archaeologists and art historians. Both its ancient seats of power and the multitude of its temple ruins have received anything like casual attention only in recent years. The origin of Gujarat, the most important rulers in Rajasthan and Gujarat, has been considered by some foreigners who came in the wake of the Hun invasions and infiltrated across Punjab and Rajas-than into western India. It would also seem to be evident that it was only the sudden political vacuum created Icy the decline of Gupta power that saw the rise of such a people whose earliest kingdom was founded around Jodhpur in Rajasthan in the middle of the 6th century A.D."5 Most of the ancient specimens of folk bronzes have perished or been destroyed. This might have been on account of vandalism of all kinds, ignorance on the part of their owners. It seems that a large number has been melted for making utensils. Whatever is available now dates back to less than a century; at the most, they are fifty to seventy years old.

Soundara Rajan. K.V.'s Some iconographic Elements of Pre-Mediaeval Temples" in Lalit Kale Akademi journal No, 8. Oct 1960, p. 15.

The folk bronzes of Himachal Pradesh, Punjab, Rajasthan, Gujarat, and the contiguous areas are fascinating examples of India's traditional and folk arts. A casual glance might make one think that they are weird, crude, grotesque, and utterly devoid of aesthetic value. This seems to be one of the reasons why they have remained in the background for so long. However, to a well-informed and cultivated mind endowed with the quickening awareness of modern aesthetics, these folk-style images appear to be eminently alluring by virtue of their startling primitive vitality as well as their dramatic and dynamic qualities. They deserve a place of special importance in the history of art not only because, along with other forms of folk tradition, they are one branch of traditional arts which have continued to maintain their antiquity and traditional characteristics over thousands of years, but also because in them lie hidden the seeds of perfection and purity of the more widely esteemed classical arts. The immense significance of folk art vis-a-vis classical art has been summed up in the following passage:

“Just as the child's mind gives an indication of the subconscious mental world of the growing adult in its psychic aspect wherefrom the main trends of the character of the later adult can be easily conceived, so to one can easily touch the nucleus of the cultural aspect of all the branches of our now fully developed art and culture if one can investigate the significance of our folk arts.”

The renowned British sculptor Henry Moore has expressed the same view that "folk art is the mother of all arts." This is true of the images in the folk style, which have maintained a continuous tradition throughout the broad span of time and space. For more than 5000 years, from the Indus Valley civilization period until the last century, this tradition has remained vital.

Most of these images are small. Nevertheless, in concept and in effect, they are monumental. They give some indication of the extraordinary imagination and artistic resources of the rural metal smiths.

Srinivasan, T.N.'s 'South Indian Folk Arts" in Vol. I, No, 2, Madras, September 1946 p. 21.

Some scholars have referred to some of these images as "unidentifiable shapes." In most cases, it is not difficult to identify the deities. We are aided in this process by the attributes held in their hands, their accompanying figures and vehicles (vahana), and symbols often linked with them.

These images were cast in style transmitted from generation to generation. So what emerged were crude figures with disproportionate limbs. In spite of being highly distorted, they are vibrant from within and dramatically expressive of their inherent qualities. Distortions, exaggerations, and the use of solid contrasts give them a dramatic intensity. A bold interplay of curved lines and surfaces gives them a violent driving force, and their sensuous organic forms seem imbued with powerful magic.

Some folk bronzes are unique works of art. Their odd, freakish, archaic, and bizarre shapes derive from the primordial world of mystery surrounding them. The archaic forces permeate every stone and tree to which the villagers offer their prayers on the way to the humble village shrines of solitary images placed at the foot of a tree or near a spring. Their archaic features further heighten this effect, the emphasis being on the round or oval head, which is much larger than the rest of the body, which is generally slender and attenuated. The facial features are characterized by an enormous mouth, protruding nose, and large round eyes. Arms and legs are short and stumpy in some cases, thin and long like tubes or wires in others. The chest has two pellets suggestive of breasts common to both male and female figurines. The ornaments are treated as decorative details. The diversity of conventions used in the representation of facial features and parts of the human body is bewildering. These stylizations appear on figurines in countless combinations and sometimes make it very difficult to ascribe specific styles to the images. Common to all images is stiffness and simplification of form. However,some of them are portrayed as vigorous action, such as the images of Durga Mahishasura Mardini and Narasimha (man-lion) incarnation of Vishnu emerging out of a split pillar to kill the demon Hiranyakashipu.

Many ancient treatises in Sanskrit contain a detailed account of the lost wax process of casting known as Madhucchista-vidhanam in the vernacular; among them; we may mention the Manasara (chap.XVIII), the Samaranganastradhara, the Yuktikalpataru, Martasollasa or Abhilashitartha Chintamani by King Somesvara Bhulokamala of Western Chalukya dynasty of Kalyan near Bombay who reigned in the 12th can. A.D. These all are mediaeval texts, written before the 12th century A.D. and containing useful information on the subject. The following passage from the Vishnu Samhita (chapter XIV) suggests that the lost wax process

Banerjee. J,N The Development of Hindu Iconography, Calcutta 1956 p. 214,

was more widely practiced "If a metal image is to be made, it must first be made of wax and then coated with earth; gold and silver and other metals are purified and cast into the mould, and capable workmen thus obtain a complete image,"2 There was another reason for preferring this process. From the virtually limitless plastic possibilities afforded the craftsmen by the use of beeswax flows, a cascade of metal sequences formed by units of design whose recurrence has so often been noted in the decoration of objects. Mastery over this technique enabled the metalworkers to interpret their vision with greater plastic dynamism.

In the towns and villages of India, where the lost wax process has been practiced for centuries and is still a living tradition, the metalworkers have devised an infinite variety of techniques that it is not possible to recount here. We can only mention two methods of this process, known as solid casting and hollow casting. These two processes are used in the same manner all over the world. It revolves around the mechanical replacement of an object originally

Vishnu Samhita as quoted by Ruth Reeves Ore Perdue Casting in India, New Delhi, 1962. p.32

As we learn from various treatises in ancient India, both the solid and hollow casting techniques of the lost wax process were employed by metal workers everywhere. Nowadays, the solid casting technique is widely practised all over Southern India. In the North, the early bronzes from Kashmir, Chamba, and other areas of Himachal Pradesh also appear to have been fashioned by the solid casting method, this is true of both classical and folk styles images. The same is the case of Jain bronzes, which have come down to us in large numbers from Rajasthan and Gujarat. The North Indian metal workers chisel and hammer the images after casting them to give them a finished and smooth look. (Kuppuram, 1989)

The folk bronzes of the North-Western region of India, be they free-standing three-dimensional or two-dimensional images, are cast by the solid casting method of the lost wax process. This is more of metal images from Rajasthan and Nasik in Maharashtra. In all the provinces falling in our area of study, the wax model used for casting the metal image is fashioned in the same manner as the terracotta figurine. In the case of three-dimensional images in bronze, it is a notable fact that the metal worker devoted maximum attention to the front portion and left the backside unfinished. All the details of garments, ornaments, attributes, and other accessories are worked out with utmost care. The reason for this was not sheer negligence or carelessness on the part of the craftsmen, but the simple idea that since the image was meant purely for worship, it was meant to be seen only from the front, not from the backside. (Hunt, 1980)

As already mentioned, in these areas, three-dimensional as well as two-dimensional flat plaque-like images are made, among the latter are included the Kirttimukha masks from Kulu and Simla hills and identical images cast in relief.

When the metal image has undergone all the stages of production and received the finishing touches, it is deemed to be ready for installation in the village shrine or household altar. The local Pujari (priest) fixes an auspicious day and time for performing the ceremonial and purificatory rituals, which include the Prana-pratishtha ceremony accompanied by the ceremonial oblations. That is, the image is consecrated and, by a symbolic rite, invested with the breath of life. And the divinity is installed in the image and embodied by its form and enshrined in the garbhagriha altar to the chanting of the holy mantras and is ready for worship. (Craddock P. a., 2007)

The metal craftsmen's tools are the same everywhere in India; while the Hindi speaking areas use the same names, more or less identical names are used in other provinces, and the same names are used with slight variations which occur due to local dialects. The lost-wax process is practiced all over the world, and the same methods are employed. Slight differences, however, may occur on account of the handling of the material.

2.1.4. Modern lost wax metal casting

Modern means recently developed ideas, new methods and evolved from traditional or old styles. Here, modern metal casting refers to the updated version of traditional techniques of metal casting. Due to the industrialization of metal casting, lots of research and development work has been done to date for mass production cost minimization. However, the basic principle of the lost-wax technique is still the same.

In India, the bronze images are cast by lost wax, better known as the cire perdue process, or by the sand process. The tradition of casting metal figurines by using wax moulds dates back to hoary antiquity, it has been amply testified by the superbly cast bronze figurine of the dancing girl from Mohenjo-Daro (3500 B.C.) possessing excellent finish.

Every metal craft center has skilled artisans who are equally proficient in both or at least in one technique of metal casting, which is sand casting method and lost wax method. Generally, smaller images are cast by the latter method. In most cases, the artisans choose their problems and select the method which is the most suitable for the occasion.

The most extensively used methods, such as sand casting and die casting, are unable to fully the following criteria. Sand casting can't make thin walls and is bad for the environment; die-casting is only good for non-ferrous metals and big orders, and both have cost multiplication when there are several delicate undercuts. Interestingly, although these and many other contemporary casting technologies were created in the West, they are no longer popular in the West, and castings are now sourced from developing nations. Even though India has a long history of metal casting, has the world's biggest pool of engineers, is endowed with abundant resources of main metals, and has a sizable domestic market.

Although the first lost-wax castings were made over 5000 years ago in India, the method was recreated and called investment casting in the 1940s in the West. It was first employed by jewellers and dentists, but it quickly gained popularity when it was used in industrial castings such as aircraft and weapon parts. (Zhou, 2003)

Except for pressure die-casting, modern investment casting can achieve the highest dimensional tolerance (1 micron per mm), greatest surface polish (1-2 micron), and thinnest sections (approximately 1.5 mm) of any casting method. Furthermore, undercuts may be made without the use of cores, draught is typically not required, and flash is not present. The kind of metal that may be cast is unrestricted, and the method is best suited for tiny pieces weighing less than 20 kg, while bigger pieces weighing up to 100 kg are frequently produced. As a result, investment casting outperforms other processes in terms of addressing the aforementioned growing needs.

Here below is described the lost wax process. First, a model in clay slightly smaller than the intended size of the finished work is made. Then it is covered with a continuous layer of wax which is modelled with all the details required on the finished bronze. This is then covered with layers of fine clay to make a one-piece mould. When heated, the wax flows out from between the mould and the core, and the space left is filled with molten metal. This method has the disadvantage that if anything goes wrong during the casting, the original model is lost. So for the safer side, the second method was devised in which a piece-mould is pre-pared. A full-size model of the statue is built, and sections of this are moulded using plaster of Paris. Separate pieces are made if there are any undercut areas to permit removal of the piece-mould without causing damage to the model. The piece-mould is lined with wax, and a core of a refractory material such as clay is constructed, which is strengthened with an iron armature; the piece-mould is removed, and a one-piece-mould is constructed around the core and wax as for the previous method; for both the methods, it is necessary to hold the mould in position within the mould so that when the wax is melted out, it does not shift. This is done by making the iron armature larger than the figure so that it extends into the mould or by sticking copper rods through the mould and wax and into the core. These can be cut flush with the metal surface after casting. Vent-holes are made in the mould to allow gases driven in front of the molten metal during the casting to escape. Usually, bronze contains ten percent of tin in copper, but compositions found in images vary considerably. Lead, zinc, and brass were also used. The composition depended to a certain extent on trie avail-ability of materials. After casting, superfluous bronze is removed, and the surface is polished with abrasives. Although initially, bronze is red, it turns black as it ages. This process can be accelerated by rubbing the image with oil; Treatment with lime gives the bronze a green patina. (Hughes R. , 1993)

Small statues may be cast in solid bronze. However, the enormous weight of a giant bronze statue and the amount of metal required for its manufacture encouraged the development of systems for hollow casting. The statue has a thin shell surrounding a solid core of non-combustible material. This is achieved by pouring the molten metal into a narrow space between the core and a mould taken directly or indirectly from a model; after the metal has cooled and solidified, the mould is removed.

In our area of study, we rarely come across bronzes cast by hollow casting technique. Instead of wax, the North Indian metal craftsman uses lacquer (lakh) to make the replica of the image cast, and the final image is obtained through the sand process of casting. This process was primarily practiced by the artisans (Chitera) belonging to the goldsmith community. Other artisans who are in some way or the other connected with the goldsmiths find this process easier to work in, compared to the lost wax process. The lacquer polish is used in the same way as the wax. To the best of the knowledge of the researcher, the sand process of casting has not been mentioned in any of our Silpa treatises. The tribals of Rajasthan have evolved their own methods and techniques of casting metal images of their deities. These techniques may appear primitive to a casual observer but are sophisticated to a high degree and deserve to be studied in greater depth. (Krishna M. , 1976)

The patina is also obtained by rubbing the image constantly with red sand mixed with water in a tub. The process of rubbing is repeated several times till the image acquires a smooth finish as though it had been polished by a buffing machine. (Hoffman Malvian., 1939)

CHAPTER THREE

THE TECHNIQUES OF LOST WAX STATUARY IN INDIA

3.1 The art of lost wax

This chapter investigates the different techniques of lost wax metal casting practiced by Indian contemporary sculptors. The researcher has documented the step by step process of three mainstream metal casting styles of lost wax sculpting from three different regions of India. Each style of metal casting has the same basic principle of lost wax metal casting technique. We began with the Indian tribal metal casting technique, which is known as Dhokra metal craft. Dhokra artisans, scattered through the Central Indian tribal belt and contiguous areas to the East, use the millennia-old lost-wax (cire per due) metal casting method to create brass/bronze artifacts. (The term Dhokra is used to describe both the mechanism and the artifacts.)

Traditional crafts are the skills of creating objects that have been passed on from generation to generation. Traditional technologies are based on trial and error. They were taken to an acceptable level of success by trial and error, and then more or less frozen. Innovations, on the other hand, are built on clearly specified scientific standards and thus open to revisions and enhancements, for instance artifacts relating to religious beliefs, rituals, and creative impulses. While the economies of rural and semi-urban areas continue to depend on the crafts of the first group, the new era places a high emphasis on economically non-essential "heritage" crafts. Although traditional technologies clearly served a role in the past, they must be re-evaluated in today's sense of economy, resource use, environmental friendliness, viability, and continues.

Another compelling argument is that India is widely recognized for its investment casting expertise, particularly through the "South Indian bronze" and "Dhokra metal sculpture" art castings that are still created today by tens of thousands of artists dispersed around the nation. Therefore, the foundry industry should pay this procedure more attention. Perhaps a hybrid approach drawn from historic investment casting, but adjusted to industrial needs through suitable, affordable, and eco-friendly technology, may be well suited to India. Let's first take a quick look at the traditional process, the state-of-the-art now, and some potential future investment casting technologies before we continue to investigate this idea.

3.2 Dhokra tribal metal casting

Metal and alloys have been used in Indian art since the dawn of time. A small bronze statuette of a dancing girl discovered in the buried city of Mohonjo Daro in Sindh demonstrates that the lost-wax (cire perdue) process was already well-known in India some 5,000 years ago and that it was done with great skill and artistry. Before such a high level of artistic performance could be achieved, there must have been a long development of metal crafts in the region. However, no examples of the craft have survived. Apart from this single example from Mohonjo Daro, there are no other ancient metal figures of artistic value dating from before B.C. period. (Mukherjee M. , 1978)

In the nearby alluvial districts of West Bengal and the mineral-rich tribal region of central India, dhokra metal casting is practiced. Dhokra (the term given to both the skill and the community) is said to have started in Bastar (Chhattisgarh state), from where it expanded through migration and assimilation to other regions (Jharkhand, Orissa, some of Andhra Pradesh, West Bengal). The following observations and conclusions largely centre on our work with Dhokra communities in the West Bengal districts of Bikna and Dariapur (in Bankura), Jharkhand's Jabardah (in Dumka), and, most recently, Orissa's Sadaibereni (in Dhenkanal).

The conventional lost wax technique is easy to use and perfect for tribal environments. A thin thread of wax is wound around the contours of a clay heart by the craftsman. It is then thickly covered with fine clay made from termite bills and baked after drying, with a narrow vent left to melt the wax away. The molten metal fills the void formed between the core and the clay sheet, which is then able to cool and solidify. The next moment is filled with expectation, as the outer clay mould is broken open, exposing the perfection of the finished sculpture. As simple as this method seems, it necessitates a high level of accuracy and expertise. The metal must be able to flow naturally and evenly across the tight spaces, replacing the wax without leaving any bubbles or holes.

Cow dung, paddy husk, and red soil are also used in the production of Dhokra artifacts, but beeswax is the most significant of all the raw materials used by the artisans. Wax wires and bits are often used for completing the artifacts, in addition to the required contouring. It is used because of its highly high plastic quality and pliability, which provides a simple but effective trigger for the artisans' intense design and faculties.(Kochha, 2011)

Missing wax casting (also known as ‘cire perdue') can be used worldwide, but the coiled thread method is only used in Dhokra. A glance at the original baskets reveals where it came from. The basket makers wound grass around a rope before coiling it into shape.

These sacred tribal statues are said to bring wealth to the home. Local gods and goddesses are sculpted here as well. This area is also known for home and puja items such as kind (a water jar with a nozzle) and uruli (a shallow cooking vessel). The majority of the parts are handcrafted without moulds or tools, making them one-of-a-kind or exclusive. (Srinivasan, 1995)

3.2.1 Process of Dhokra metal casting at Bastar village

This is a documentation assessment of the Dhokra metal casting techniques, used by the craftsmen’s from Barkai village, Bastar, Chattigarh. Barkai is a small village of tehsil-Makdi, Bastar district in Chasttisgarh state, India. It is a tribal craftsmen's village, especially brass metal work. Those artists are known as Dhokra casters, these craftsmen were renowned for making tribal idols, religious images, and animals like horses, elephant etc and other objects. These ancient tribal statues are said to bring wealth to the home. Here are also made local gods and goddesses. (Tiwari, 2015)

This study explains at how a craft is linked to craftsmen and how craftsmen are linked to a craft. Metal is a typical craft tool used by Indian cultures. A Dhokra metal casting is an important traditional skill. The metal utilised is brass, which is cast using the lost wax process to create magnificent items. Dhokra is not just found in Orissa. Bengal, Bihar, and Madhya Pradesh are also home to this species. Dhokra refers to a collection of metal objects created using the 'cireperdue' or lost wax process. Because of its importance in ordinary people's lives, the metal casting technology has survived for millennia. The Dhokra metal craft is slowly losing away as modernisation takes hold and people's lifestyles change.

Dokra art - Each masterpiece is developed from the ground up and is one-of-a-kind in the globe. Because of the inherent nature of the Dhokra art process, the colour, size, and shape of the sculpture will vary somewhat. These non-ferrous metal casting objects are entirely handcrafted by tribal's in India's interior. The ancient Harappa and Mohenjodaro civilizations employed the 4,000-year-old "lost wax casting" method in their art. Every artefact is cast individually in this method, and the item is destroyed in the process. As a result, each masterpiece must be constructed from the ground up and is one-of-a-kind in the globe. For the craftsmen and their families, art is a source of income. (Untracht, 1968)

The study's goals and objectives are to comprehend an old art that provides an insite into our society's ancient metallurgy. To have a better understanding of the Dokra craft production method and the materials used in the process. The goal of this is to examine the classic metal casting process, paying particular attention to the waxes used and why, the modelling procedure, the furnace and crucible, the casting and finishing methods, etc. Here, the researcher used techniques including visiting the metal casting studios and documenting the whole metal casting process, from wax model creation through metal casting and polishing, also conducted interviews with senior tribal craftsmen at their workshops to see their prior work and methods.

3.2.1.a Material required

Lost-wax casting is used by the Dhokras to create hollow brass sculptures and pictures. Lost wax is a method of making a metal object by first creating a wax model of the item and then melting the wax to produce a mould hole that is filled with molten metal. The methods of Dokra metal casting traditionally used are known as cire-perdue or Lost wax method process. Following are the tools and material required in the Dhokra metal casting process:-

1. Aari Mitti/Chikti Mitti (Black Soil)

2. Bhoosa (Rice Husk)

3. Rui Mitti (Riverside Soil)

4. Gobar (Cow-dung)

5. Lal Mitti (Red Soil)

6. Sem Patta (Bean Leaves)

7. Mome (Wax)

7. Jalawan (Fire Wood)

8. Koyla (Wood Coal)

9. Bhatti (Furnace)

10. Kendua kathi (Blower machine)

11. Nihan (Small chisel)

12. Batani (Big chisel)

13. Hathora (Hammer)

14. Kui (Crucible)

15. Chimta (Toung)

Solid casting and hollow casting are the two basic lost-wax casting procedures. The former is more widespread in Central and Eastern India, whereas the latter is more common in Southern India. The steps are as follows: -

3.2.1.b Preparation of wax

Dhokra craftsmen use natural bees wax for their metal casting process from the ages. For fashioning the wax models, thin wax stings are prepared first. For that wax is melted to add wax colour is it (Figure3.2.1) and when that wax starts to sets while colling down, a piece of soft wax from that is used to create strings with the help of a press mould (Figure3.2.2). The wax is likewise shaped into a wire structure used for minute details and fitted around the core model in this case.

Figure 3.2.1 Melting bees wax with red wax colour.

Figure 3.2.2 Creating Wax strings of soft bee’s wax from a press mould.

3.2.1.c Making of core body

Local clay is used to make the cores. After drying, the clay was sieved through sacking and combined with uncrushed sand. This sand-rich clay was combined with water to the desired consistency and used to create appropriate core-figures. A clay model core is created, slightly smaller than the artefact' final intended size (Figure3) and the surface of that core is smoothened by rubbing leaves (sem patta). The core can be toughened by burning or drying in the sun. Fine clay is always used for the core model. Over three or four days, the cores were carefully sun-dried.

Figure 3.2.3 Creating core body with clay.

3.2.1.d Model making

Around the core, a thin layer of melted wax is applied (Figure 3.2.4) so that further wax can be applied easily which are wax wires/strings, with that a wax model is created up to the thickness of metal needed in the completed product (Figure 3.2.5). The head, body, legs, and other components of the picture are handcrafted independently when creating the wax sculpture (Figure 3.2.6). Then, after warming, they are improved by being shaped with a knife and scraper. Using heated iron tools, the various completed components of the picture are finally joined together (Figure 3.2.7). The pedestal is fashioned as a component of the wax model itself when creating a tiny metal picture, but when creating big models, the pedestal needs to be manufactured separately.

Figure 3.2.4 Wax layer is applied on sundried clay core body.

Figure 3.2.5 Modelling with wax strings on core body.

Figure 3.2.6 The wax model is kept on piece of cloth, to assemble the parts

Figure 3.2.7 Wax model is ready for mould making process.

3.2.1.e Mould making

A thin coating of extremely fine clay is applied to the wax model, creating an imprint of every aspect of the model (Figure 3.2.8). After the thin layer has dried and hardened, further layers of clay are added to the mould (Figure 3.2.9), as well as one or more pouring channels through which molten metal can flow to fill the mould. A split bamboo stick was traditionally used to drill through the dry first layer. A big casting may need the use of two or more channels. For molten metal to flow within the mould, a clay funnel is inserted (Figure 3.2.10). Also, in this case core pins are applied (Figure 3.2.11), and binding wire is used by wrapping up around the clay mould with iron rods to reinforce the clay mould and then a last layer of clay is applied on the moulds (Figure 3.2.12). After that a last layer of clay slip is applied on the mould to fill the gaps between the mould and the wire wrapped (Figure 3.2.13). Then the moulds are placed under the sun for initial dry process (Figure 3.2.14). After the mould is sundry, handle is created with galvanised wire on large size moulds only (Figure 3.2.15)

Figure 3.2.8 First layer of fine clay is applied for mould making process.

Figure 3.2.9 Further layers of clay are added to the mould

Figure 3.2.10 Clay funnel is attached with wax runner on the mould

Figure 3.2.11 Iron nails are added as core pins.

Figure 3.2.12 Galvanised wire and binding wire are used to reinforce the mould

Figure 3.2.13 Last layer of clay is added on the mould

Figure 3.2.14 Moulds is place under the sun for initial dry process

Figure 3.2.15 Handel is created with galvanised wire on large size moulds

3.2.1.f. De-waxing the mould

For De-waxing process the moulds are placed inside a local kiln (Figure 3.2.16) made up with terracotta bricks and fired with wood to baked (Figure 3.2.17), for that iron tongs are used to add woods gently around the moulds (Figure 3.2.18), so that moulds will not damage. The wax melts and is lost (thus the term lost-wax method), leaving a hollow mould behind. This creates a hollow that is precisely the same size, shape, and surface characteristics as the intended object. Because of the closed system of dewaxing firing, it is difficult to reclaim the wax, which might either vaporized and burned or absorbed into the mould's clay.

The loss of the modelling medium might not have been an issue for forest-dwelling nomads who would have obtained natural resources for themselves on their journeys, but it became significant cost inefficiency after the dhokra people settled down.

Figure 3.2.16 Local kilns is prepared with bricks

Figure 3.2.17 Dewaxing process of moulds in local kiln

Figure 3.2.18 Iron tongs are used to add woods gently around the moulds

3.2.1.g. Casting

A primitive furnace was constructed using loose bricks in a handy open place (Figure 3.2.19). Cow dung and purchased charcoal were used to build the fire in that furnace and a crucible is placed with brass metal in it. When the mould was deemed ready, tongs or pair of iron rod were used to take it from the fire. The metal cup was placed at the top, allowing molten brass to flow down into the mould cavity (Figure 3.2.20). The molten metal then solidified between the mould's core and inner surface, forming a negative imprint of the wax model in all its details. The hardened metal's outside surface so mimicked the shape and features of the original wax sculpture, while the core created a hollow interior.

Figure 3.2.19 Traditional furnace with coal firing

Figure 3.2.20 Pouring of molten metal into the moulds

3.2.1.h Taking cast out from the mould and finishing stage

The sculptor carefully removed burnt clay (mould) after the cast gets cool down to extract the object (Figure 3.2.21). Iron rods and wires are removed, and the sculptor removes all unwanted mould remains with iron chisel (Figure 3.2.22). Then the extra metal, runners and core pins are removes from the brass cast (Figure 3.2.23,24) with the help of different tools like hammer chisel and now days with angle grinder. The image now is exactly that seen in the wax model. Details of the dress and ornaments as well as other final touches are essential to make the icon perfect in all the aspects and surface flaws and imperfections are corrected.

Figure 3.2.21 The mould is removed from the cast with a hammer.

Figure 3.2.22 Chisels are used to remove the mould remains.

Figure 3.2.23 Nails are removed from the cast with chisel Figure

Figure 3.2.24 Unwanted metal flashes are chiselled carefully.

India, a country of unity and variety with numerous traditions and customs, has a very promising State in the form of Chhattisgarh, which is rich in tribal handicraft. The Bastar region in Chhattisgarh is one of India's most popular tourist attractions. Bastar's traditional handicrafts are quite popular among tourists. These Dokra casters from India's Eastern States share not just shared roots and modifications, but also a distinctive lost wax casting method and aesthetic. The wax model that is melted out of a mould, leaving a hollow area to be filled with molten metal, is known as Cire Perdue (lost wax) casting.

Because of its traditional and indigenously developed technology in producing traditional types of brass metals products, the Indian brass metal industry, which is one of the most important components of the metal craft, is facing stiff competition in the emerging manufacturing scenario. As a result, artisans are seeking alternative employment in order to survive, and brass and bell metal artisan skills continue to decline and appear to be on the verge of extinction in some clusters/areas, necessitating product diversification, design development, technological advancement, and proper market exploitation, among other things.

By promoting Bastar handicraft, we are not only promoting the craftsmen' secret abilities to the world, but also popularising the Indian culture by elevating it in the global context.

3.3 South Indian Traditional metal casting

In this research the South India metal casting techniques of Kunhimangalam village craftsmen have been discussed. Kunhimangalam is a small village in Kannur district of Kerala, near Payyanur. It is a craftsmen's village, especially Panchloha, brass and bell metal work. Those artists are known as moosaris, these craftsmen were renowned for making idols, lamps and other objects. Many temples in Kerala as well as the Karnataka region of Mangalore and Coorg have idols made of Kunhimangalam panchaloha (five metals). For them, making idols is a sacred task, not just a business. One thing they are known for is the range of lamps they manufacture, particularly the Lakshmi vilakku (lamp), which is flanked by two elephants by the goddess Lakshmi.

This traditional oil lamp is believed to be sacred and bring prosperity to the house. Krisha and Dasavathara lamps are also made here. Home and puja products like kindi (water con tainer with a nozzle) and uruli (shallow cooking vessel) are also popular at this location. Most of the pieces are manufactured without moulds or machinery and are therefore exclusive or exclusive. In and around Payyannur, there are over a hundred families involved in this craft, many of whom take direct orders and deliver to customers. An institution was started a few years ago to train the younger generation in the craft but is not in existence now.

3.3.1 Process of South Indian metal casting at Khunhimangalam village

This chapter assesses the metal casting techniques of Kunhimangalam village with the help of literary sources and ethnoarchaeological observations. And to do that, researcher has attempted video and photography documentation of metal casting process from the beginning steps to the final stage of finishing, which is a process of continues twenty days. As Cire-Perdue (lost-wax method) is in practice at Kunhimangalam village. This study will focus on technological adaptation through experimental study conducted at Kunhimangalam village. The word bronze comes from “Brindisi”, the name of a small town and port on the Adriatic coast of Italy which had been famous for its bronze images since Roman times (Kuppuram, 1989). In India, metal icons find a very special place in temple as well as within domestic shrines across the country(Udayakumar, 2011).The antiquity of bronze sculpture dates back to the Indus civilization (Bandyopadhyay, 1987) but it develops as an independent school of art during the classical period of the Pallavas, Cholas and the later dynasties of South India (Udayakumar, 2011). In terms of understanding the casting process for producing metal images, the earliest evidence in

South Asia, is seen in the Lost-Wax technique for the bull and dancing girl of Mohenjo-Daro dated to around 2500 B.C. (Bandyopadhyay, 1987). Indian metal sculpture in the south India mostly flourished during the Chola period, but there are some specimens discovered having a high aesthetic and technical quality belonging to Pallavas ruling from Kanchi. For example a Nataraj sculpture which belongs to the 8th century A.D. from Kuram, District Chinglepet, (Government Museum, Madras) (Sivaramamurti 1962; Mehta 1971).

On the other hand, through this age-old process, Kunhimangalam artisans are still practicing the art of metal work. This group of people have settled in a small town near Payyannur in Kannur, who are adept at molding metal into divinity with the expertise handed over from generations. The Kunhimangalam Shilpi's often work with brass (Copper + Zinc) or Panchloha (Copper+ zinc+ gold + silver + iron) or Bell metal (Copper +tin). If the tin content is high the alloy is called bell metal. Like in pottery, in which traditionally the turning wheel is reserved for men, all parts of Kunhimangalam casting work can be done by men only. Children learn the craft through imitation and instruction. A remarkable aspect of this craft is its unique and distinct identity. The Kunhimangalam Shilpi's produce objects such as animals, lamps and figurines, images of deities like goddess, Durga, Lakshmi etc. (UDAYAKUMAR, 2014)

Here researcher followed methods like visiting the metal casting workshops in Kunhimangalam and did documentation of metal casting process from the beginning to the end, means from wax model making to metal casting, till finishing, also interviewed senior traditional craftsmen of Kunhimangalam at their workshops, to see their previous work and techniques used by them.

The current problem of research revolves around contemporary life. This thesis is an attempt to understand the process of God idols casting at Kunhimangalam village. An attempt is also made to identify the reason behind their solid casting of God idols. The focus of this paper is to study the traditional process metal casting especially like which wax they use and why, their modelling process, furnace, crucible, casting and finishing techniques etc.

3.3.1.a Process

The methods of Kunhimangalam metal casting traditionally used are similar to Lost wax process can be divided into step by step stages, mentioned below:

1. Preparation of wax
2. Wax model making
3. Mould Making
4. De-waxing of mould
5. Placing the moulds into a soil pit
6. Melting of metal
7. Pouring of molten metal into moulds for Casting
8. Taking cast out from the mould
9. Cutting of extra metal and finishing
10. Polishing

3.3.1.b Preparation of wax

The image should be prepared of wax with composition of bees wax 60% and pine tree gum 40 % with black oxide to add colour to in wax model (Figure 3.3.1), pine tree gum strengthens the wax and helps in dewaxing process. Then wax sheets are made from that wax, by betting up that wax with wooden mallet (Figure 3.3.2). Wax sheet makes modelling work easy, according to the navatäla (nine täla) measurement, with proper disposition of limbs including arms and weapons according to the iconographic texts. Long tubes, each with a flared mouth resembling the käéa flower, should be added on the back, at the shoulder, on the nape, or on the crown, which is called Prabha mandal.

Figure 3.3.1 Melting wax with pine tree gum and black oxide.

Figure 3.3.2 Creating Wax sheet by beating wax with wooden mallet.

3.3.1.c Wax sculpting

In fashioning the wax model, parts of the image such as the head, body, legs, etc. are made separately by hand. These are then refined by warming them and shaping them using a knife and scraper (Figure 3.3.3). Finally, the different finished parts of image are jointed together using heated iron tools. In the case of making a small bronze image, the pedestal is shaped as part of the wax model itself, but in case of large models, the pedestal has to be made separately. After finalizing the modelling in wax, runner and channels are attached, to create the pouring mouth for metal. (Figure 3.3. 4)

Figure 3.3.3 Wax modelling using a knife and scraper.

Figure 3.3.4 Wax runner and channels are attached on the top.

3.3.1.d Mould making

The method of moulding includes different types of moulding media and their preparation, e.g. hard clay, semi hard clay and soft clay. In case of small image only three layers of clay are required but for large images more layers are required, the clay which is sourced from the river bed. During the application of clay, the wax model is kept either on a piece of paper or on a white cloth (Figure 3.3.6,7).

Soft-clay: For preparation, four parts of well levigated clay which is used for making pottery and one part of ordinary clay are mixed. (Figure 3.3. 5)

Preparation of clay for second layer or outer later is prepared by adding to it tiny bitts of jute cloth, fine chopped and mixed with the pottery clay. The coating must be repeated three times, each after an interval of two days, and dried in the shade. Before the final coating, iron strips are added on the surface of mould all around, which works as reinforcement and strengthened the mould Figure 3.3. 8) and then the final coating is the most liberal one. The mouth and the channel of the tube, wherever fixed, should be left free when the coating is applied.

Figure 3.3.5 Preparation of clay for mould making process.

Figure 3.3.6 First layer of mould making process with fine clay.

Figure 3.3.7 While mould making process, wax model is kept on piece of cloth.

Figure 3.3.8 Iron strips are added to strengthen the mould.

3.3.1.e De-waxing the mould

Then the moulds are placed under the sun for the initial dry process (Figure 3.3.9). After the mould is dried under sun, it is placed over fire and baked, until the wax melts and flows out of the mould(Figure 3.3.10).Preheated moulds are removed from fire then drain holes is being used for the removing of wax from inside the mould, then a pit is dug to place a vessel to collect the molten wax flowing out from the hot mould(Figure 3.3.11), later the mould is fully covered with bricks in a form of dome and fired for complete de-waxing(Figure 3.3.12), then the mould is removed from the fire and placed in a pit with the mouth facing upwards.

The drain holes are plugged in order to avoid the molten metal flowing out; further the pit is covered with soil all around without leaving air gap.

The vent holes are temporarily covered in order to prevent the clay from entering the cavity, the clay is stomped all around the mould to cover it leaving the vent holes.

Figure 3.3.9 Moulds is place under the sun for initial dry process.

Figure 3.3.10 Initial de-waxing process by open firing

Figure 3.3.11 Mould are place on a vessel to collect the wax.

Figure 3.3.12 Final firing of moulds for the complete De-waxing.

3.3.1.f Pouring of molten Metal

Casting In South India five metals were used for the production of the idols which is called as "Panchaloha" (Kar 1952; Ruth 1962; Krishna 1976). These include a mixture of copper, silver, gold, brass and tin. The rule used by sculptor to estimate the weight of the alloy occupying the mould cavity is that it should be normally 8 times the weight of the wax model. For melting the metal, traditional furnace is made with clay and local sand stone. In which coke or charcoal are used as fuel of firing (Figure 3.3.13). When the metal and mould temperatures are proper for casting, then the molten metal is removed from the furnace and stirred before pouring into the mould, the mould is placed into the ground pit horizontally in a slightly slanting position with pouring hole facing upwards, from which molten metal is poured into the moulds. In order to avoid entry of impurities like charcoal floating on the surface of the molten metal, an iron rod is used, while pouring metal into the mould (Figure 3.3.14), the molten metal is poured into the holes for filling the cavity and the person pouring the metal is covered with wet sacks or gunny bags to prevent the heat of molten metal. After completing the casting process, the mould is allowed to set for cooling approximately for twelve to twenty-four hours, later on the mould are removed from the pit and the casting is taken out.

Figure 3.3.13 Traditional furnace with coal firing for melting the metal.

Figure 3.3.14 Pouring of molten metal into the moulds, buried

in the ground pit with mould pouting mouth facing out upwards.

3.3.1 Taking cast out from the mould and finishing stage

The sculptor carefully removes burnt clay (mould) after the cast gets cool down to extract the object (Figure 3.3.15). Iron rods and wires are removed, and the sculptor removes all unwanted runners in the bronze idol/object. The image now is exactly as seen in the wax model (Figure 3.3.16). Details of the dress and ornaments as well as other final touches are essential to make the icon perfect in all the aspects. These aspects are added in the later stage. The smoothening of the image is done using the fine grade emery paper. Traditionally, the image is cleaned with tamarind, soapy water and scrubbed with a copper brush until it is polished.

Figure 3.3.15 Mould is removed from the cast.

Figure 3.3.16 Unwanted channels are removed before polishing the idol.

In a small town near Payyannur in Kannur, there is a group of artisans who are adept at moulding metal into divinity with the expertise handed over from generations. Kunhimangalam is one of the oldest places of metal idols casting village in Kerala. Sculptures in bell- metal, Odu and "Panchaloham" of this place are well known. The artisans of this village are known in the world market for their brass metal crafts.In 2018, the state government declared the bell-metal sculpting of the Moosari community as a heritage art and their settlement in Kunhimangalam as a heritage village. But only 11 persons in Kunhimangalam are now making bell-metal figurines, sculptures, and lamps. The 'Panchaloha' statues, traditional lamps and other crafts are sent all over India and the world to various destinations. These highly gifted artisans create brilliant pieces of idols of deities, lamps, divine articles and sculptures in metal. The old statue of Nataraja (Lord Siva in dancing posture) is the most famous bronze craft in India. Yet bronze (bell metal or weapon metal) is used in Kerala popularly known as "Odu" to make small and large pots, lamps, etc. Huge wick lamps of various sizes and shapes, such as the Nilavilakku, Thookkuvilakku-hanging lamps, etc. are widely used in every house.

Kunhimangalam has a large community of Moosaris whose craftsmanship is unparalleled. An individual traveling through Kunhimangalam can experience this age-old practice of sculpture making. These master craftsmen breathe life into hard metal and transform them into elegant figurines, they work on metals is first-rate and their specialty of casting in Panchloha, the rare combination of five metals namely gold, silver, lead, copper and tin are known worldwide.

Metal models were very carefully crafted in the early period with all the details present in the wax model itself, and these were etched on metal naturally, and after the casting ther e was little finishing work. But in later period, up to the present day, the image as cast was usually a rough one. The final finishes were added elaborately, which involved so much of chiselling work that the result was almost a carved-out image rather than a cast one. This whole process of making an average size idol, from wax modelling to casting and till finishing takes approximately twenty days or more depends on work, which gives a precious outcome.

If Kerala is considered God's Own Country, Kunhimangalam can be termed as the land of "Godly Sculptures", such is their craftsmanship. If the new generation fails to realize and preserve this unique art of Kunhimangalam, this pristine village art will be culturally eroded.

3.4 Modren Metal Casting of sculptures

This chapter is an assessment of modern metal casting techniques, which refers to the late twentieth and early twenty-first centuries. Which included the non-ferrous metal sculpture casting process followed by the artists who cast their artwork by themselves or by professional metal casters on commission, including commercial foundries in which artists send their models for casting and techniques practiced in institutional foundries.

During ancient civilizations, investment casting was utilized to make utility products, jewellery, and art castings. Today, it is used to make jewellery, art castings, turbine blades, and a variety of other industrial and scientific components.

Returning to the tried-and-true lost wax casting method will allow us to meet future casting needs such as thin complicated shapes, little machining, and small order quantities. It was created in India over a long period of time, but in the last several decades, new mass manufacturing techniques emerged in the West, many of which had unfavorable environmental implications.

The most popular techniques now in use, such as sand casting and die casting, cannot entirely satisfy the aforementioned requirements. Die casting is only appropriate for non-ferrous metals and for high order numbers, whereas sand casting cannot create thin walls, which is required for casting of sculptures. Both processes incur cost increases when numerous complicated undercuts are present. It's interesting to note that despite the fact that these and many other modern casting techniques were invented in the West, castings are now sourced from developing nations since they are no longer popular there.

However, the latest update introduced now in the lost wax casting technique was the ceramic-sell casting process, which only is about the material change in the making of the investment mould. Ceramic shell makes the investment mould lighter and stronger than the conventional ones, making the casting work easier. Still, the conventional method of investment mould making is more prevalent in India. The reasons behind this are ceramic-sell investment moulding process is more expensive than the conventional medium, discussed below.

3.4.1 Process of modern metal casting for sculpture in northern India

3.4.1.a Modelling a wax sculpture

Bee's wax was once used for modelling, however it has lately become highly costly and has mainly been replaced by less expensive microcrystalline waxes. These modern waxes, which are by-products of the oil industry and produced in a variety of mixtures, provide sculptors access to hard, soft, and ductile waxes for diverse modelling techniques. Wax modelling just requires a small number of tools and supplies. The hands are the most crucial "tool" while modelling in soft wax, much like when modelling in clay. But you may also use metal or wooden spatulas and steel rifflers (tools used for modeling purpose). The metal spatula blade may also need to be heated using a spirit lamp or candle. (Ruth, 1962)

The initial masses for huge works can be constructed out of polystyrene, which reduces the quantity of wax required. In order to create armatures, copper wire is necessary. When 'welding' wax edges together, a soldering torch or mild brazing flame can be utilized. A pot for melting wax, brushes for applying molten wax, and wax rods for use as runners and risers are all essential pieces of equipment.

For completing surfaces, files are helpful. To pour metal into the moulds, a runner cup or gate will be required. A cylindrical form with a curved base is the ideal design for this. This fundamental form may be cut from polystyrene and smoothed using a surform blade or file tool. It should then be coated in soft wax and the surface treated to an even finish.

Small-scale sculptures can be directly modelled in wax, and it can also be used to create an exterior shell over a core or armature for a sculpture that will be cast. Wax is a delicate and mostly transient media since it doesn't entirely solidify. A solid wax sculpture has to be handled carefully and shouldn't be exposed to too much heat or put in a position where it might be knocked over or damaged.

However, both the process and the outcome of wax modelling may be immensely rewarding. It is particularly appropriate for creating little figurative sculptures. Wax needs to be worked into a pliable mass before modelling. Some waxes are made such that they are always malleable, and the heat from the hands makes them even more so. Melted wax can also be poured onto a flat, cool surface and allowed to solidify into a sheet to create a mass of wax for modelling. The firm ball is formed by picking up, rolling, and kneading the sheet while it is still warm. After then, the form may be adjusted using the hands and fingers, and small features can be added using hot modelling tools. Modeling methods are mostly a matter of personal taste and are best developed via actual use. No specific guidelines can be established since the key to a good modelled sculpture is the interplay between the sculptor's skill and the material's inherent properties. The wax may be applied in small lumps or strips and moulded into shape with fingers or tools for both solid wax sculptures and those with a core or armature. Using hot metal spatulas, wax may also be melted into the preexisting surface.

Wax's characteristic shine, which is heightened by running a flame over it, and a tiny translucency are its surface characteristics. The model's exterior shape can be polished to create a continuous, unbroken surface or left to reveal the modelling process, with rough texture and a wax lump that is only partially melted contributing to the form's liveliness.

It is simpler to preserve the vigour of the surface texture on a large-size model, especially for subsequent casting, than on a small scale, where too much detail may obscure the shape. On any scale, wax, however, encourages a complete expression of the modelling craft and is a very sensitive media. When a wax sculpture has to be modified or repaired, such as when it is damaged, these modifications can be accomplished as long as the wax is still soft and not too hard. Melt some fresh wax and use your fingers to carefully mould it into the model to repair a wax sculpture.

3.4.1.b Small scale wax sculpture armature process

Usually small wax models do not requires armature, but it depends on the shape and volume of the form of the wax model. In leaner type of forms, it will be necessary to create a wire framework or armature on which to shape the wax unless the proposed model is an exceedingly basic one. Use copper wire to create this, and braze the wire intersections together. In addition to withstanding the wax fire, brazed copper wire is also the metal that is most easily absorbed when molten bronze is put into the mould. Steel wire shouldn't be utilized since it is a poor heat conductor and will cool the molten bronze, which will lead to poor misrunning. Misrunning causes the molten metal to solidify too quickly in mould cavity, leaving tiny fractures on the sculpture's surface. These require welding with a torch and bronze rod to be re-paired. Steel rusts easily, which is another reason why it shouldn't be used.

Modeling wax that is pliable and ductile may be totally moulded by hand. Similar to modelling clay surfaces, harder waxes may be modelled and pulled together with steel rifflers or wooden modelling spatulas. A spirit lamp or candle can be used to heat the spatula's blade, and metal spatulas are also an option. Using a candle has the benefit of leaving a black sooty residue on the surface. Tool transfers and enhances the wax's colour throughout the modelling process. Additionally, this lessens the inherent translucency of many waxes, which makes it easier to create the shape. Carefully "flaming" the model is also achievable while working on a tiny scale. This can make the materials extremely malleable and fluid properties clear.

3.4.1.c Large scale wax sculpture armature process

A bigger and stronger internal armature is required for larger wax sculptures, which can eventually be removed during the moulding process. This armature can be manufactured of any appropriate strong material as it won't be kept within the mould. Initial masses can be built up with slices of polystyrene that are connected to the armature by brushing the surfaces with molten wax in order to reduce the quantity of modelling wax required. This first build-up should be sealed with molten wax after it has achieved an appropriate size. This will provide a solid foundation for applying the ultimate wax thickness. A completed wax model like this one is used to make mould pieces.

3.4.1.d Technique for hollow metal casting

There are different techniques for creating hollow wax model. The following is a straightforward method for making hollow wax shapes. Create a rough clay volume and repeatedly dip it in melted wax to create an even layer that is roughly 2mm thick. Wax should be allowed to cure before being sliced with a hot, thin blade, the clay removed, the hollow pieces cleaned, dried, and then joined together with a hot metal instrument. The hollow object created in this way can be used as a mould or to create a sculpture that will be directly cast in metal. The sculpture may be enhanced by adding wax to the surface to create certain surfaces and details. Such modelling may be cemented by swiftly immersing the entire object in molten wax, giving the sculptor access to a variety of rough and smooth surfaces. Or, of course, the core might be fashioned beforehand, in lieu of the clay, and left in the hollow wax forms. The hollow wax forms can be filled with a refractory core material suitable for bronze casting. This is essentially how the ancients used to cast metal and is described as such in Dhokra Metal Casting. It is also known as the basic procedure that has been predetermined core technique.

Similarly in another way, first construct a core that is the shape and resemblance of the planned design; maintain it slightly reduced in size when creating a wax model for casting a hollow in bronze. It should ideally be around 1/4inch (6mm) smaller than the real size. This can be accomplished by modelling it in clay, creating a flexible mould, and casting a refractory core using a refractory compound—one that can tolerate heat—either directly onto a support armature. Before applying wax, the core has to cure and then dry. The process through which the substance dries out is called curing. There are several steps to the setting process, and it must be left for at least 24 hours to mature properly. It is simpler to apply the first layer in the form of liquid hot wax and then continue modelling the surface with soft wax after it has dried. The modelling is carried out in the same manner as previously described. The wax will be less prone to damage when handled later on if the final surface is lightly flamed, creating a tougher and more durable outer layer. (Swarnakamal, 1980)

This procedure entails generating a wax casting by pouring wax into a flexible or plaster mould made from the original clay figure. In order to create an "investment mould," a second mould is created around the wax once it has been prepared. Then, in a kiln, this mould is fired at a high temperature to completely burn out any remaining wax. A "ludo mould" is the name given to the baked mould. The gap created by the wax, which was melted out during the previous baking, is subsequently filled with molten metal that has been put into the ludo mould. The name of the method comes from this wax loss during baking. The grooves in the mould known as runners are where the molten metal flows through to fill the cavity. Risers, which are just channels in the mould, serve as vents for gases and air. The size of the runners depends on the size of the work, but mostly we use two different sizes which are created for wax runner are (a) 12 inch length and 10mm diameter for main runner and (b) 12 inch length 6 mm diameter for other channels

3.4.1.d Wax cast process through mould

In India metal casting is practiced in different regions with a little change in material. However the basic principal of lost wax technique is same but material quality or some material has got change due to the change in region.

3.4.1.d.i Hollow wax model

Figure 3.4.1 Wax application on plaster mould

A plaster waste mould or rubber/silicone mould may be used to create a hollow wax in two different ways. The mould is initially carefully wrapped up and internally aligned for the first approach. The wax is then heated until it becomes liquid in a skillet over low heat. Never leave a wax pan that is heating up. If it warms up too quickly, it might blow up. When a "bloom" emerges on the surface of the wax, it is ready to be poured into the mould. A wax that has a "bloom" seems cloudy and dull. The mould is filled with melted wax, which is rolled within before being poured out in a large quantity. The procedure is continued until the wax casting is about 3-5mm thick, after which it is allowed to cool until set. A core of refractory cement that is strengthened by some galvanized wire can be poured within the finished wax carving once it has cooled. Once this has dried, the wax that has been cored may be taken from the mould and given 24 hours to cure. The wax can then be modified if required prior to casting it in metal.

Figure 3.4.2 Finishing wax model with steel tool

The second approach involves melting the wax in a skillet over low heat until it is liquid and spreading it directly onto the surface of the mould. This sensitive process needs to be carried out again. Each time wax is added to the mould, care must be taken to brush the whole surface. The mould is carefully put back together and safely fastened once the item has attained the correct thickness and the edges have been polished. If there is access, the inside seam can be sealed by brushing it with liquid wax; if not, wax can be poured in and rolled. The core can be poured while it is cool. The wax buildup is visible and more readily managed when done with a brush. But the pour and roll technique leaves no seams and is quicker and more effective.

The inner surface mould for a metal casting keeps the hollow in the right place, which establishes the metal's thickness. In lost wax casting, investment is poured into the hollow wax to create the core, which is properly strengthened and vented. In order to be picked up and incorporated in the investment mould, pins are pushed through the wax into the core while still protruding from the wax surface. When the wax is melted off, these pegs maintain the proper orientation of the core and investment mould.

3.4.1.d.ii Solid wax model

By simply pouring a solid wax into a flexible mould that has a bloom on the surface and allowing it to cure, a solid wax may be removed. If necessary, a wax casting can be made from a plaster mould. When casting basic reliefs with little to no undercut, this is frequently helpful. It is recommended to soak the plaster mould in water for at least an hour, or until it is completely saturated. The melted wax can then be poured into the flat mould. Let the wax set and firm until it is about 3-5mm thick. The thicker wax casting will float away from the master with a little assistance once the entire mould has been submerged in water, because the surface is not as crisp as a rubber moulded surface, this method is not appropriate for intricate work. Additionally, if any wax sticks to the plaster mould surface, fractures can happen quite readily.

3.4.1.e. Wax modelling process through wax sheet

Precast thin wax sheets can be used to construct and model drapery and abstract pieces. When the wax is poured, these sheets may be moulded with texture or may be smooth. When the sheets are dry and hard, they may be cut into the necessary forms, bent or handled by hand, and combined by spot welding the edges with a hot spatula.

Figure 3.4.3 Artist pouringliquid wax on wet plaster mould

Figure 3.4.4 Liquid wax takes few minutes to become wax sheet

With extreme caution, it is feasible to "wax weld" edges together by utilizing wax rods as a type of filler rod for the seams with a soldering torch or low brazing flame. When the model has gained some structural sturdiness, it will be able to continue using simulated inclusions where appropriate. The wax's consistency, however, needs to be taken into consideration.

Figure 3.4.5 Modern artist M. Dharmani creating model direcet with wax sheet

Figure 3.4.6 Wax model sculpted by Senior sculptor M. Dharmani

3.4.1.f Core pins

After the fashioning of wax model, the next step is to determine whether the core pins are required or not. Usually core pins are required in hollow metal casting process, core pins hold the core between the investment mould to create the required negative space after the dewaxing of investment mould. If core pins are not applied, then the core body will dislocate while dewaxing process and that will disturb the form which is required to cast in metal. These pins, which should be driven through the wax model to meet the core while yet leaving enough length outside the wax to be held by the external investment, are a crucial component in hollow casting metal casting. These pegs will stop the core from dropping and maintain it precisely suspended with the mould. The hollow casting, which is typically 3-5 mm thick, must be ensured.

The metal fixtures keep the mould and core in the right positions during metal casting in order to retain the desired metal thickness. Common iron nails are typically utilized as these pins since they are made of ferrous metal.

Figure 3.4.7 Wax model with core pins

Although more expensive, stainless steel pins can be reused if handled carefully. However, there is always a chance that the molten metal can soften the pins and cause the core to shift if non-ferrous pins are used. Therefore, non-ferrous pins would have to be thicker than those already in use. One cannot avoid the requirement to drill out and tap, or weld, the hole to obtain a sound surface by utilizing non-ferrous pins. Even if the pins are made of the same metal, oxidation will still occur around them and form a black ring which needs to be work out at the finishing stage.

3.4.1.g Runners and Air vent

After the core pins application next very important and technical part is the application of runners and risers/air-vents. There are two different techniques for runners application one is direct method (Gravity casting) and another is indirect method (Flow casting). Both are used in investment casting as per the requirement. The direct system, where metal flows directly into the cavity of the mould, and the indirect technique, in which metal travels to the bottom of the runner to fill the mould as it rises to assure flow.

Mostly in large size metal casting, runners are applied as per the indirect/flow casting technique. The model is shown in the figure with the runners and risers in place. The positioning of the runners and risers is crucial since it's critical for the bronze to flow evenly and without catching an air bubble. The pouring gate (sproue) must next be created and attached to the cored wax. The system of channels through which molten metal pours and air or gases escape is known as the pouring gate. The air and fumes escape up the "risers" while the metal travels down the "runners." To ensure the fastest and smoothest flow of metal, the runners are immediately transferred from a pouring cup or funnel to the strategically placed locations on the sculpture. To give the fastest flow and prevent the metal from cooling too quickly, many gates are often required. The risers are made from any spot on the artwork where air may be trapped and the flow of metal up to the investment's top exterior surface prevented.

Figure 3.4.8 Wax runners attached to finished wax model

When the piece is ready for the metal pour, air traps will often be the sculpture's highest points. Wax rods are used to make the runners and risers (Fig 3.4.8), those are then welded to the wax casting by simply passing a hot metal tool between the rod and the wax casting. The diameter of runners varies depending on the size of the sculpture, ranging from 6 to 13 mm for big castings. Making wax rod is simple and may be done using two-piece plaster moulds made of wooden dowelling or by pouring wax into a metal tube and letting it set. The cast wax rod may be forced out of the tube by slowly warming it. For runners, the rods are appropriate. Risers are manufactured by dipping threads in wax and are thinner. The sole requirement is that they be thick enough to enable gas or air to escape. To allow gases to escape, large cores also need to be vented. When the piece is in the casting position, the risers should be positioned on the highest places.

3.4.1.h Creating sprue

This is the general term for the passages used to feed and release air from a mould during any type of metal casting. The system of runners and risers that make up the pouring gate is made up of these channels, it is a cone shape funnel also acts as a reserve while colling down of metal after pouring in the investment moul, that manages the shrinkage of metals and helps to achieve the complete required metal form. Following the dewaxing procedure, the runners, pouring sprue, and mould cavity are all filled with metal. To enable the quickest and smoothest flow of metal, a runner is stretched from the sprue to the precisely designated places on the sculpture.

3.4.1.i Investment mould making process

After the wax sculpture has been cored, fastened, and fitted with a pouring gate, the investment mould is created around it. A refractory plaster or plaster of Paris combined with equal parts of grog or brick dust can be used to create the investment. Some composition for making the investment mould is as follows:

Table 4.3.1 Different composition for making the investment mould

Grog (terracotta brick dust) Plaster	1 parts 1 part
Ludo (reconstituted plaster/investment matrial) Plaster	3 parts 1 part
Proprietary refractory cement Plaster	10 parts 1 part
Plaster High alumina cement Sand	1 part 2 part 6 part
Silica flour Groge (ground ceramic material) Plaster	1 part 1part 1part

The investment is carefully painted on to the wax surface, all over the sculpture and pouring gate, taking care to leave a well-keyed surface to create the best adherence to subsequent layers of investment. This method enables the replication of the finest detail. The finest grog sieve mesh should be employed to ensure the quality of this initial layer. The mould is then built up until it is fairly thick and, after baking, quite sturdy. To provide the mould the necessary strength, reinforcing with chicken wire works best in big moulds. Heavier mesh grog should be utilized to build up the bulk of the mould.

Poured investments are straightforward and rather wasteful; however this drawback is balanced by how quickly an investment may be made. Making a flask is as easy as cutting a piece of thin sheet metal, linoleum, plastic sheeting, cardboard, or an empty tin. A metal wire mesh is used to reinforce the investment mould by placing between the wax sculpture and the wall created for the investment mould, then plaster of Paris and grog/ brick dust should be mixed in equal proportions and then added to the flask. The prepared wax should then be dipped into the mixture. Air bubbles that will form beads on the cast surface can be eliminated by agitating the wax or by hastily brushing investment over the wax surface before dipping. Hold the wax in place until the investment dries.

3.4.1.j Dewaxing

Dewaxing and baking a wax investment mould is a crucial procedure, and it must be emphasized that if done incorrectly, the results of pouring hot metal can be explosive. The kind of kiln or furnace appropriate for this procedure should be carefully considered. Typically, sculptors build a temporary terracotta brick and clay made local kiln around the investment moulds since the dewaxing process needs a temperature of 600° to 700° C. Depending on the size and quantity of investment moulds, the entire dewaxing procedure might take anywhere from 10 to 20 hours. Keep in mind that the wax within the mould will first spill out and either ignite and burn up with the kiln or fill the air with black smoke.

Figure 3.4.9 Sculptors creating local dewaxing kiln with terracotta bricks

Figure 3.4.10 Sculpture applying clay slip to seal the bricks gap of local kiln

Different fuel sources can be used in this operation, although often wood and LPG/PNG are used. Electric dewaxing chambers are also an option, but those are preferred for small-scale metal investment moulds. Depending on the need, permanent or temporary dewaxing kilns are utilized in wood or LPG fire. When burning a large number of moulds, some metal casters look for a suitable location and construct a makeshift kiln consisting of bricks and clay/fire clay around the mould.

3.4.1.k Metal pouring

The metal must flow fast and without freezing to every area of the mould cavity. Gases produced by the molten metal push air out of the mould. These gases and air escape through vents that were taken from positive form characteristics that are likely to retain air and obstruct the flow of metal, known as risers.

Air traps typically develop at undercut forms that stick out from the main form when it is ready to be filled.

Figure 3.4.11 Team of sculptors Pouring molten metal in to investment moulds

Figure 3.4.12 Investment moulds are taken out from the pit after solidification on metal

Figure 3.4.13 Metal sculpture are taken out by removing investment mould

3.4.1.l Finishing and patination

The investment mould and wires mesh are removed from the cast, and the sculptor cleans the cast and cuts the unwanted runners. The current picture is an exact replica of the wax figure. Tools are used to rectify flaws, welding may be done if necessary, and other finishing touches are crucial to ensuring that the sculpture is flawless in every way. The picture is then washed with diluted nitric acid in water and scraped with a brass brush until it is suitably degreased.

Patination and surface treatment are two forms of processing that are inextricably linked to an object's overall surface quality. The surface that will be coloured needs to be carefully cleaned and ready, whether it is highly polished, abraded, or textured. Generally speaking, colouring won't hide minor defects on the surface. The quality of the finished surface is usually enhanced by the use of texture during preparation. The basis for inventive treatments in many coloured finishes is the contrast between coloured regions and bare metal areas. Additionally, the Patination process may reveal surface features like the grain structure that is obscured by a polished finish. Patina amplifies the surface of metal sculpture if applied aesthetically.

Figure 3.4.14 Runners and extra metal are removed to get the desire sculpture

Figure 3.4.15 Sculpture scurface need to clean and degreas befor patination process

Figure 3.4.16 Patina recipes are applied to achive desired color

Figure 3.4.17 Finally wax or lacquer coat is applied to preserve the patinated surface.

CHAPTER FOUR

INDIAN CONTEMPORARY SCULPTORS

4.1 Indian contemporary Tribal sculptors

4.1.1 Baldev Bagmare

Figure 4.1 Baldev Bagmare

Baldev Bagmare is one of the Indian contemporary tribal sculptors, specialised in Dhokra metal casting. He has been working in Dhokra metal craft for more than twenty-five years. Born on 8th September 1979 and he lives in Tigariya Didtric, Betul, Madhya Pradesh, India. He has won many awards from Indian government as mentioned : National level Vishva-karma Award 2011, Best artisan award (Art & craft) by MP Tourism Award 2017 and many more. Baldev Bagmare has 20 years of experience in the Dokhra craft. His creation, Craft, is adored throughout India. Baldev, an expert in dDokhra craft, was given the State Award by the Madhya

Pradesh Government. In Madhya Pradesh, the Rajbhavan and numerous museums display his work.

He has occasionally worked as a trainer at the State Museum of Bhopal, Bharat Bhawan, Trifade, and Adiwasi craft. In addition to other places, he has demonstrated his craft in Delhi, Bangalore, Madras, Kerala, and Bhopal. He is currently a business owner and also trains individuals and organisations.

Figure 4.2 Traditional bass Ox Dhokra sculpture

Figure 4.3 Baldev Bagmare working in his studio

5.1.2 Banno Ram

Figure 4.4 Banno Ram

Mr. Bannu Ram Vaidhi, village Barkai , Tehsil, Makdi, district, Konda village, Bastar, Chhattisgarh. His father's name is Mr. Sakharam. The financial condition of his family was not good, due to which his parents could not attend school. His parents did not even have a good house to live in, nor did they have food to eat. His house was a hut made of tirpal(plastic sheet), where he was born, his mother used to work in another's house. Her mother used to bring some rice and pulses and feed his family, they were two brothers, one brother's name was Mr. Bansilal, after some time mother died and after some time his father also died, his age was very young, about 10 a year old when his father and mother died, after which he used to work all day at other's house and used to go to unload the goods from the bus truck at night, due to which he used to get some money, one or two rupees. With which he used to come home on foot to his home village on foot for many 40 kilometers, he is like his father, Shri Sakharam, who used to do Dhokra art work, He had a little knowledge of that work. But he tried to create few and sell those, to make bread and butter for him. He lived in a hut and worked very hard to learn the metal casting technique. Meanwhile, he was married to Mrs. Triveni, and after that both of them used to go to work in other's house. He was first called to Lokrang in Bhopal from where his life turned to some stable state. He worked hard day and night and made a house with some money and he work continued to earn, after that he was awarded the state level award from the Chief Minister of Chhattisgarh, which brings recognitions to talent and after that he was called in many Government metal casting camps in different states like in Kerala, Mumbai, Delhi, Agra, Kashmir. In 2018, he was awarded with the National Award, which makes his financial condition improved a bit.

He learned this work with lot of struggle& difficulties, he believes, if he did not do learn dhokra metal casting technique on right time, and then he would not be able to survive. Some of his participation in National level camps mentioned below:

Gurukula Public school Bhandy education trust national level artist camp March 14 to April 4th 2010 , Nation tribal artists camp From 1st July To 10th July 2015 Head at Delhi Public school srinagar Kashmir, Indra Gandhi Rashtriya Manav Sangrahalaya Trabal Museum SCSTRTI Bhubaneswar During 19th To 27 November 2014, Shilpa Virasat Nation Sculptures Camp at Shobhavana at between 20th December 9th January 2010, Kreala Lalithakala Akademi and the South Zone Cultural Center From 19th Apri to 7th May 2008 hill palace Thripunithura, Kerala Folklore academy Department of Culture Govt of Kerala From 9th January 2016 to 19th January 2016,Varna Bhoomi Bulbarga Karnataka 20 Nov to 14 Dec 2011 and Bastar Garhwa Dhatu Kala Takshashila Semankit Gramin Samduik Kendra.

Figure 4.5 Traibal artists working with wax

Figure 4.6 Trible sculptorBanno Ram removing mould layer after casting

Figure 4.7 Tibal brass sculpture, punch kanya nag jhula

4.2 Indian contemporary Traditional sculptors

4.2.1 Rajendran T.V. Trv

Figure 4.8 Rajendran T.V. Trv

Rajendran TV Trv is contemporary traditional metal sculptor. He lives in Kunhimangalam, the bronze heritage village in Kannur district. He was born on 04/05/1979 in Kuthirummal, Kunhimangalam, the son of the famous sculptor Thekke vettil Chandu and Parvathy. He completed his primary education at Govt LP School Kuthirammal, upper-primary education at government Central Up School Kandamkulangara, and high school education at Govt Higher Secondary School Kunhimangalam. During his education, he participated in many State Level Competitions and won many prizes in work experiences. He has received the Kerala folklore Academy ' Yuva Pratibha Puraskara' 2018 and the Kshetrakala Academy bronze sculpture award for the year 2020. He is the Treasurer of the Kunhimangalam bronze Heritage conservation Study and Research Centre trust. His wife PP Soumya and his two children are Suryanand and Sreenand.

Figure 4.9 Sculptor Rajendran TV preparing on wax model

He is the current generation of Sculptor in the field of a bronze sculpture with the Heritage of nearly 9 generations. He has been working in bronze sculpture for 25 years. He learned sculpting in metal from his father and four elder brothers. After completing primary education he started his work, initially cooking vessels and lamps were made. Gradually the focus shifted to Idol making. Idols have been erected for more than 300 temples. and twenty dedicated idols have also been created. In addition, the Ramayana lamp, Dashavatara lamp, tree lamp, Ashtalakshmi lamp, Lakshmi lamp, Krishna lamp etc which are made in the most modern style of architecture and precision of the ancient structures are also used. More than 350 bronze structures are being made in Kunhimangalam and he makes all those different styles of metal sculptures, laps etc at his studio cum foundry attached to his home.

Rajendran's son Suryanand T V is only in fifth class, yet his nimble fingers shape and cut the black wax into two peafowls sitting on a tree with ease. He's working on a bell metal sculpture employing a method that's only found in the Moosari town of Kunhimangalam, around 10 kilometres from Payyannur. "He has no idea it's a 900-year-old art form. Suryanand's father, Rajendran T V, 42, a master artisan and bell metal artisan, adds, "He picked it through witnessing our work in the backyard foundry."

Rajendran, who barely completed Class X in school, is happy with his son's growth. His son also creates bell metal sculptures. Rajendran, received the Kshethra Kala Akademi's prize for finest bronze sculptor in 2020. The state government designated the Moosari community's bell-metal carving as a cultural art and their habitation in Kunhimangalam as a historical village in 2018. However, he claims that just 11 people in Kunhimangalam are presently manufacturing bell-metal figures, sculptures, and lamps. Rajendran and his four elder brothers — Raveendran, Muraleedharan, Babu, and Rajeevan — make up five of the eleven. Legend has it that the people moved from Palazhi in Nileshwar to Kunhimangalam centuries ago to produce idols and temple accessories for the Sree Veerachamundeswary temple. Members of the community have gone on to various occupations throughout time.

Figure 4.10 Sculptor Rajendran TV working on finishing of Prabhamandal

The Mooshari community has established a Trust to teach children how to make Kunhimangalam-style bronze sculptures, lamps, and containers.

Mithun T K, Muraleedharans fine arts student, is combining what he learned in college with his family's expertise. “An Indonesian temple just gave him an order. This is proof that the art and skill will go on,” Babu adds. He claims that individuals in his town quit producing sculptures because it required careful and lengthy hours of effort, not becauseLamps with complex craftsmanship including stories from myths are one of Kunhimangalam's specialties. Rajendran is also working on a Ramayana lamp for a customer in Dubai. He had previously created a Dasavatara lamp showing Lord Vishnu's ten incarnations. The artist's understanding of mythology will be evident in their work. “These lamps are complex pieces of art that were cast in a single piece. Each die can only be used once, thus each of our goods is one-of-a-kind,” Rajendran explains. People seldom purchase brass and bronze kitchenware for their homes these days, but they do order showpieces, idols, and temple accessories. At least 33 distinct varieties of lights are produced by Kunhimangalam, because of a lack of orders or money. Kunhimangalam's handcrafted goods are now sought after not just by temples, but also by high-net-worth individuals, corporations, and hotels.

Bronze Sculpture method at Kunhimangalam

There are two types of bronze sculptures made at Kunhimangalam. Solid sculptures and hollows. sculptures are first designed in wax to make solid sculptures. After designing in wax,the top of the sculpture is covered with various types of prepared clay and its mould is made. The mould is prepared and then it is heated slightly and the wax inside is removed. Then the mould is cast. After it cools,the exterior soil is cracked and the sculpture is taken out and finished

Figure 4.11 Traditional Shiv Parvati sculpture by Sculptor Rajendran TV

Figure 4.12 Traditional Garudh Dev sculpture by Sculptor Rajendran TV

Figure 4.13 Traditional brass idol of Lord Subramanyam

4.2.2 V V Ramachandran

Figure 4.14 V V Ramachandran

In addition to being a contemporary traditional metal sculptor, V V Ramachandran is a senior Pujari at the Sri Subramanya Swami Temple in Kunhimangalam. He was born on August 15th, 1955 in Kunhimangalam, a village with a bronze heritage in the Kannur district. Since he serves as the chief Pujari of the historic temple in Kunhimangalam Village, he resides there. His home and studio for sculpture are both located inside the temple's boundaries.

Figure 4.15 VV Ramachandran is sitting in the right corner with other Sculptors/Pujaris in front of Sri Subramanya Swami Temple

Figure 4.16 V V Ramachandran preparing wax model

In Kunhimangalam village there is a tradition that the idols of deities required for temples should be created by the Pandits only. So, in Kunhimangalam the pandits and pujaris are also trained as sculptors from their childhood, which continues as their family legacy and handed over from generation to next generation. They use lost wax technique for creating the idols and other items such as different types of oil lamps, the Ramayana lamp, Dashavatara lamp, tree lamp, Ashtalakshmi lamp, Lakshmi lamp, Krishna lamp, Vattalam (a big vessel used for cooking) Animals forms like elephant etc. He created countlesthe traditionalHindu gods and goddesses such as Vishnu Dev, Dash Avatara, Bagwati Devi, Devi Bhdrakali etc, in Panchaloha through traditional lost wax method (Panchloha: Panch means five and loha means metal, so Panchloha is an alloy a mixture of five metals namely copper, zinc, tin, gold, and silver). Ramachandran explained that they creates idol for temples as solid cast in panchloha as they believe a hollow cast is same a khandit murti (Idol that should not be worshiped) as in the beginning of temple history we find idols/murti was made with Shilla (stone/marble) which is a solid form idols. Since his childhood his life is dedicated to leaning and understanding the different shastras and puranas related to sculpting and Hindu religion. He follows the manuscripts like Architecture of Manasara while creating the idols of gods and goddesses.

Because of his knowledge, understanding and experience, Sh. Ramachandran is also known as the living Encyclopaedia in is Village He is a person who loves to share his knowledge with others, he likes to stand with others for helping and sharing his experience while casting process. Ramachandran Participated in many camps like metal casting camp by Kerala Lalitakala Academi 2018, as well as received many Honours and Awards like Kerala Folklore Academy Award in 2020 etc.

Figure 4.17 VV Ramachandran is standing at the left corner, while metal poring process of metal casting

According to VV Ramachandran, they use the same modelling and casting techniques, materials, and processes as in previous generations, but they have chosen to use a few new electronic machines to make their work easier and to save time and labour. For instance, they use a hot air gun to create wax models, a metal melting furnace powered by an electronic blower, an angle grinder to remove excess metal from casts, and a lathe for a variety of operations like cutting, sanding, drilling, facing, and imparting symmetry to some work pieces. These are the advantages, he believes, they have as technology advances through the generations, but he has noticed that the younger members of pujari families are choosing other careers, which could have an impact on the community's future.

4.3 Indian Contemporary sculptors

4.3.1 Padam Bhushan Ram V. Sutar

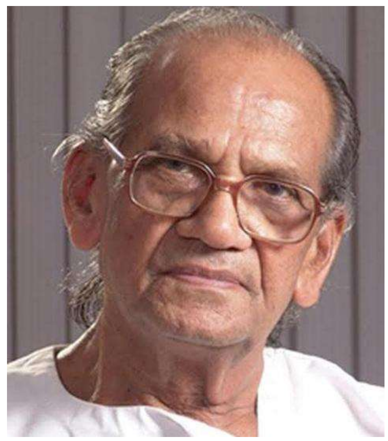

Figure 4.18 Padam Bhushan Ram V. Sutar

One of the well-known sculptors recognized for his massive works on a grand scale is Ram V. Sutar. He is regarded by many as India's most outstanding sculptor. Ram Sutar, who is currently in his mid-eighties, was born on February 19, 1925, in the little town of Gondur, which is about 3 kilometers from Dhule. Located close to Chalisgaon Junction, Dhule is a tiny district town. The closest rail station from which to go to other regions of Maharashtra or India is Chalisgaon.

The carpenter family of Vanji Hansraj Sutar resided in the hamlet of Gondur. His ancestors originated in Gujarat. Long ago, many families moved from other countries to Maharashtra. In Gondur, there are about fifty households. A small lake lies close to the settlement. Families in Gondur had access to agricultural land, and farming was their sole means of subsistence. If they had extra food, the households with larger agricultural holdings might sell their produce in Dhule. If not, the locals had enough land to support their own family. (Sutar, 2010)

Ram Sutar is the son of the late Vanji Hansraj Sutar, a carpenter and blacksmith who made bullock carts, tongas, ploughs, and other farming implements as well as anything needed to build dwellings. A member of the Vishwakarma family was Vanji Hans Raj. The typical tools used by Vishwakarma people include scales, measures, hammers, chisels, plumb, iron, gold, etc. They certainly qualify as competent employees in a certain industry.

The barter system was common back then. Vanji Hansraj Sutar received payment in the form of wheat, millet, pulses, cotton, oil, etc. whenever he worked for someone.

Eight children—four boys and four girls—were born to Vanji Hansraj Sutar and his wife is Sitabai Hansraj Sutar. The sisters Kasturi, Dwarka, Keshar, and Indumati were the youngest, followed by Bhatu Mistry, Ram V. Sutar, Kashinath, and Eknath.

Ram Sutar has been creating drawings and paintings since he was a little boy. "Chhatrapati Shivaji, Tukaram Maharaj, and forts of Chhatrapati Shivaji" were his three favourite themes. His work was well received by the professors, and he quickly rose to the status of a favourite. He was often asked by the instructors to create illustrations for their classes on the whiteboard. For his teacher, Vanji, who also happened to be his name, he also made coloured paintings of Shivnery Fort, Bharatpur Fort, and other favourite topics.

He continued his schooling by enrolling in another primary school in the village of Imdala after finishing the fourth grade. Ram Sutar used to make his daily barefoot trek to the school in imdala village, which was about three kilometres away from the residence.

Ram Sutar had learned about Shriram Krishna Joshi, a teacher of drawing at the Teacher's Training College in Dhule, while he was still in school. Ram Sutar went to see him and expressed an interest in learning to paint. Mr. Joshi concurred and invited him to visit his home anytime he felt like it to study. Shriram Krishna Joshi appreciated Ram's work and supported him when he first started going to him to learn how to draw and paint.

Joshi Guruji was aware of the Bombay Art Society, which held exhibits and presented prizes for the top submissions to encourage aspiring painters. He sent the Ram Sutar-carved relief of "Shivajiand Bhawani" for display in Bombay. The submission was recognised as a remarkable work of art and given a Silver Medal. His first honour for his artwork was that one. Throughout high school, his professors were immensely amazed by his abilities. Joshi Guruji began to have a fatherly fondness for him and assisted Ram Sutar in continuing his education in painting.

He was the first child from the Vishwakarma community to complete an advanced sculpting programme.

Ram Sutar sculpted a four-foot-tall bust of Mahatma Gandhi for a school just before enrolling in the Sir J. J. School of Art in Bombay (now Mumbai), and the money he earned from the sculpture was used to pay for his schooling there.

There was no requirement to pass the Matriculation test in order to enroll at the Sir J. J. School of Art. Ram Sutar was persuaded by Joshi Guruji to enroll at the J.J. School of Art in Bombay. Ram Sutar started attending J.J. School of Art. Ram Sutar was effortlessly able to create sculptures and sketches when he first started going to the lessons. This was due to his prior sculpture-making experience and his knowledge of clay matching, waste moulds, and carving. His modelling, drawing, and painting skills astounded his professors, who opted to advance him immediately to second year.

In addition to assisting him in enrolling for the training programme, Joshi Guruji also assisted him in finding housing by connecting him with his relative B.B. Joshi in Bombay. Joshi Guruji used to provide him Rs. 25 per month for his expenditures throughout the first year. Ram, however, began receiving a scholarship of Rs. 25 in his second year and began manufacturing and selling modelling equipment to other students to supplement his income.

Ram Sutar loved his time in college but realised that little he learned there was new because he had already carved sculptures and was familiar with waste moulding, plaster casting, and piece moulding. His sketches were quite good. College students were required to duplicate the sculptures imported from Italy and other regions of Europe since western art and sculptures were worked upon as the pinnacle of excellence.

He said the professors mistook his drawings for tracings and, in order to assess his abilities, they handed him a different coloured pencil and asked him to observe and sketch the anatomy on a separate sheet of drawing paper. He completed the task without difficulty in front of the instructors. The professors felt convinced that the sketches were indeed hand-drawn and not transcribed, going back on their promise.

Ram Sutar also produced sculptures in the Indian style, such as Trimurti, and he produced a Samudra Manthan sculpture in the classical style, which the academicians praised highly.

Ram Sutar was highly skilled at carving stone sculptures, and the instructors were in awe of his master strokes. Additionally, he won awards for his crafts, like the stone dog he sculpted. I hope we could find the lost sculptures from the J. J. School of Art so we could have a duplicate for our collection.

Ram Sutar used to visit contemporary sculptors to learn and see their work in progress while he was a student at the J.J. School of Art. When assistance was needed, he also used to offer it freely. Ram was constantly enthralled by the sculptures created by many artists, including Mhatre, Talim, Wagh, and Karmakar. They were familiar with Ram since they had judged his work at Bombay Art Society competitions and during their visits to J.J. School of Art.

Ram earned his diploma in sculpture from the J.J. School of Art in 1953 after completing a four-year programme there. He received the Mayo Gold Medal with first division at the youngest age in his town. Despite the fact that he was the winner of the Gold medal, it was not possible to present him with it since the medal's original dye was in London and it had to be awarded after the finished medal was ready.

Unfortunately, Pt. Govind Ballabh Pant passed away in the interim. Ram Sutar was asked to submit a model for the creation of his statue in a letter from the Pt. Govind Ballabh Pant Memorial Society. Ram Sutar created a miniature model and submitted it. Models were submitted by several other artists. Ram Sutar was informed by Shri G.L. Bansal, Chief Coordinator of Pt. Govind Ballabh Pant Memorial Society, that his model had been chosen and a ten-foot-tall bronze statue will be installed next to Rail Bhawan."

The busts of Mahatma Gandhi, Pt. Nehru, and Trimurti are among the beautiful sculptures created by Ram Sutar. Chitra Kala Sangam was established by renowned photographer Shri Virender Prabhakar. Chitra Kala Sangam sent these miniature replicas to a number of notable people, including Mrs. Indira Gandhi, Shri Morarji Desai, Shri G. L. Bansal, and many more. Ram Sutar created some modern-art paintings and sculptures in addition to his work at the Bistidari building. Saaki, Christ, the Three Faces of Life, the Reclining Figure, and many other artistic sketches were created by him.

On March 23rd 1999 he was honoured with Padamshree Award By the Hon'ble President of India Shri K.R. Narayanan. And later in 2016, Padam Bhushan from the Government of India.

Even though he has produced numerous sculptures that no other sculptor has yet produced, his dream of creating the largest sculpture was realised when he finished the Statue of Unity project in 2018. At 182 metres tall and situated in the Indian State of Gujarat, it is the tallest statue in the world. Sardar Vallabh bhai Patel, an Indian leader and nationalist, is portrayed.

Figure 4.19 Bronze statue of Mahatma Gandhi by Ram V. Sutar in Parliament House

Figure 4.20 Bronze statue of Maharaja Ranjit Singh by Ram V. Sutar

at Rambagh, Amritsar

Figure 4.21 Bronze bust of Dr. Rajendran Prasad by Ram V. Sutar, fromer President of India Installed in Kurukshetra University Haryana

Figure 4.22 Bronze bust by Ram V. Sutar of Maharaja Ranjit Singh

4.3.2 Padam Shri Biman Bihari Das

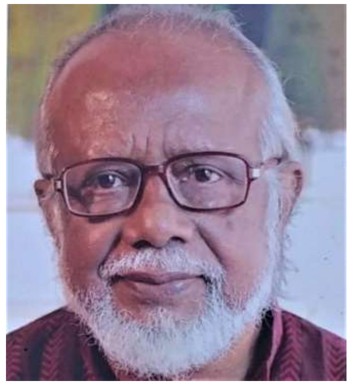

Figure 4.23 Padam Shri Biman Bihari Das

A Concise Professional and Personal Description

A brief prologue of artist's personal history; which has been the initial inspiration for my later ideas regarding art, aesthetics and global culture. Biman was born in an ancient town (Tamluk, Midnapore District, South of West Bengal, India), in a culturally and historically prosperous atmosphere of rural West Bengal in India. The place is replete with traditional craftsmen and ancient art forms in terracotta and stone, along with historical monuments & artistic objects like sculptures, paintings, frescos, etc, which made up his fundamental and preliminary inspiration and training for my later career in fine art.

His formal training took place at the most prestigious Govt. college of Art and Craft in Calcutta (which has been the initiator for the Bengal art Movement, and has been associated with international cultural figures like Rabindranath Tagore, Jamini Roy, Abanindranath Tagore, etc). He had completed five years Diploma course under the noble guidance of his professors and special guidance from Guru Prof Chintamoni Kar, the then Principal, Govt. College of Art and Craft, who is a great sculptor of international repute. Later on, he did his research on Bengal Terracotta temples and wood/stone carving as a National Cultural Scholar (Govt. of India) under Prof. Chintamoni Kar for two and a half years. During his research, he had experimented with several simplifications of both, complicated and oriental, forms; and three-dimensional concepts. He had also done extensive study on -methodology of carving, finishing and polishing. Shri Biman has also done many experiments on vitrified terracotta sculpture. With these experiences, for the first time he received a chance to display his works on a sponsored exhibition at Alliance Francaise, Calcutta and he received several encouragable comments.

Aftercompleting his research, he shifted to Delhi and joined as lecturer at the College of Art, New Delhi. With this, he also started his own professional life, with - several experiments, participations, and competitions and received several awards including National Award. After teaching approximately three years, he received the chance to get further training in England and joined the prestigious Art Schools of United Kingdom (where he was a British Council Scholar); where he received his guidance in contemporary and modern forms of art and aesthetics. Under Prof. Jeffrey Smedley, his life turned in to another shape; as incorporated - special training for bronze casting methods (Lost Wax Process).

The actual journey started after their invaluable advice and guidance - for experimenting the Indian classical subjects with the contemporary modern sensibility. With this new and revolutionary idea, Shri Biman experimented with several traditional Indian motifs, fusing them with contemporary forms and aesthetics (like cubism, surrealism, abstractionism, etc.). Thus his created series of works titled "Shiva Lingam, Lord Buddha, Budding Joy" in the Art Colleges in England and was highly appreciated. Later on, they collected as permanent collection by the National Gallery of Modern Art, New Delhi. During his stay in England, he had the chance to meet Great Sculptor Sir Henry Mooreand was able to avail his guidance and blessings. Shri Biman also met other famous sculptors like Reg Butler and Prof. Meadow. The most exciting part was to visit many museums in England, Paris, Italy, Scotland.

Henceforth, his whole career has been devoted to researching upon, the modernization of traditional Indian forms. Aesthetically it has included aspects like, simplification of forms, using abstractionism on Indian motifs, usage of contemporary symbolisms, etc. Thus, he has created forms like — Krishna Cult, Mithuna, Devi, Nayika, Nayak, Lord Buddha, etc (all of which are very popular and traditionally Indian artistic icons); transforming them into contemporary forms and motifs. Along with them, he also tried to depict universal emotional forms like - love, joy, freedom, peace, harmony, mother and child, Gate etc - through an experimentation that utilizes conventional art forms on these themes. Sri Biman has also developed an intense scholarship of western technique of fine art (like portrait making, bronze casting, welding, oil painting, water colours paintings, patina, etc.) along with his successful creative endeavors, He has also intensively researched and practiced a very vital form of sculpture as an art — the art of portrait making Over the years, Governments of several countries, along with private bodies, have commissioned him to make portraits of political leaders, social leaders, entrepreneurs etc.

Figure 4.24Mithuna-VI, Bronze sculpture by Biman B. Das

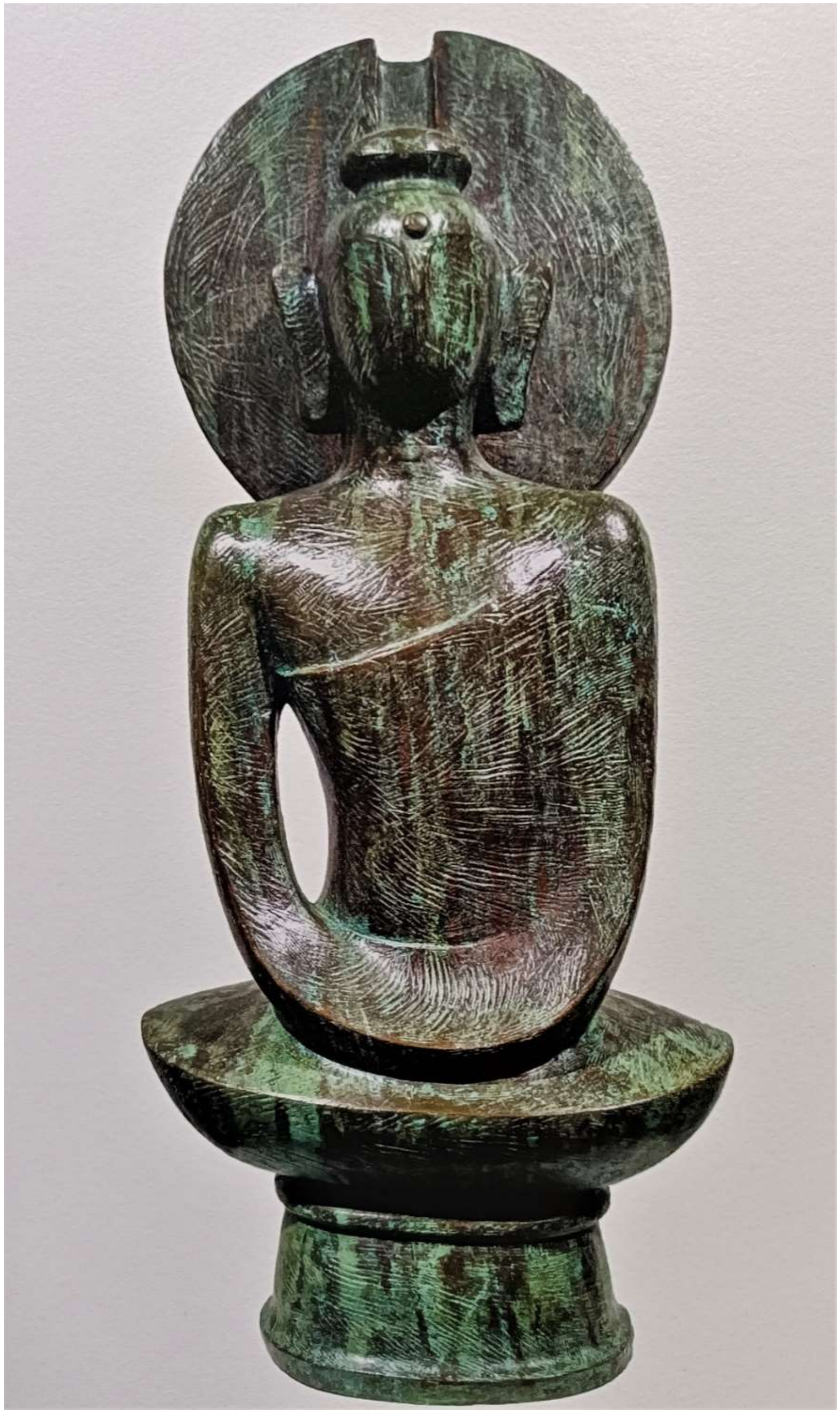

Figure 4.25Lord Buddha XII, Bronze sculpture by Biman B. Das

Figure 4.26Lord Buddha, Bronze sculpture by Biman B. Das

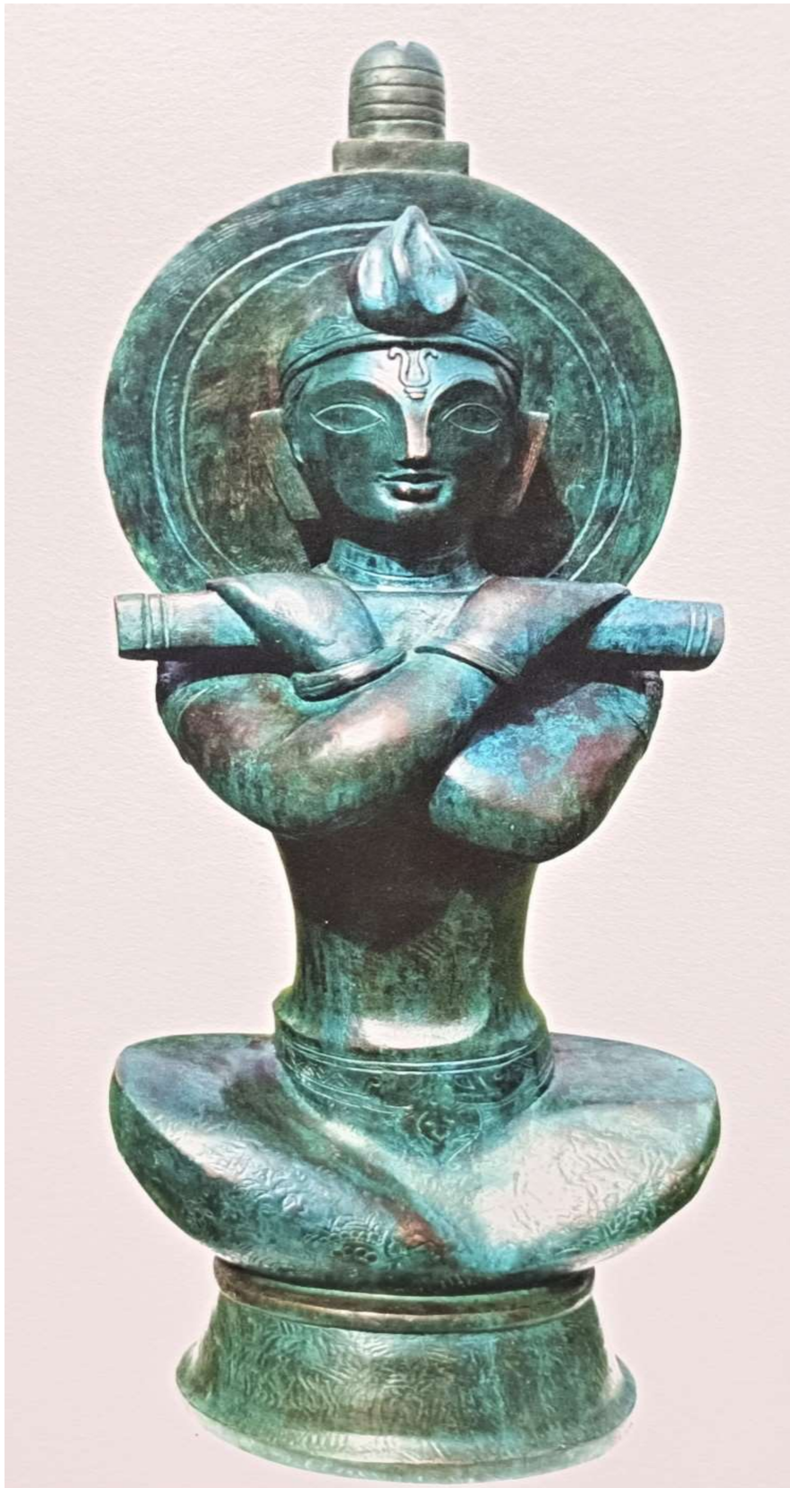

Figure 4.27 Krishna Cult- XIV, Bronze sculpture by Biman B. Das

4.4 Sculpture Academicians

4.4.1 Prof (Dr) Sanjeev Kumar

Figure 4.28 Prof (Dr) Sanjeev Kumar

Although he was raised in Delhi since his father was a teacher at a government school, he was born into a farming family in the State of Uttar Pradesh (Baghpat). He solely received his schooling in Delhi. In 1994 and 1996, respectively, he earned his BFA and MFA in sculpture from Delhi College of Art. He earned his Ph.D. from KUK in 2017. Since the majority of the family members were scientists, no one in his family particularly valued the arts, especially fine art. He began as an Honors student of Economics but left the institution after only a year and enrolled at the College of Art Delhi in 1990. He first encountered his mentor Prof. Biman B. Das, the driving force behind my whole journey to this point, when he enrolled at the institution.

He has worked on a variety of topics, including the union of men and women, Mahishasurmardini, and Ardhaneshwara. His preferred materials are metal and stone. He generally solely produced my sculptures in these two mediums due of my intense interest in both. He mainly enjoys working on legendary themes like Mahishasurmardini and Ardhaneshwara.

Figure 4.29 Prof. (Dr) Sanjeev Kumar demonstrating in front of students at Govt. College of Art, Chandigarh

He attended Art College during a period when there were few opportunities to demonstrate one's ability, making it challenging to become a successful artist. But he was able to carry on in the art of sculpting thanks to his Guru’s support. Though things became easier as the difficult period passed. He wants to mention that he considers it a stroke of luck that he was hired right away after earning his MFA. It made it simple for him to make a name for himself in the sculpting world.

His life and personality have always changed as a result of art. He thinks of himself as being highly emotional, sympathetic, perceptive, helpful, and insightful. His goal was to emulate his Guru, who was a superb sculptor, a flawless teacher, and a stunning individual. His primary form of expression is a tree, so when he first enrolled in the Government College of Art in Chandigarh, he was much inspired by the diverse trees. He was also greatly inspired by the geometric patterns of the city's architecture. Both components appear in his artistic creations. Several of his sculptures are on exhibit throughout the city: one is in Kala Gram, another is at the Hotel Shivalik, another is in the Rose Garden in Chandigarh's underpass, and a third is at Sukhna Lake. These traits may be seen in all these sculptures.

In 2021 he is selected by UPSC as Professor in College of Art, University of Delhi. His dream project is to educate his students honestly and impart the information he has acquired to them, as well as to produce a big bronze sculpture with a mythical theme that embodies the essence of the city. He wants to encourage upcoming artists to work as honestly and diligently as they can. There are no quick cuts in the domain of sculpting, and one cannot preserve and bring out the innocence, which the author believes is very necessary for an artist, without hard effort and honesty.

Figure 4.30 Mithuna-Couple-33, Bronze sculpture by Prof (Dr) Sanjeev Kumar

Figure 4.31 Ardhnarishwara-31, Bronze sculpture by Prof (Dr)Sanjeev Kumar

Figure 4.32 Ardhnarishwara-26, Bronze sculpture by Prof (Dr)Sanjeev Kumar

Figure 4.33 Ardhnarishwara-17, Bronze sculpture by Prof (Dr)Sanjeev Kumar

Figure 4.34 Gate-of-Love-3, Bronze sculpture by Prof (Dr)Sanjeev Kumar

4.4.2 Thomas Kavoor

Figure 4.35 Thomas Kavoor

He is working in the University of Rajasthan,Jaipur as a professor and HOD of Sculpture. He has excelled in the art of making monumental Statues.

Figure 4.36 Thomas Kavor teaching mould making technique to his student

In 2001, he started a sculpture Studio "Sukruthi" with all modern facilities to create finest quality Bronze Sculptures from small to large scale.Studio Sukruthi is built bya committed team of professional artists and well experienced technicians under the leadership of Shri, Thomas John Kovoor.He has made sculptures of Mahatma Gandhi,Lal Bahadur sastri,Indira Gandhi,Rajiv Gandhi,Swami Vivekananda Ambedkar and many more.

80 Dandi Memorial Statues' bronze casting began at Studio Sukruthi in Jaipur, Rajasthan, under the direction of Artist and Teacher Shri Thomas John Kovor. A project of the Ministry of Culture, Government of India, the National Salt Satyagraha Memorial Dandi is coordinated and carried out by IIT Bombay in collaboration with an international team and is advised by a high-level Dandi Memorial Committee.

Figure 4.37 Sculptor Thomas Kavoor sculpting in studio Sukriti

The Vattiyurkav monument is expected to cost around 1.75 crore. The Memorial honours the historical symbols of the Indian War for Independence. Thomas John Kovoor has prepared the design. This depicts the solidarity of Keralites in their fight for freedom as a mountain-shaped, three-layered brick building. Around the main Monument, four bronze statues will be erected, each of which will serve as a symbol for nonviolence, patriotism, freedom, and resistance to foreign authority. Each Structure stands taller than 6 feet.

Q: why you chose metal as a medium for your sculptures?

A: metal casting is nothing but a translation of clay modelling.

At the beginning of my carrier, I prefer wood and stone carving. I started metal casting in the 1980s. When I was working in the college of art, I received a commission work of a sculpture from the Indian Government to be cast in metal.

es (as the metal is commonlal significance as metal casting is used from very ancient times in both east and west directions.

Figure 4.38 Bio- gas plant, Bronze sculpture by Thomas Kavor

Figure 4.39 Study-V, Bronze sculpture by Thomas Kavor

Figure 4.40 Study-III, Bronze sculpture by Thomas Kavor

Figure 4.41 Study-XI, Bronze sculpture by Thomas Kavor

Figure 4.42 Study-XII, Bronze sculpture by Thomas Kavor

CHAPTER FIVE

PATINA

5.1 Patina Meaning and history

The patina literal meaning is a film of oxide formed on the surface of a metal (Produced by oxidation or other chemical processes)

"Metal sculptures get oxidized due to their prolonged exposure to different weather conditions. This can spoil the color of metal surface. To preserve the metal and to preserve, the sculptor gives its various chemical treatments." By C.S.N. Patnaik.

The patination of metals extend back over many years and are found in all the great metal sculpture. From the Indus valley dancing girl, Chula bronzes to date, we use different metal or their alloys to make sculptures and those sculptures also needs to preserve from further natural oxidation or corrosion, where patina plays a vital role in preservation as well as an esthetical sense.

It is nearly hard to study patination technique with scientific precision. The person applying these chemicals to the surface of the bronze, brass, or copper will always determine the outcome, even with meticulous attention to solution proportions and receipts. The ideal approach is to work with a subject matter expert to learn the topic and do your own tests under his supervision until you get satisfactory results.

This research tried to meet the needs of sculptors and fine metalworkers by presenting recipes and practical techniques that relate to materials that are currently available.

Recipes have been collected from as wide a range of sources as possible and each has been tested with a selection of cast and sheet materials. Repeat tests have been carried out, both on test samples and larger-scale objects and as far as possible, procedures have been refined, and new techniques developed. The results of this research are presented in this book. Except for a few potentially very hazardous recipes that were not tested, the results have been included, from the excellent to the mediocre, so that as rich a source of information as possible is made available to the metalworker. Patination on metal is not an exact science but depends on the individual's skill and judgment. Some of the recipes that have proved intractable to the authors will no doubt be taken up and used to excellent effect by others.

In addition to presenting recipes and techniques, we have tried to include relevant information relating to safety; a subject that is almost totally neglected in the older literature. Modern terminology is adopted to avoid the confusion caused by archaic chemical names and systems of weights and measures.

The principal application for metal sculpture patination is, as it has traditionally been, in decorative fine metalwork and sculpture.

5.2 Metal Patination Techniques

The practice of giving a metal surface a false patina; typically used on non-ferrous metal sculpture. Different chemicals and formulas can be used; the techniques of application used to patinate the different metals are same. But there are different ways of applying the patina recipes on metal, which is chosen as per the artwork and artist requirement. First difference in application technique is depends upon metal temperature, that can be differentiated as cold patina and hot patina. The application method of chemicals in patina formulations on sculptural surfaces then undergoes further changes. The oldest way of patination in which sculpture is buried for a long time in the ground or a sand pit to patina it, which is the oldest and easiest process. The alloy and acid or lime content of the soil or sand will determine how quickly the surface oxidises. Animal dung and urine may both be added to soil to change its composition. In some of the old sculpture foundries, there existed a patina pit like that and who eager to mimic the appearance of antiques or natural patina. The invention of artificial patinas utilizing heat and a range of chemicals was made possible since such time-consuming techniques using pits or prolonged immersion in the sea are not particularly feasible. Basically, there are three methods: applying chemicals to a heated surface, applying chemicals to a cold metal and heating it, and putting the bronze in a chemically charged environment. Using a brush, the chemicals may be applied. When using acids to create green patinas, one without a metal ferrule is crucial and ought to be utilized for all brush applications. The chemicals will become contaminated by the metal ferrule, changing their effects. A secure substitute is a dabber made of absorbent material attached to a wooden or plastic rod. Another option is to use a spray; a hand-pumped pressure spray works well for small objects, as does a venturi mouth spray, but avoid breathing through it.

The metal should be hot enough for the liquid to sizzle when the chemicals are applied to the heated surface. Apply the chemical using a stippling motion for an even surface. To avoid over-oxidizing the surface, which will lead to a thick buildup on the surface that is likely to scale off and become patchy, periodically rinse the surface with clean water.

According to an old proverb, "a rich patina hides a lousy casting." The impact of texture and colour, of course, depends on personal preference and taste. Chemicals can also be splattered to create streaks and blotches, dribbled on and let to flow, or coarsely painted over the surface.

The chemicals must be used more sparingly and gently heated to speed up the oxidation of the bronze when applied to a cold surface since they are harder to regulate. When using this method, take careful not to overheat the metal and wait until it has cooled before adding more acid. The patina is more subdued with this process, which is the slowest, according to certain painters.

If you have the time, applying powerful chemicals to a cold surface and letting it oxidize slowly over a lengthy period of time will help you create delicate patinas. One sculptor sprays a fine mist onto his ready bronze once each day for several months using a spray. Although the results are truly stunning, he does work in an extremely hot and dry environment.

The most even colouring may be achieved using a technique that often only applies to tiny objects kept in a mist cabinet and poses no damage to the surface: placing the work in a chemically charged environment. Either hot or cold bronze is possible.

It's crucial to get the bronze ready for patination. The surface has to be spotless, grease-free, and devoid of any fire scale left behind after brazing or welding. This can be accomplished using ammonia or methylated spirit (denatured alcohol). Sandblasting, which is now often employed to remove ceramic shell investments, may be utilized to polish the surface of some artworks. The metal was cleaned inside and externally in an acid pickling bath prior to the use of sandblasting. After such a treatment, rinse the metal sculpture with fresh water to remove any remaining acid before applying the patina, making sure the inside has been well cared for.

5.2.1 Surface for Patination

Surface treatment and Patination are examples of processing that cannot be separated from an object's overall surface quality. Whether highly polished, abraded, or textured, the surface that will be coloured has to be thoroughly prepared. Generally speaking, colouring won't cover up surface flaws. The application of texture during preparation frequently improves the completed surface's quality. The contrast between coloured sections and bare metal areas serves as the foundation for creative treatments in many coloured finishes. Additionally, the colouring process may make surface characteristics visible that are hidden in a polished finish, such as the grain structure.

5.2.1.a Structure and surface

One inherent difference in colouring is the difference between the nature of rolled sheet materials and cast materials. We are used to obtaining sheet materials in inventory thicknesses, with good surface finishes, carefully controlled compositions, and a resulting high consistency in working properties. Manufacturers have carefully developed these modern sheet metal inventory characteristics to provide industry and crafts with materials that can produce controlled and predictable results. On the other hand, we are also used to the idea that with cast materials. However, the composition of the ingots used can be accurately specified. The quality of the result depends largely on the casting process used, the design of moulds, and the process's skill. However, when cast and sheet materials are ground and polished, they may appear to be closely similar. Although metals presented in this form appear homogeneous to the eye, they have a distinct grain structure, whose exact form depends on the material's processes. Modern production processes result in sheet materials with a very fine, even grain structure, of a scale that makes the grain invisible to the naked eye, even after the suitable treatment.

5.2.1.b Surface preparation and cleaning

The object should be thoroughly clean and degreased before colouring. It is essential to ensure that any dirt or grease that may have become trapped in holes, hollows, or angles during polishing operations is removed. Any residual grease will be released when the object is immersed and may contaminate surfaces and prevent colouring. Attention should be paid to porosities and inclusions in cast surfaces. The surface should be bristle-brushed with pumice before immersion. To provide a slight ‘tooth’ that assists the action of the chemical agents and helps to produce a more even and tenacious finish. In some cases where the surface effect depends on a high gloss finish, luster colours, for example. This should not be carried out. In most cases, the solutions used will tend to etch the surface to some degree, and there is no advantage in starting with a high polish. The extent to which solutions may be expected to alter the surface quality is indicated in individual recipes.

5.2.2 Patina application techniques

Many traditional finishes, particularly those associated with the production of a green patina on bronze sculpture, are produced by the direct application of solutions to the surface of an object. Colouring is seldom accomplished in one application but characteristically involves a cycle of sparing applications and periods of drying, for a matter of days or even weeks. Until the desired colour has developed.The technique is of particular relevance in the colouring of large sculptures, which it would be impractical to colour by immersion, but is equally helpful for colouring smaller articles. It is also very economical in the use of chemicals.

5.2.2.a Application by dabbing and wiping

A suitable method of applying the solution is to dab or wipe it onto the surface with a soft cloth. In many cases, it may be necessary to dab the surface vigorously with the moist cloth for the initial applications to help break down the surface tension and ensure that adequate wetting occurs. The surface should be left only very sparingly moist. one way of ensuring this is to apply the solution with one cloth and then to wipe over the wet surface with a second, nearly dry cloth until only the very slightest glaze of moisture is apparent. The object is then left to dry thoroughly. When completely dry, it is rubbed with a soft dry cloth, as described above, before the next application. This sequence of sparing applications and periods of thorough drying is repeated until the patina has fully developed. Very gradual development is essential to a well-patinated and coherent surface. The temptation to hasten the process should be resisted. More liberal applications may appear to increase the development of an opaque layer more quickly. However, the results are often superficial, and the surface tends to break down when a different solution is applied. Forced drying by warming the object on a hotplate or with hot air has a similar effect, producing a superficial layer of dried chemicals which tends to have little adherence. In many cases, the finished surface consists of a green or blue-green patina on a ground colour which may be a shade of ocher, brown or black. Sometimes, when the solution is applied very sparingly by wiping, the ground colour alone tends to develop, and the green or blue-green colour is slow to form. When this occurs, the solution may be applied less sparingly when the ground colour is well developed. When the patina has developed fully, and treatment is complete, the object should be left to dry for several days and rubbed down carefully with a soft dry cloth before finishing with wax.

5.2.2.b Application by brushing

An alternative method of application, favored by French artist of the nineteenth century, is carried out by applying and thinning the solution with soft bristle-brushes. The solution is first brushed on so that the whole surface of the object is wetted. A dry brush is then used to thin out the solution on the surface with light, rapid strokes in all directions. When the brush becomes too moist to be effective, a different dry brush is used and is replaced as necessary until the whole surface is nearly dry. The object is then left to dry completely before the next application. The brushing application was often carried out while the object was gently warmed on a hotplate. This technique tends to produce a surface with a powdery appearance, and although it can produce results more quickly than by wiping and requires considerable practice to make it perfect.

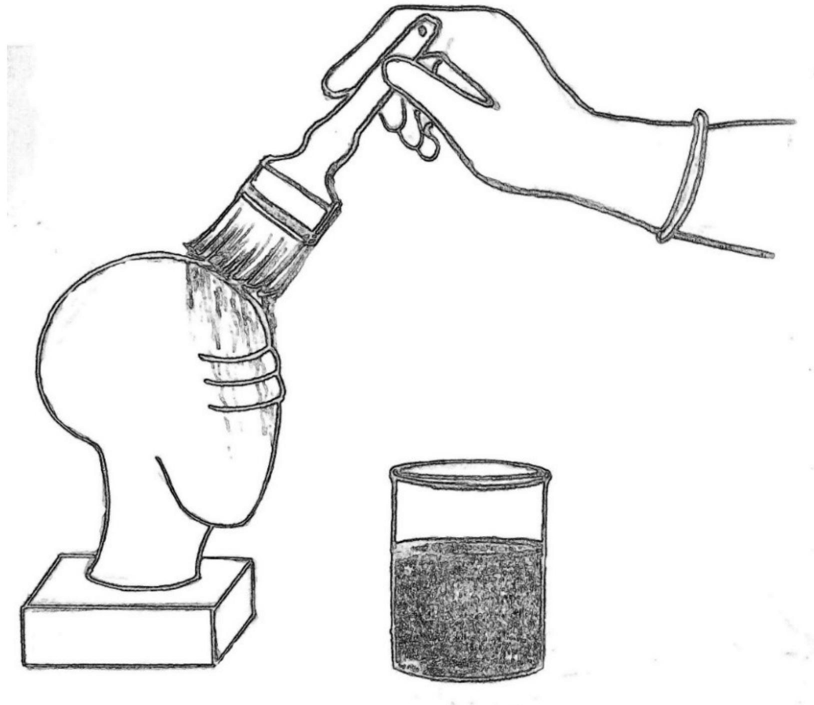

Figure 5.1 Application of patina recipe on sculpture with a brush

5.2.2.c Application by spraying

A more recent application method consists of spraying the object's surface with a fine mist of solution and allowing it to dry before a further application. This process is repeated until the patina has developed. No specialized spraying equipment is required, as a fine mist can be obtained with readily available hand-held pistol grip sprays as used by gardeners for insecticides. These are made of plastic that is resistant to the range of suitable chemicals for use in spray treatments. The fine-bore tubing and filter used in these hand sprays should be thoroughly cleaned after use. The success of the technique depends mainly on the care with which it is carried out. If the spray is applied unevenly or too liberally, then the solution tends either to pool or stream, depending on the orientation of the surface.

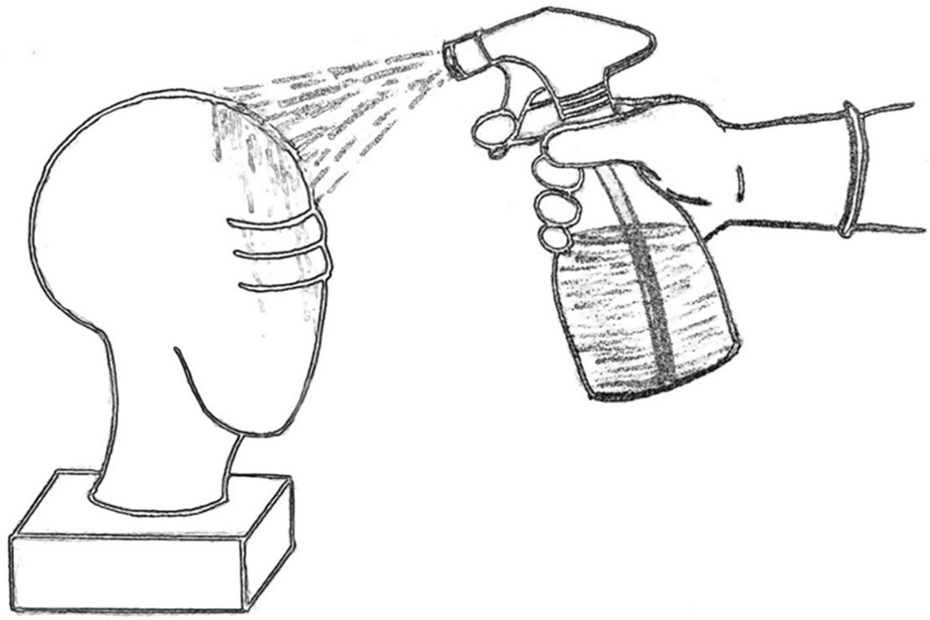

Figure 5.2 Application of patina recipe on sculpture with a spray

The mentioned process gives an uneven streaks and patches in the final patina. Ideally, the surface should become coated with a mist of fine droplets. Some specialized chemical compounds are available which can help to achieve this. These chemicals have been used commercially in the artificial patination of copper roofs, and results are reported to be good. The chief disadvantage of spraying as a technique, apart from the difficulty of obtaining an even fine coating, is that it presents a significantly more significant health hazard. Fine airborne mists of chemicals are easily inhaled and absorbed, and for this reason, the more toxic or corrosive chemicals should never be applied by spraying. It is also the case that chemicals which can be applied relatively safely by other methods may be harmful if inhaled in the form of a spray. Therefore, it is essential to use this technique to ensure adequate localized extraction to draw away the airborne mists and wear a nose and mouth face mask fitted with the correct filter.

5.2.2.d Application by dipping

Smaller articles may conveniently be coated with a solution by a short immersion. The article is then removed, and the surface is either wiped or brushed. As described above, until very sparingly moist and allowed to dry.

5.2.2.e Timings of patination process

Precise timings for patina development and drying cannot be given. The actual time taken for a patina to develop will depend mainly on the scale of the object being coloured and the general atmospheric conditions prevailing, particularly the humidity level in the air. A humidor damp atmosphere can assist in developing a green or blue-green patina and increase the required drying times. The timings recorded in individual recipes are for small-scale test surfaces and indicate the length of time taken for patina development in the tests that were carried out. With larger objects and variant levels of humidity, colour development can take several times as long.

5.2.3 Finishing

It is essential to allow ample time for the surface to dry out thoroughly after treatment, before wax finishing. Any moisture trapped beneath the wax will give rise to imperfections that are difficult to remedy. Some green or blue-green patinas, particularly those produced with solutions containing higher concentrations of chlorides, tend to 'sweat' moisture intermittently for some time. Although very sparing applications of the solution will minimize this, drying time should always be generous, when patina development is complete. Moreover, the surface is thoroughly dry, the object is finally rubbed down with a dry cloth, and then wax is finished in the usual way.

5.3 Patination recipes and their test plates

The recipes are grouped into six main sections, dealing with Bronze, cast gun-metal, cast yellow brass, copper-plate, and cast aluminium. Within each section, the recipes employing the more usual metal patination techniques are grouped according to the colour and surface finish obtained. These are followed by recipes involving techniques developed during the research that produce very variegated colours and textures and are grouped according to the technique used.

Each recipe gives a list of ingredients, outlines the procedure to be used, and provides information about stages in the process of patination. Detailed information about the techniques employed and the equipment required is given in the chapter on metal patination techniques. The reader should refer when selecting a recipe and planning the patina of a particular piece. The reader is also strongly advised to consult the chapter on safety at this time. Although specific hazards are indicated in the notes accompanying each recipe, the more general safety considerations are as important and must not be ignored.

The difficulties that may be encountered during patina are given in the notes accompanying individual recipes. Recipes are described as ‘not recommended’ if they proved to be particularly intractable in tests and are likely to be problematic in sculpture patina. Those recipes, on the other hand, which readily produced consistently good results, are marked with an asterisk.

There are various factors in each patina technique that will affect the timings quoted in recipes. One of the more obvious is the question of scale. A surface is worked with a scratch-brush or a flashlight. The time taken will depend on the object's size. Turnings, where quoted, relate to the patina on small surfaces. In the case of immersion patina, the timings given are for small objects where one or two litres of solution are involved. It should be noted that as the size of the object is increased and larger quantities of solutions are used, timings tend to become progressively extended; an object is requiring ten or fifteen litres of solution, taking up to two or three times as long to desired patina.

Each procedure has variable factors of this kind, which are discussed in the section relating to it in the chapter on metal patination techniques. Generally speaking, colour development should be monitored visually, and the timings quoted are used as a guide to the general pattern of patina development.

5.3.1 Recipe selection

Selecting a recipe for an application involves rather more than simply choosing a patina colour. In addition to the design problems associated with specific objects, two important general considerations should be borne in mind when planning pieces that involve patination. Firstly, it should be noted that chemically induced finishes are generally unsuitable for use on articles for foodstuffs, and we cannot recommend that the finishes are given in this book be used on surfaces that will come into direct contact with food or drink. Secondly, handling and wear are factors that should be considered. Finishes can vary from deeply etched surfaces to light blooms of Patina, and the choice of a recipe will depend on the application. Some finishes may not be suitable for practical use in a case or may need to be used in conjunction with textured rather than plain surfaces, for example, where constant handling is expected. It is advisable to carry out a small-scale test before embarking on the colouring of a piece, where investment in a considerable quantity of chemicals may be involved. This will help to ensure that the surface quality and toughness produced are appropriate to the proposed application. The principal applications for patination as traditionally have been in decorative fine metalwork and sculpture. First, we start with gun-metal plates and their recipes.

5.3.2 Cast Gun-metal plates and their patina recipe

The particular gunmetal to which the recipes and result refer is (85% copper 5% zinc,5% tin,5% lead) commonly used as an industrial purpose casting.

Gun-meal with a significantly different composition will, in some cases, yield variant Patina.

The primary colour heading for each recipe refers to the results obtained on polished surfaces unless otherwise stated. References are made to the colour and surface obtained and to grain enhancement where this has occurred. Here, wax polish works better to protect the metal and patina color, especially for indoor or gallery sculptures.

5.3.2.a Gun-metal- Sea blue

Figure 5.3 Sea blue patina result on gun metal plate

Table 5.1 Sea blue patina recipe for gun metal

Copper nitrate	100 ml
Ammonium chloride	25 g
Sodium chloride	25 g
Time	24 hours (approximately)

- **Three applications, separated by intervals of two hours**
- copper nitrate can be made easily by the following process: -

Put some pieces of copper (100 g) in a jar or bottle and fill it with 3/4 water and 1/4 with nitric acid. Cover it tight and leave it for a week or more. Then it is ready to use. Use distilled water (battery water).

5.3.2.c Gun-metal 3. Apple green

Figure 5.4 Apple green patina result gun metal plate

Table 5.2 Apple green patina recipe for gun metal

Ammonium chloride	25 g
Sodium chloride	50 g
Water	250 ml
Time	8-10 hours

- **Two applications, separated by intervals of two hours**
- **Sodium chloride is also known as common salt.**

5.3.2.d Gun-metal 4. Sea green

Figure 5.5 Sea green patina result on gun metal plate

Table 5.3 Sea green patina recipe for gun metal

Hydrogen peroxide sol.	50 ml
Ammonia sol.	50ml
Cooper sulfate	25 g
Sodium chloride	25 g
Water	250 ml
Time	6-8 hours

- **Two applications, separated by intervals of two hours**

5.3.2.e Gun-metal 5. Reddish brown

Figure 5.6 Reddish brown patina result on gun metal plate

Table 5.4 Reddish brown patina recipe for gun metal

Potassium ferricynaide	25 gm
Iron red oxide	25 gm
Water	250 ml
Time	5-6 hours

- **Two applications, separated by intervals of two hours**

5.3.2.f Gun-metal 6. Golden yellow

Figure 5.7 Golden yellow patina result on gun metal plate

Table 5.5 Golden yellow patina recipe for gun metal

Potassium chromate	50 g
Water	250ml
Time	3-4 hours

- **Two applications, separated by intervals of two hours**

5.3.2.g Gun-metal 7. Dark brown

Figure 5.8 Dark brown patina result on gun metal plate

Table 5.6 Dark brown patina recipe for gun metal

Ferric nitrate	50 g
Potassium sulfide	35g
Barium sulfide	100 g
Ammonia sol.	50 ml
Water	250 ml
Time	2 hours

- **Single application**
- **Potassium sulphide is poisons, so keep Proper precautions with chemicals.**

5.3.2.h Gun-metal 8. Black

Figure 5.9 Black patina result on gun metal plate

Table 5.7 Black patina recipe for gun metal

Barium sulfide	50 g
Potassium sulfide	50 g
Water	500 ml
Time	1 hour (Approximately)

- **Single application**
- **Potassium sulphide is poisons, so keep Proper precautions with chemicals.**

5.3.2.i Gun-metal 9. Black with green spots

Figure 5.10 Black with green spots patina result on gun metal plate

Table 5.8 Black with green spots patina recipe for gun metal

Copper nitrate	50 ml
Hydrogen peroxide sol.	50 ml
Vinegar	50 ml
Sodium chloride	50 g
Water	250 ml
Time	3-4hour

- **Two applications, separated by intervals of two hours**
- **Vinegar which commonly used for cooking porous.**

5.3.3 Cast brass plates and their patina recipe

The particular brass to which the recipes and result refer is (55% copper, 45% zinc) commonly used as general-purpose castings. Brass with a significantly different composition will, in some cases, yield variant Patina.

5.3.3.a Brass 1. Black with pink spots

Figure 5.11Black with pink spots patina result on brass plate

Table 5.9 Black with pink spots patina recipe for brass

Copper nitrate	50 ml
Hydrogen peroxide sol.	50 ml
Vinegar	50 ml
Sodium chloride	50 g
Water	250 ml
Time	5-6 hours

- **Single application**

5.3.3.b Brass 2. Dark brown

Figure 5.12 Dark brown patina result on brass plate

Table 5.10 Dark brown patina recipe for brass

Ferric nitrate	50 g
Potassium sulfide	35g
Barium sulfide	100 g
Ammonia sol.	50 ml
Water	250 ml
Time	1-2 hours

- **Single application**
- **Potassium sulphide is poisons, so keep Proper precautions with chemicals.**

5.3.3.d Brass 4. Sky blue

Figure 5.13 Sky blue patina result on brass plate

Table 5.11Sky blue patina recipe for brass

Hydrogen peroxide sol.	50 ml
Ammonia sol.	50ml
Cooper sulfate	25 g
Sodium chloride	25 g
Water	250 ml
Time	6-8 hours

- **Two applications, separated by intervals of two hours**

5.3.3.e Brass 5. Yellow ocher

Figure 5.14 Yellow ocher patina result on brass plate

Table 5.12 Yellow ocher patina recipe for brass

Ferrous sulfate	25g
Copper nitrate	50ml
Ammonia sol.	50ml
Water	250ml
Time	5-6 hours

- **Two applications, separated by intervals of two hours**

5.3.3.f Brass 6. Antique green

Figure 5.15 Antique green patina result in brass plate

Table 5.13Antique green patina recipe for brass

Cooper sulfate	25 g
Ammonium chloride	25 g
Water	250 ml
Time	24 hours approximately

- **Two applications, separated by intervals of two hours**

5.3.3.g Brass 7. Light green

Figure 5.16 Light green patina result on brass plate

Table 5.14 Light green patina recipe for brass

Ammonium chloride	25 g
Sodium chloride	50 g
Water	250 ml
Time	6-8 hours

- **Two applications, separated by intervals of two hours**
- **Sodium chloride is also known as common salt.**

5.3.4 Copper plates and their patina recipe

Copper is a ductile metal with very high thermal and electrical conductivity. Pure copper is soft and malleable; a freshly exposed surface has a reddish-orange colour. Gun-metal, bronze, and brass all are alloys in which copper is the primary metal.

The most significant example of the natural patinated surface is the Statue of Liberty which is made up of copper. The green colour on the surface of the statue is a patina, formed due to the exposure to seawater, which contains sodium chloride, which results in a green colour patina.

5.3.4.a Copper 1. Antique green

Figure 5.17 Antique green patina results on copper plate.

Table 5.15 Antique patina recipe for copper

Cooper sulfate	25 g
Ammonium chloride	25 g
Water	250 ml
Time	24 hours approximately

- **Two applications, separated by intervals of two hours**

5.3.4.b Copper 2. Black

Figure 5.18 Black patina result on copper plate

Table 5.16 Black patina recipe for copper

Barium sulfide	50 g
Potassium sulfide	50 g
Water	500 ml
Time	4-5 hours

- **Two applications, separated by intervals of two hours**
- **Potassium sulphide is poisons, so keep Proper precautions with chemicals.**

5.3.4.c Copper 3. Sea blue

Figure 5.19 Sea blue patina result on copper plate

Table 5.17 Sea blue patina recipe for copper

Hydrogen peroxide sol.	50 ml
Ammonia sol.	50ml
Cooper sulfate	25 g
Sodium chloride	25 g
Water	250 ml
Time	8-10 hours

- **Single application**

5.3.4.d Copper 4. Reddish-brown

Figure 5.20 Reddish brown patina result on copper plate

Table 5.18 Reddish brown patina recipe for copper

Potassium ferricyanide	25 g
Iron red oxide	25 g
Water	250g
Time	6-8 hours

- **Single application**
- **Use distilled water**

5.3.5 Bronze plates and their patina recipe

Different metals have been utilized throughout history to create sculptural items, and it is clear that some metals are favored for both aesthetically pleasing and functional purposes. Due to its robustness, natural colour, and variety of patinations, bronze is perhaps the most popular alloy.

5.3.5.a Bronze 1.plate and their patina recipe

Figure 5.21 Black patina result on bronze plate

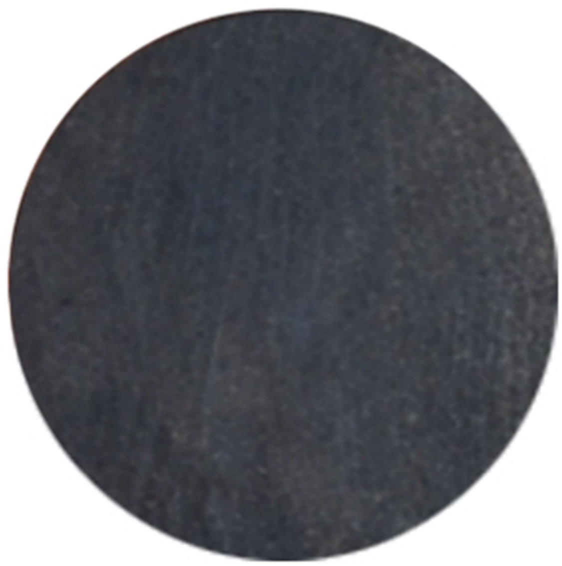

Table 5.19 Black patina recipe for bronze

Ammonium sulphide	25g
Water	250 ml
Time	3-4 hours

- **Single application**
- **Use distilled water**

5.3.5.a Bronze 2. Basic brown

Figure 5.22 Basic brown patina result on bronze plate

Table 5.20 Basic brown patina recipe for bronze

Ferric nitrate	25 g
Water	250 ml
Time	3-4 hours

- **Single application**
- **Use vapour mask, as ferric nitrate release fumes.**

5.3.5.c Bronze 3. Algae green

Figure 5.23 Algae green patina result on bronze plate

Table 5.21 Algae green patina recipe for bronze

Cooper sulfate	25 g
Ammonium chloride	25 g
Water	250 ml
Time	10-12 hours

- **Two applications, separated by intervals of two hours**

5.3.5.d Bronze 4. Apple green

Figure 5.24 Apple green patina result on bronze plate

Table 5.22 Apple green patina recipe for bronze

Ammonium chloride	100 g
Copper sulphate	10g
Vinegar	50 ml
Water	250 ml
Time	5-6 hours

- **Two applications, separated by intervals of two hours**
- **Vinegar which commonly used for cooking porous.**

5.3.5.e Bronze 5. Blue Patina

Figure 5.25 Blue green patina result on bronze plate

Table 5.23 Blue patina recipe for bronze

Ammonia sol.	50ml
Cooper sulfate	25 g
Sodium chloride	25 g
Water	250 ml

- **Two applications, separated by intervals of two hours**

5.3.6 Cast Aluminium plate and its patina

Aluminium is a relatively soft, durable, lightweight, ductile, and malleable metal with an appearance ranging from silvery to dull grey, depending on the surface roughness. Corrosion resistance can be excellent due to a thin surface layer of aluminium oxide that forms when the metal is exposed to air, effectively preventing further oxidation. However, patina can be done on the surface of the aluminium.

5.3.6.a Aluminium 1. White and black spots

Figure 5.26 White and black spots patina result on aluminium plate

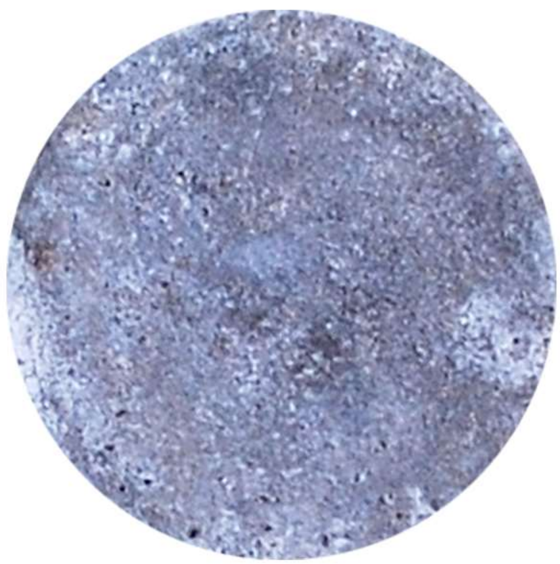

Table 5.24 White and black spot patina recipe for aluminium

Sodium hydroxide(caustic soda pellets)	100 g
Calcium chloride	30 g
Water	250 ml
Time	24 hours

- **Two applications, separated by intervals of two hours**
- **Since this patina affects the surface of metal, artificial patina (paints) are preferred. For instance, black Japan gives off a beautiful black antique effect while also maintaining the aluminium's surface.**

5.4 Safety precaution in Patination

Two security considerations must be considered. To begin with, chemicals' inherent properties and interactions can cause hazards because chemicals or their derivatives are toxic, corrosive, or dangerous in various ways. The following text contains information about how to incorporate a chemical into a specific recipe. The list of contaminants and risks contains the more general properties and associations of potentially dangerous chemicals. The other type of defense is more general but equally important, and it entails the preparation and use of chemicals in the laboratory in the context of various patination techniques.

In an area where chemicals are weighed, prepared, or used, food and drink should never be prepared or consumed. There is a clear danger of accidental contamination. Such limitation also extends to cigarettes, where the possibility of pollution may be compounded by the cigarette inhalation of the product, for example. In addition, some of the chemicals used, notably degreasing solutions and oxidizing agents, present a fire hazard in the presence of naked names. A strict no-smoking rule should be applied.

5.4.1 Chemicals and their hazards

Nitric acid: This is a powerful corrosive acid which causes severe bums to the eyes and skin. If swallowed, it would cause severe internal injury. It is also a powerful oxidising agent and may cause tires if mixed with combustible materials. The vapour irritates all parts of the respiratory system and must not be inhaled. The vapour also severely irritates the eyes and skin. Violent reactions can occur with a wide range of chemicals; acetic acid, ethanol, chromium trioxide, flammable liquids and gases. If robust nitric acid solutions are added to copper or brass, then brown fumes of nitrogen dioxide are evolved, which are toxic and must not be inhaled.

Citric acid: Contact with the eyes and skin should be avoided. It May be harmful if taken internally

Copper sulphate: Harmful if taken internally. Contact with the eyes and skin should be avoided.

Ammonia: Ammonia solutions are corrosive and can cause severe burns. The vapour is very irritating to the eyes and all parts of the respiratory system. The solution burns the eyes severely, burns the skin, and will cause severe internal damage if swallowed.

Ammonium chloride: Harmful if taken internally

Barium sulphide: This is harmful by inhalation or if swallowed. If it comes into contact with the skin, it should be washed off with plenty of water. The addition of acids will liberate toxic hydrogen sulphide gas.

Copper sulphate: Harmful if taken internally. Contact with the eyes and skin should be avoided.

Copper nitrate: Harmful if taken internally. Contact with the eyes and skin should be avoided

Ferric nitrate: Ferric nitrate is harmful if swallowed. Contact with the eyes and skin should be avoided.

Hydrochloric acid: It is a corrosive acid that can severely burn the eyes and skin. If swallowed, it would cause severe internal damage. The vapour irritates all parts of the respiratory system and must not be inhaled. The vapour severely irritates the eyes.

5.4.2 General precautions

A clean and organized working method is the most general safeguard in metal Patination. The design of the laboratory should be carefully planned to provide enough space for the different activities involved. The different parts of the system should be segregated as far as possible, and, in particular, a separate area for processing and preparing chemicals should be given. Adequate ventilation must be provided, preferably in the form of localized extraction, which serves the area where colouring is carried out and where concentrated liquids are diluted. Personal safety equipment should be available for use, including nose and mouth face masks with appropriate filters, face shields and goggles, gloves, plastic or eraser aprons, and protective footwear. A standard first-aid kit should be available, containing supplies of sterile dressings for burns. A clean and organized working method is the most general safeguard in metal colouring. The design of the laboratory should be carefully planned to provide sufficient space for the different activities involved. The different parts of the system should be segregated as far as possible, and a separate area for processing and preparing chemicals should be given. Any proposed additions or alterations should be considered in consultation with a qualified drugstore.

The cleaning cycle will, in most cases, include the use of an organic polishing compound remover or degreasing agent. This is necessary when using these chemicals to ensure that adequate ventilation is provided, preferably in the form of localized extraction, to the risk of a build-up in the concentration of the vapours. Inhaling them in any quantity can have profound effects, initially giving rise to feelings of light-headedness, headaches, and nausea and leading to loss of consciousness in extreme cases. The high concentration of many of these vapours also constitutes a severe explosive hazard and fire risk. Therefore, it is essential to ensure that there are no naked flames in the vicinity and that the area is adequately ventilated. In any stick shift cleaning with these chemicals and cleaning agents in general, it is essential to wear gloves. The cumulative effect of the degreasing action of cleaners can lead to severe skin conditions. It was found that both household and industrial eraser and synthetic eraser gloves were attacked by cleaning agents, causing them to swell and disintegrate. Similar though less pronounced effects occurred with PVC gloves. High-grade PVC gloves were the least affected and are probably the most suitable for use with organic or inorganic degreasing agent or cleaners like for nitric acid.

5.4.3 Symptoms and first aids

The most frequent cause is likely to be skin contact with chemicals of some kind. Any contaminants that contaminate the skin should be washed away as soon as possible with plenty of water. This is especially relevant when dealing with corrosive and poisonous chemicals. If the eyes are contaminated, they must be irrigated with water right away, either with an eyewash bottle or a gentle stream of water. It is essential to make sure that any water used to clean a contaminant from one eye does not end up in the other. A reflex movement can occur in some cases, causing the eyelids to close tightly .They should be carefully separated and washed as soon as possible. Both eye conditions need immediate medical attention.

Skin reactions may occur more slowly as a result of prolonged or constant exposure to chemicals, in addition to the immediate effects of corrosive chemicals whose activity is likely to be apparent. Itching or swelling, reddening of the skin, rashes, or mild blistering are common symptoms." When this happens, exposure to the chemical should be stopped before the signs go away, and medical help should be found if the consequences are severe. If the symptoms return after returning to work, medical advice should be sought. While the hands are the most frequently affected, the symptoms of airborne dust vapours will also impact the ears, body, and arms. A chemical can sensitize the skin in rare cases, causing no immediate symptoms for weeks or even months. However, resulting exposure can cause severe inflammation and injury, and recovery can take a long time and be complicated. If exposure is renewed, the skin also becomes so sensitive that it responds aggressively in the presence of the drug, and the sufferer will not be able to reach the same space as the chemical without experiencing a recurrence that affects the whole skin surface." This is clearly a life-threatening situation, and all interaction with the chemical must be stopped at all costs. If this form of reaction is suspected, medical help should be found right away.

High amounts of prolonged or chronic contact are more likely to cause the symptoms of inhaling gases, vapours from hot solutions, and clouds of dust. Symptoms such as nasal distress, headaches, fatigue, light-headedness, and a propensity to feelings of lethargy or debility may all be signs of inhalation effects. The most important way to deal with this threat is to make sure there is enough ventilation and to get medical help as soon as signs appear.

If a sterile operating procedure is used, the chance of ingesting contaminants by mouth should be minimal. The mouth-aspirated pipette, which can never be used, poses the greatest danger. If chemicals are ingested, the procedure would be determined by the type of chemical used. Corrosive surfaces cause mouth burns, and can be managed and frequent mouthwashes with water. Mouthwash can never be eaten. In the case of toxic agents, a similar procedure should be offered first, followed by consuming large amounts of water or milk to dilute the solvent until the mouth has been cleaned. It's often recommended that vomiting be forced, but this isn't always the case.

As previously said, chemical burns from corrosive materials can be handled by cleaning with copious quantities of water. Dry wounds from fires and heat sources should be treated with sterile dressings that are applied loosely. It's important not to burst blisters if they appear. Handling should be kept to a minimum to reduce the risk of bacteria, and the temptation to disinfect the surface should be avoided. A doctor should treat both burns and scalds that are more serious than minor. It's essential to keep detailed records of the chemicals used in an injury and the medications that were used and make sure that this knowledge is brought with a patient to the hospital.

5.5 Patination on Sculptures

The patination recipes can be applied on sculpture as solo or through multiple patina technique to achieve more than one color on sculpture surface. It depends on the artist and the art work requirement, in which a base patina is done first and then the layer of different patina is applied as desired by the artist. This patination process can be compared with the face makeup, as after giving the foundation base layer, highlights and shadows are created to show the contours, both works for the beautification of the subject. Patina as a surface treatment gives aesthetic values to the art works, by enhancing the texture and contours that appeals to the viewer. Few examples of finished patination treatment on the metal sculptures are shown in image gallery.

CHAPTER SIX

CONCLUSION

India is renowned globally for its investment casting expertise; particularly in the form of the 'South Indian bronze' and 'Dhokra' art castings, which are still produced by numerous craftsmen nationwide. This presents a convincing argument for the foundry industry to focus more on this method. A possible solution could be a combination of traditional investment casting techniques with modern, cost-effective, and eco-friendly technology tailored to the country's industrial requirements. The Dhokra tradition is complex and informal, practiced by more-or-less independent groups, unlike the South Indian lost-wax tradition, which is codified. The finer points of the method, as well as motifs and themes, are discussed.

Orissa is a State in India. Silver filigree work has influenced Dhokra artifacts, known for their fineness. There is a vast range of variation within the broad uniformity of a technology caused by local availability, specifications, and sensitivities. Dhokra craft is better understood as a set of interconnected but distinct sub-traditions rather than a single entity.

The fact that the Dhokra artisans have lived in one place for centuries, their technology is also a throwback to their nomadic days. (For a list of recent technical advancements, see below.) Metal casting was already performed with each family setting up its makeshift, fuel-inefficient open furnace before our presence three years ago. The craft remained active even though science has been fossilized. In reality, four stages of development can be distinguished.

The initial Dhokra repertoire was plain and stark, in line with the makers' lifestyle and ideology. The Jadu Patuas in Jabardah makes them for themselves and their Santhal clients. Artisans make them for themselves and souvenir customers elsewhere.

After that, the Dhokra artisans calmed down and began to satisfy the demands of their customers. As a result, their work in Bengal now included very ornate Hindu gods and goddesses icons.

In contrast to their customers, who worship their god, Dhokra artisans in Bikna worship their creations (horses, elephants, etc.) and Bhairon, a kind of Shiva and a nonvegetarian deity. Santhal's fowls and peacocks wear small anklets made by Jadu Patras in Jabardah. For cockfighting, small knives may be added to these anklets.

Then it is described by two significant changes following India's independence in 1947: state and social elite patronage and contact with artistic sculptors such as Meera Mukherjee. She effectively absorbed Dhokra art methods and motifs into her practice and, once recognized as an insider, added new ways to the Dhokra artisans. During this period, the stylized Bankura horse, which had previously been a preserve of the Kumbhkars (clay craftsmen), was successfully adopted for metal casting. The Dhokra artisans have been forced to adapt to the demands of the cheap souvenir market, which is a relatively new phenomenon. Such "novelty" objects as a Ganesh with an umbrella define this period.

Even if much of the work is absolute kitsch, it is a source of revenue, although a meager one. Purchases by federal departments have decreased over time. This period has had such an influence on the craftsmen that they now identify their works using the terminology used by the merchants ("tribal doll," "mother goddess"). Traders sometimes pay exploitatively low prices as they visit the craftsman's village to make purchases. In these circumstances, the artisans implicitly attempt to increase their salaries by lowering craftsmanship and sacrificing the efficiency of the inputs. As a result, they will use lower-quality metal scrap and coal tar instead of the wax mix known as dhyana. Such is the sad state that these artisans who gladly accept low rates for daily orders. Regrettably, this is not the case.

A pucca furnace, using molten metal rather than waste, brazing rather than tin soldering, modifying the alloy composition, and the principle of measurement are all examples of technological advancements. The new furnace produces no flame, saves fuel and aluminium, and allows for huge pieces. It has also changed the casting process from a family affair to one that involves the whole city. Surprisingly, innovative standards have grown to meet the available technologies. The artisans have not only increased the size and quality of the pieces, but they have also introduced new types and motifs on their own.

It is crucial that India continues to employ numerous new processes to create bronze images while maintaining the old traditions. We may examine the variations in how these techniques evolved, starting with the Indus Valley Civilization and continuing through the Pallava and Chola periods thanks to the continuation of conventional practises. From the 10th and 13th centuries onward, when craftsmen began to move here under royal sponsorship from the 9th century onward, cities like Bastar and Kunhimangalam are now key centres for the manufacturing of such pictures. Ancient sculptors' methods and techniques are still used today by their successors. They follow the style and convention set out in the old texts while also adding their own ingenuity and imagination. They have kept traditions and made a significant effort to generate images of remarkable creative worth and competence. What is crucial in the context of archaeology is that research on conventional bronze casting techniques helps in deciphering these processes from artefacts and other features found in the archaeological record. It is crucial to recognize certain manufacturing tool types as well as variances in the types of furnaces used and waste produced, etc.

Dhokra art is an example of Indian tribal art. This is a trendy style all across the world. This style was initially known as "tribal" but developed with time. Initially, it was limited to the Bastar region, but after some time, this region began progressing because of this art and globalization. Globalization had an impact on art and the society of Bastar. So this art is a significant part of the Bastar economy. Its exports expanded within the country and internationally, allowing these families to prosper financially. As a result, globalization has benefited this art form and its economy. It plays a significant role in rural industries and the survival of rural people. Therefore, the art market is developing globally. Today, this art is an essential source of employment in the Bastar region.

Although there has been some technical advancement, the procedure for making wax, casting, etc., is essentially the same. For instance, sculptors today utilize plaster instead of the soft moulding material of old, which was rivers bed clay. Changes in raw materials or technological advancements can have both benefits and drawbacks. In the past, raw materials that were mostly locally accessible were utilized, but thanks to advancements in technology, raw materials that were imported are now being employed in the creation of photographs. The majority of South India still uses the ancient Lost-wax techniques for idol making, for example, even if certain contemporary techniques are employed in portions of the manufacturing processes. The main feature of this work is that it demonstrates the continued use of bronze technology within families and the involvement of the entire family in the project. This unique technique of making a bronze is rapidly disappearing in the current era of machine production, and in a few years, the ancient manufacturing process will be abolished. The main goal of this effort is to preserve the tradition of Lost-wax skills before it is lost, to raise social consciousness among the people and the next generation, and to make people aware of its history and relevance.

The existence of a mould is the greatest evidence that casting actives were present at the site. Ancient mould types include open, Lost-wax-based terracotta sand moulds. There is currently no credible evidence from Indus Valley Civilization sites for any metal casting mould. The sole stone "mould" that has been published is from the Lothal, Gujarat site, where S.R. Rao recognized two grooved stones as an open-casting mould (Pigott, 1999).

There is no direct archaeological evidence of a furnace, crucible, etc., for bronze casting from the Pallava and Chola periods in South India because the workshops are primarily found close to the towns and temples, and the bronze production work has been ongoing from ancient times to the present from generation to generation. In Tamil Nadu, locating an archaeological context for bronze casting takes much work.

In a small town near Payyannur in Kannur, a group of artisans are adept at moulding metal into divinity with expertise from generations. Kunhimangalam is one of the oldest places of the metal idol-casting village in Kerela. Sculptures in bell-metal, Odu, and "Panchaloham" of this place are well known. The artisans of this village are known in the world market for their brass metal crafts. In 2018, the state government declared the bell-metal sculpting of the Moosari community as a heritage art and their settlement in Kunhimangalam as a heritage village. However, only 11 people in Kunhimangalam now make bell-metal figurines, sculptures, and lamps. The 'Panchaloha' statues, traditional lamps, and other crafts are sent all over India and the world to various destinations. These highly gifted artisans create brilliant pieces of idols of deities, lamps, divine articles, and sculptures in metal. The old statue of Nataraja (Lord Siva in dancing posture) is India's most famous bronze craft. However, bronze (bell metal or weapon metal) is used in Kerala, popularly known as "Odu", to make small and large pots, lamps, etc. Huge wick lamps of various sizes and shapes, such as the Nilavilakku, Thookkuvilakku-hanging lamps, etc., are widely used in every house.

Kunhimangalam has a large community of Moosaris whose craftsmanship is unparalleled. An individual travelling through Kunhimangalam can experience this age-old practice of sculpture-making. These master craftsmen breathe life into hard metal and transform them into elegant figurines. Their work on metals is first-rate, and their speciality of casting in Panchloha, the rare combination of five metals, namely gold, silver, lead, copper, and iron, is known worldwide. They follow proper iconography while wax fashioning. Metal models were very carefully crafted in the early period, with all the details present in the wax model itself. These were etched on metal naturally, and after the casting, there was little finishing work. However, in later times, up to the present day, the image as the cast was usually a rough one. The final finishes were added elaborately, which involved so much chiselling work that the result was almost a carved-out image rather than a cast one. This whole process of making an average size idol, from wax modelling to casting and finishing, takes approximately twenty days or more, depending on the work, which gives a precious outcome.

The procedure for making wax, casting, etc., remains essentially the same, but there have been some technological advancement. For instance, sculptors today utilize plaster rather than the soft clay employed in ancient times for soft moulding. Changing the raw material or developing technology has several benefits and drawbacks. Most of the raw materials used in the past were readily available locally. However, thanks to technological advancements, raw materials from other countries are now employed to create pictures. Even if specific contemporary techniques are employed in manufacturing idols, the concept and production remain to adhere to the ancient practises, as is the case in most of south India. The main feature of this work is that it demonstrates the continued use of bronze technology within families and the involvement of the entire family in the project. Traditional manufacturing will cease in a few years due to the rapid decline of this craft of bronze-making in the current era of machine production. The objective of this effort is to preserve the tradition of Lost-wax skills before it is lost, to raise social consciousness among the people and the next generation, and to make people aware of its history and relevance.

If Kerela is considered God's Own Country, Kunhimangalam can be termed the land of "Godly Sculptures," such is their craftsmanship. If the new generation fails to realize and preserve this unique art of Kunhimangalam, this new village art will be culturally eroded.

In modern metal casting techniques, we observe many changes regarding metal casting process materials, but the basic principle of metal casting is the same. Here a master cast of plaster, cement, or resin (really, of a tough substance), a hollow wax original, or a wax with a predefined core are a few techniques to prepare and submit work for the foundry to recreate in copper alloys. Make sure the foundry will accept a wax prepared by someone other than there moulders before sending either of the latter out to be cast, and if there is a core inside the wax, be sure to let them know what the core is composed of. It is a must to provide the foundry man with as much information as possible about your original and the casting that must be manufactured. Treat him as an expert like you would a doctor; the more trust there is between you and the foundry worker, the better the outcome.

Any hard material original may be brought to the foundry, and a skilled founder and moulder can make a copy from any master cast. Be sure to negotiate any trimming of the original with the moulder before providing the master cast. The master should be carved as little, if at all, by good moulders. The need for cutting varies, depending on the foundry; one factor is the size of the most significant crucible that is readily available.

Making a mould with a volume is more significant than the largest crucible's capacity for molten metal is futile. Another justification for reducing is the invested mould's manageability. It can be exceptionally easily damaged while it is brittle after baking if it is too big and heavy to handle. If a master cast needs to be trimmed at all, it is best done at the sculptor's workshop when the master is made so that the artist can verify that suitable Roman joints were used. Good forepersons will visit the artist's studio to discuss this with them, and it is advised to seek their counsel, especially when a huge sculpture is involved. The master casts mentioned was primarily used for lost-wax casting, as is proper. However, they are appropriate for sand casting, the other widely used metal casting method that is more cost-effective than the lost-wax method. Roman joint-ed designs like those shown above can be used for sand and lost wax moulding. In order to illustrate the differences between the casting process and the end product, The researcher will explain bronze casting using both techniques. However, it must be understood that there may be a large number of additional sand and investment, riser and runner formulas. The idea is always the same, despite variations in equations and current practice.

The metal castings mentioned below are mostly for lost casting. It is customary for lost wax metal castings to be hollow for several reasons, including

(a) Economy (less metal will be used),

(b) Weight savings (as compared to solid castings),

(c) Structural strength (a hollow casting is more substantial than a solid casting),

(d) Potential cracking where forms are of different sizes. Although there is much overall shrinkage, it differs from metal to metal, and any resulting deformation may be unfavorable.

Even though it is possible to manufacture hollow castings when any criteria are significant, it is much simpler to solidify extremely tiny castings. The amount of metal saved in manufacturing a tiny hollow cast would be trivial, and the time spent making it hollow may be better spent employing an arc in the size and placement of runners to ensure that shrinkage and prevent fractures. The runners that enable the molten metal to pour into the cavity can be modified to equal out proportions and disperse shrinkage around the casting.

If the thickness turns out excessive, solid casting can be achieved by placing an armature composed of a related alloy at the thick form's core. This serves as a chill bar, causing the bulk of the molten material to cool at a similar rate to other components, lowering the risk of fracture brought on by uneven shrinkage.

The above research shows many differences between metal castings techniques practiced in different regions of India, i.e. Tribal metal casting from middle India, Traditional metal casting from South India and modern metal casting from North India. Let us compare the above mentioned metal casting techniques used for making non-ferrous sculptures.

Table 6.1 Comparison of Dhokra metal casting, south Indian metal casting and modern metal casting of sculptures

Dhokra metal casting	South Indian metal casting	Modern metal casting
In the Dhokra casting, a clay core is prepared over which the wax model is made. Or small statue are made direct in solid wax.	Preparation of solid wax model in case of tempel idols and hollow wax modelling for some other artifacs	Wax model is made by Direct wax modelling or wax cast taken out from the negative mould
Investment mould is made from the clay, husk and sand	Investment mould is made from clay and finely chopped jute threads and fine sand	Investment mould is made of plaster and lotto
Wax lost while dewaxing process	Some wax is saved and collectedwhile dewaxing process	Wax lost while dewaxing process
Coal is used in local furnace for melting the metal, mostly brass scrap.	Coal is used in local funace for melting the metal, mostly panch loha (alloy of five metals)	Coal, diesel, LPG etc different fules are used in different furnace as per the requirnment.
Moulds are not buried in sand/soil pit, while metal casting.	Moulds are buried in sand/soil pit, while metal casting.	Moulds are buried in sand/soil pit, while metal casting mostly, exception like in ceramic shell casting.
Brass and bell metal are	Panch loha is used for making God idols, also	Bronze, gun-metal and brass are used as per the

used mainly	brass and bell metal are used to make other artifacts.	requirement.
For final finish, metal wire brush is used to clean the surface of artifact and no patina is applied.	Golden glossy finish is preferred as final surface treatment.	Different types of surface treatments are used as per the requirement, Patination process is the most popular for indoor artworks and for outdoor paints are used generally.

This research makes an effort to bring together data from literature and from the enduring traditions of sculpture metal casting in various Indian locations. As a result, documentation of the art and science of bronze sculpting technology was carried out in many workshops across the world. Based on the anthropological study undertaken here, an attempt was made is also made to look for archaeological signatures suggestive of bronze casting. This research tries to analyze the technical distinctions between contemporary and historical bronze technology.

Patina is one of the key features of making process non-ferrous metal sculpture because it enhances aesthetic appeal and protects the metal's surface from additional oxidation reactions that might damage the sculpture's surface. The results of patina experiments on various non-ferrous materials are discussed in the chapter Patina. The researcher then uses all of the patina recipes recorded there again on various metal sculptures. The times specified in recipes will vary depending on a number of elements in each colouring process. The size issue is one of the most obvious ones. Using a flashlight or a scratch brush, a surface is worked. The length of time depends on the size of the item. Turnings refer to the colouring of tiny surfaces when they are cited. The time provided for immersion colouring pertain to tiny objects and one or two litres of solution. It should be noted that durations tend to go longer as an item gets bigger and more solution is used; an object that requires ten or fifteen liter of solution may take up to two or three times as long to colour.

Patina is similar to a woman's makeup in that both beautify or highlight the features of each and are equally significant from an aesthetic standpoint. However, in the context of sculpture, it alludes to a naturally aged surface that exhibits the depth of the elements and the effects of ageing, as seen on old sculptures dug up from the earth or the sea. Those that have been removed from the sea have developed a patina as a result of extended contact with saline water and other crustacean activities.

Burying the bronze object for a long time in the ground or a sand pit is the earliest and most basic patination technique. Depending on the alloy and the amount of acid or lime in the soil or sand, the surface will oxidise. One can change the soil's chemistry by incorporating urine or animal dung. Such a patina pit was a characteristic of some of the earlier art bronze foundries and was present on the premises of certain art forgers attempting to mimic the patination of natural objects or ancient artefacts. The time required to soil a sculpture for extended periods of time or submerge it in the water to develop more natural patinas, however, is typically not available to sculptors. The majority of patinations are achieved with chemicals.

According to an old proverb, "A deep patina conceals a lousy casting." The impact of texture and colour, of course, depends on personal preference and taste. In order to create runs and blotches, chemicals can either be splashed across the surface or vigorously painted over it. However, everything must be done safely by adopting safety measures like wearing gloves, a breathing mask, and eye protection, among others. All of these formulae work best when combined with warm to boiling water and will respond more quickly when used on hot surfaces. The metal casting might be covered with a plastic sheet to hasten the operation of any of these cold-applied formulas. These experiments, which combine various chemical compositions, as well as those involving the application of patina recipes have a great deal more potential for producing a wide range of novel outcomes. As industrial technology advances, casting techniques are improved, particularly for large-scale sculpture casting, and labour costs associated with producing art are reduced. As experienced from the past the field of sculpting techniques has a lot more room for research and development in present and in the future.

The age-old skill of the dhokra artists of the Bastar district in the Indian state of Chattisgarh is being practiced today. Their manufacturing efficiency is improved by the newly created technology, which should lead to increased profitability. Since the Indian government helps artist families sell their creations in many states, the market and profit margins for dhokra artifacts have improved. Additionally, the trade procedures of the artists are starting to exhibit a new level of professionalism. Relatively little financial investments have produced significant improvements when given appropriate leverage, which might ultimately ensure the artistic and economical existence of the dhokra communities. Long-term, nevertheless, the craftspeople must make important choices regarding their work.

They might decide to go the industrialization way, on the one hand. Alternatively, and as it seems, they would rather; they may grow into a consumer industry focused on high-end, highly valuable artifacts. This may be seen providing high-end craft-content artifacts to an expanding middle-class tourist and indigenous clientele. Finding a steady market niche for themselves and their goods is essential to the dhokra industry's growth and survival. Regardless of the outcome, supply channels must be formed and this market must be expanded.

It is simple to demonize middlemen, but if the craftsmen' economic circumstances improve and their terms of trade are strengthened, there is absolutely no reason why they cannot play a significant part in the growth of this market. Helping the dhokra artisans financially—not as a charity but rather as a fair fee for their creations—will guarantee that the standard of their work rises, innovation is fostered, and the custom is gladly handed down to the following generation for improvement and continuity. The fact that this wish seems to have come true in an incredibly short amount of time is a sign of the project's success. The craftsmen who make dhokra scultures are practitioners of a long-standing tradition that dates back thousands of years. These craftspeople are not 'primitive'; rather, they are 21st-century individuals who have been caught up in a cycle of poverty. They are not displayed in a theme park dedicated to culture. They have to be allowed to choose their own path in life. Simultaneously, they represent innumerable generations of wisdom, which is a component of humankind's and India's collective cultural legacy. It would be a tragedy if all of this information and the collected wisdom of millennia were lost, regardless of the path the craft takes in the future.

IMAGE GALLERY

Figure 7.1 Cold patination process on bronze sculpture

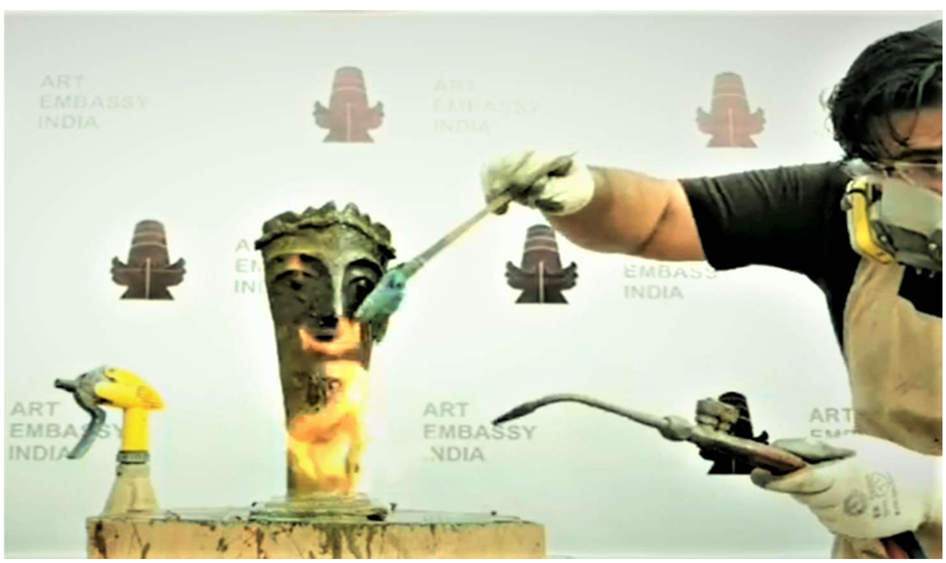

Figure 7.2 Hot patination process on bronze sculpture

Figure 7.3 Abhilasha-5, bronze sculpture by sculptor Pulkit Jawa

Figure 7.4 Abhilasha-2,bronze sculpture by sculptor Pulkit Jawa

Figure 7.5 Sapna ka Sapna, bronze sculpture by sculptor Pulkit Jawa

Figure 7.6 Srijan,bronze sculpture by sculptor Pulkit Jawa

Figure 7.7 Sneh-6,bronze sculpture by sculptor Pulkit Jawa

Figure 7. 8 Sneh-7, bronze sculpture by sculptor Pulkit Jawa

Figure 7. 9 Srijan-11, bronze sculpture by sculptor Pulkit Jawa

Figure 7. 10 Srijan-8,bronze sculpture by sculptor Pulkit Jawa

Figure 7. 11 Srijan-6. bronze sculpture by sculptor Pulkit Jawa

Figure 7. 12 Srijan-7, bronze sculpture by sculptor Pulkit Jawa

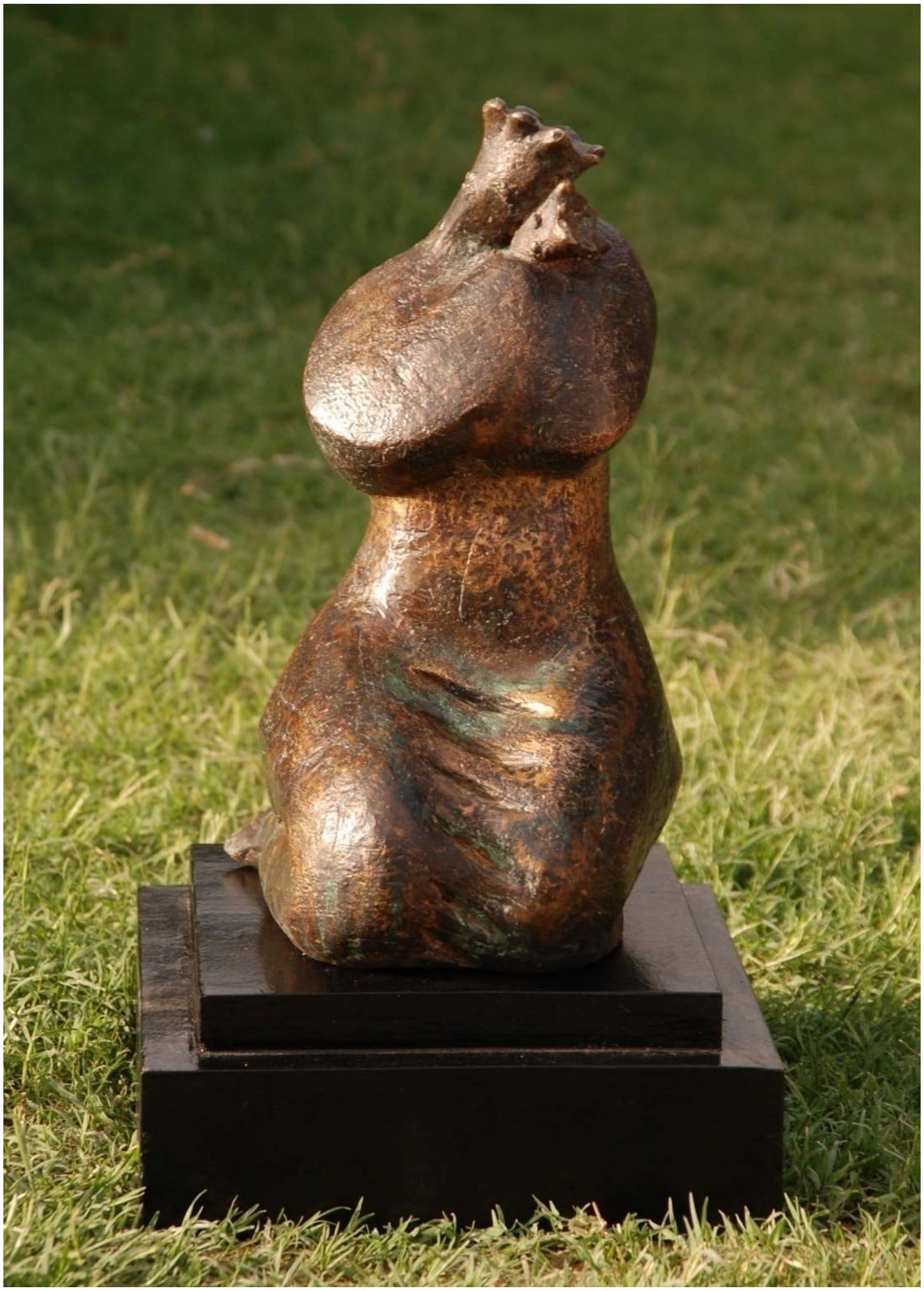

Figure 7. 13 Sneh-1, bronze sculpture by sculptor Pulkit Jawa

Figure 7. 14 Sneh-3, bronze sculpture by sculptor Pulkit Jawa

Figure 7. 15 Srijan-5, bronze sculpture by sculptor Pulkit Jawa

Figure 7. 16 Srijan-3, bronze sculpture by sculptor Pulkit Jawa

Figure 7. 17 Tamanna, bronze sculpture by sculptor Pulkit Jawa

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APPENDIX

Appendix: List of Interviews of Art practitioners

S.NO.	Name	Area of specialization	Reason of interview
1.	Sh. Banno Ram	Dhokra metal casting	Indian contemporary Tribal sculptors
2.	Sh. Baldev Bagmare	Dhokra metal casting	Indian contemporary Tribal sculptors
3.	Rajendran T.V. Trv	South Indian traditional idols metal casting	Indian contemporary Traditional sculptors
4.	V V Ramachandran	South Indian traditional idols metal casting	Indian contemporary Traditional sculptors
5.	Padam Shri Biman Bihari Das	Expert in modern lost wax sculpting	Indian Contemporary sculptors

6.	Padam Bhushan Ram V. Sutar	Expert in modern lost wax sculpting	Indian Contemporary sculptors
7.	Thomas Kavoor	Expert in modern lost wax sculpting	He is an eminent academician and sculptor.
8.	Prof. Dr Sanjeev Kumar	Expert in modern lost wax sculpting	He is an eminent academician and sculptor.

List of Publications

S no	TITLE OF PAPER WITH AUTHOR NAMES	NAME OF JOURNAL / CONFERENCE	PUBLISHED DATE	ISSN NO/ VOL NO, ISSUE NO	JOURNAL INDEXING
1	Patina Techniques An Experimental Approach Towards Irons Sculptures	Our Heritage	2nd July 2019	ISSN:0474-9030; Volume-67, Issue-2	UGC- Care listed
2	Brass Patina Techniques: An Experimental Approach	History Research Journal	6th November 2019	ISSN:0976-5425; Volume-5, Issue-6	UGC- Care listed
3	Kunhimangalam metal casting Process of religious idols	National Conference on "Innovation in Visual Arts (NCIVA'20)"	7th October 2020	ISBN:978-81-949292-6-0	University level

List of conferences

S.No	Name of Conference	Title of Paper Presented	Date
1	Paramhansa Yogananda Internation Conference on Resent Trends in interdisciplinary Rearch	Patina Techniques: An Experimental Approach Towards Iron Sculpture	09th& 10th September 2019
2	National Conference in Innovation In Visual Arts (NCIVA'20)	Kunhimangalam Metal casting of process religious idols	07th October 2020
3	International Conference on the theme of "Brushstroks of Innovation: Exploring Contemporary Trends In Fine Arts"	Investigating Difference And Similarity Between Contemporary Practices of South Indian Bronze And Chhattisgarh Dhokra Casting	04th May 2024


(Golden Jubilee Celebrations of Himachal Pradesh University)

Paramhansa Yogananda International Conference on

Recent Trends in Interdisciplinary Research

Jointly organised by
Dept. of Visual Arts, H.P. University, Shimla & Pratibha Spandan Society, Shimla

09th & 10th September, 2019

Certificate of Participation

This is to certify that PULKIT JAWA, DEPARTMENT OF FINE ARTS, LOVELY PROFESSIONAL UNIVERSITY, PHAGWARA, PUNJAB has presented a paper on PATINA TECHNIQUES: AN EXPERIMENTAL APPROACH TOWARDS IRON SCULPTURES in Paramhansa Yogananda International Conference on "*Recent Trends in Interdisciplinary Research*" organized by the Department of Visual Arts, Himachal Pradesh University, Shimla in association with Pratibha Spandan Society, Shimla on 09th-10th September, 2019 at Himachal Pradesh University, Summerhill, Shimla, Himachal Pradesh, INDIA.

Prof. Him Chatterjee
Chairman, Dept. of Visual Arts, HPU

Dr. Mritunjay Sharma, D.Lit.
Conference Convener

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Theme : "Education 4.0 : Perspectives on Visual Art Practice, Pedagogy and Representation"

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This is to certify that Mr. **Pulkit Jawa**, **School of Fine Arts, LPU, Punjab** has presented Research Paper titled **Kunhimangalam metal casting process of religious idols** in the Online **"NATIONAL CONFERENCE ON INNOVATION IN VISUAL ARTS" (NCIVA'20)** organised by **Amity School of fine Arts, AUUP,** on 07th October 2020.

Mr. Varun Sahai
Conference Convener
Amity School of Fine Arts

Prof. (Dr.) Pradeep Joshi
Conference Chair
Director General, Amity Directorate of Applied Arts / Fine Arts / Performing Arts / Visual Arts

Prof. (Dr.) Balvinder Shukla
Vice Chancellor
Amity University Uttar Pradesh

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NAAC GRADE A++

Certificate of Participation

This is to certify that **Prof./Dr./Mr./Ms. Pulkit Jawa** has Presentation paper on **INVESTIGATING DIFFERENCE AND SIMILARITY BETWEEN CONTEMPORARY PRACTICES OF SOUTH INDIAN BRONZE CASTING AND CHHATTISGARH DHOKRA CASTING** by online mode / Offline Mode in the International Conference on the Theme of **"Brushstrokes of Innovation: Exploring Contemporary Trends in Fine Arts"** held on **04th May 2024**, organized by School of Liberal and Creative Arts (Fine Arts), Lovely Professional University, Punjab.

Date of Issue : 07-06-2024
Place : Phagwara (Punjab), India

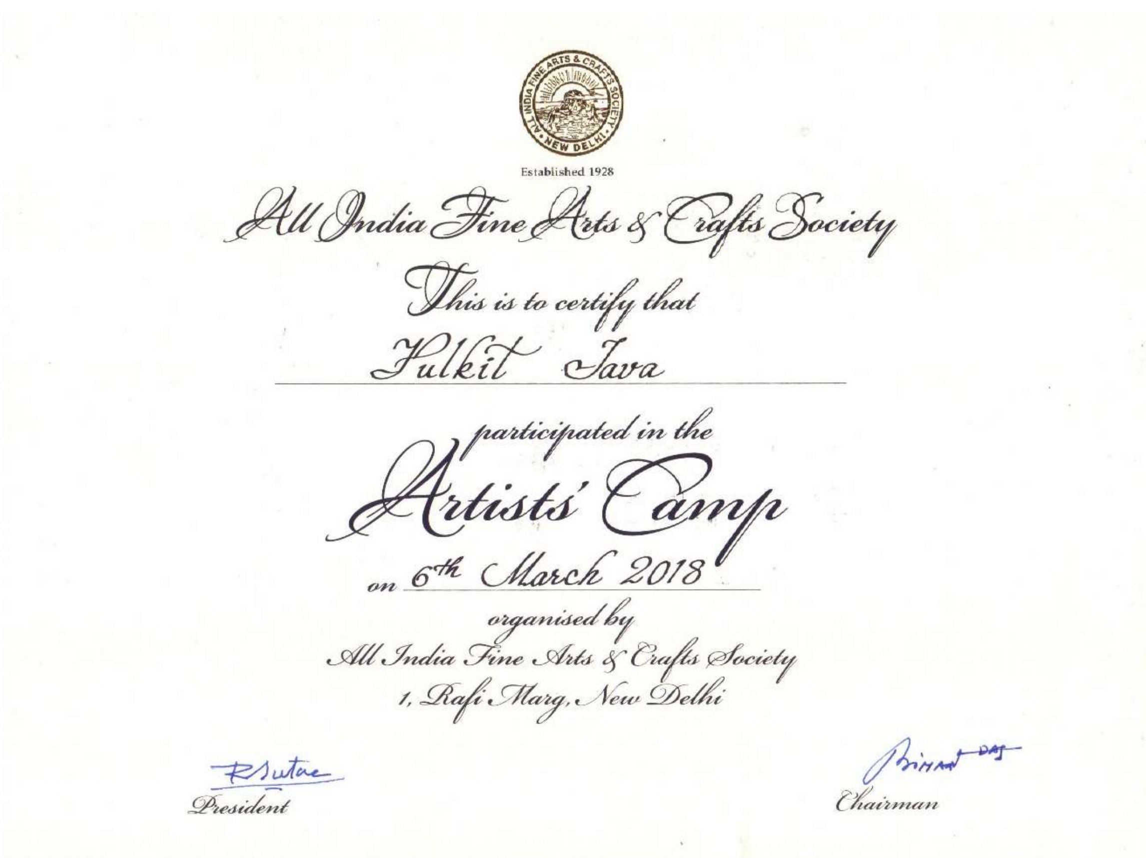
Prepared by
(Administrative Officer-Records)

President of STEMIO STEM
Dr. Pothala Praveen
International Organization Singapore

Head of School
Prof. Pavitar Parkash Singh
School of Liberal and Creative Arts (Fine Arts). LPU

List of Workshops/ Camps

S.No	Workshop/Camp Name	Organization Name	Date
1	Artist Camp (Metal sculpture)	All India Fine Arts & Craft Society	6th March 2018
2	National Bronze Sculpture Camp	Kerala Lalithakala Akademi	23rd December2018- 11th January 2019
3	International Dhokra Sculpture Workshop	U.P State Lalit Kala Akademi Lucknow & Institute of Fine Arts, CSJM University, Kanpur	4-12 February 2020


Established 1928

All India Fine Arts & Crafts Society

This is to certify that

Pulkit Java

participated in the

Artists' Camp

on 6th March 2018

organised by

All India Fine Arts & Crafts Society

1, Rafi Marg, New Delhi

President

Chairman

Government of Kerala
Cultural Affairs Department

Kerala Lalithakala Akademi

NATIONAL BRONZE SCULPTORS' CAMP

Certificate

This is to certify that MR. PULKIT JAWA has participated in the National Bronze Sculptors' Camp conducted by Kerala Lalithakala Akademi from 23rd December 2018 to 11th January 2019 held at Kunhimangalam, Kannur, Kerala.

KERALA LALITHAKALA AKADEMI THRISSUR

Nemom Pushparaj
Chairman

Ponniam Chandran
Secretary

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U.P. STATE LALIT KALA AKADEMI, LUCKNOW
&
INSTITUTE OF FINE ARTS, C.S.J.M. UNIVERSITY, KANPUR

"International Dhokra Sculpture Workshop"

04-11 February, 2020

Certificate of Participation

This is to certify that
Pulkit Jawa
in the category of 'Teacher/Research Scholar/Student' has participated in "International Dhokra Sculpture Workshop" at Institute of Fine Arts, C.S.J.M. University, Kanpur, U.P.-India.
We wish the participant best wishes for the future.

Dr. Brijesh Katiyar
Incharge
Institute Of Fine Arts, C.S.J.M. University, Kanpur

Dr. Yashwant Singh
Secretary
U.P. State Lalit Kala Akadami, Lucknow

Prof. R.S. Pundhir
Chairman
U.P. State Lalit Kala Akadami, Lucknow

List of MOOCS

S. No	Online courses	Organization Name	Date
1	Folk and Minor Art in India	NPTEL/ SWAYAM	Jul-Sep 2019
2	Academic Research Writing	TLC, Ramanujan College, University of Delhi	02 May-08 May 2022