ISSN 2012-922x

SAARC CULTURE

South Asian Association for Regional Cooperation

Volume 10, 2024

SAARC

SAARC CULTURAL CENTRE
SRI LANKA

Ethno-technological Perspective of Current Wisdom of Metal Craft and Craftsmanship, Tamil Nadu and Karnataka

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Abstract

Ethnotechnology is a term used to describe the study of ancient technology specific/ unique to cultural groups of people. Today, technology and craft are defined as applied science. Still, early humans developed technologies like stone tool knapping, pottery-making techniques, metal casting technology, textile manufacture, stone bead-making techniques, etc. Metallurgy may be defined as metal extraction, purification, alloying, and application. Some eighty-six metals are known today, but most were discovered in the last centuries. The 'seven metals of antiquity', as they are sometimes called, were, in order of discovery: gold, copper, silver, lead, tin, iron and mercury. The first evidence of metallurgy in the Indian subcontinent covers Mehrgarh in Baluchistan, where a small copper bead was dated to about 600 BCE; it is however thought to have been native copper, not the smelted melted extracted from ore. Archaeological excavations have shown that Harappan metal smiths obtained copper ore (either directly or through the local community) from the Aravalli hills, Baluchistan or beyond. Through the ages metal technology has developed in different forms (vessels, weapons, decoration materials, etc.), with other metals such as copper, silver, iron, zinc, etc. This paper will discuss the tracing and understanding of the ancient metal technology with current wisdom practices of (Tamil Nadu and Karnataka) through systematic fieldwork and will focus on the related material which is used and used by metal craftsmen.

Keywords: Chola bronze casting, ethnoarchaeology, metalworking, wax model

Introduction

Metallurgy is a complex art since it concerns the transformation of materials through the control of fire, in particular during casting, annealing and soldering, and by the specific physical and chemical properties of precious metals and copper-based alloys, such as fusibility and malleability. Metalworking tools are normally simple; on the other hand, the different stages of the *chaîne opératoire* require complex know-how and technological specialization (Armbruster 2010). Interpretation and modelling of early metallurgy in South India has been shaped by two primary concerns, both focusing on iron metallurgy because of its dominance in the archaeological record. The first is whether the early iron in the peninsula was the result of diffusionary or migratory processes or whether iron was an Indigenous development. The second concern has been to understand and demonstrate the skills of the early practitioners of metal technologies. Taken

together, these concerns have directed archaeological research towards an emphasis on uncovering the earliest evidence for various ferrous metallurgical practices through excavation and artifact analyses (Gullapalli 2009). Ethnoarchaeology as a distinct subdiscipline of anthropology is a relatively new phenomenon. The field is still in the process of formation and as such still lacks a generally accepted definition or fully developed body of theory and methodology (Stiles 1977). Ethnographic data have long been used by archaeologists for understanding, interpretation and explanation of things found in the archaeological record and ethnographic data collection. Ethnoarchaeology research allows the author to understand the comparative and comprehensive research of metal working tools, the workshop equipment, the objects production, the gestures of the craftsman and the organization of the craft. This type of research was obtained from old chronicles, and ethnographic texts, through an examination of antiquity from museum collections and systematic fieldwork that involves the traditional craftsman in his workshop. This paper deals with the current metal technology process of different study areas, which can bring out the continuity of the making process of objects from generation to generation.

Archaeologists define technology in many ways, depending on their research problems. For some problems, technology is viewed mainly as manufacturing processes- the artefacts and activities involved in making other artefacts. This paper deals with a functional analogy to establish forms, the making process of objects, texts used in the making process of objects, raw materials used for making objects, craftsman settlement of workshop and migration of the craftsman.

Methodology

Ethnotechnology is research emerging from anthropology and it is adopted by archaeologists, is a qualitative methodology that lends itself to the study of the beliefs, social interactions, and behaviours of small societies, migration, materials used by craftsmen and the interpretation of data collected. There are three methodological features of ethnographic research, which have differing philosophical backgrounds, ‘Naturalism’ has its roots in the realist research tradition, which seeks to discover an authentic description of the world. Understanding and induction, in turn, are related to the social constructionist research tradition, which suggests that there are several descriptions, or versions, of the reality the trustworthiness of which depends on what we believe is true, and how relevant the description is. Ethnographic fieldwork typically begins with participant observation, which is later complemented by other data (e.g. interviews and documentation). Keeping field notes is a key activity performed

by the ethnographer or archaeologist. Everyday events are recorded along with the participant's viewpoints and interpretations. Initial observations focus on the general, open-ended collection of materials derived from learning the basic cultural rules and language used at the site. To fulfil the aim of the research, the methodology is used such as literature source (text), and systematic fieldwork of craftsmanship workshop of a different region of South India. These research methods add a practical and human side to the study of ethnoarchaeological records.

Current Knowledge of Bronze Technology in Tamil Nadu and Karnataka

In this paper, the current knowledge of the bronze image-making process includes the regions of Tamil Nadu and Karnataka. A bronze image is made through the *lost wax* method. Technically speaking, it is known as *cire-perdure* and in ancient texts, the *shilpa shastras* call it *Madhuuchchishtta Vidhana*. The process starts with mixing, beeswax and *Kungilium* with a little oil. It is kneaded well and from it, the desired figure is made. Fine details are sculpted into it, and this forms the wax model in the original.

In South India, the Vishvakarma community, both artisans and craftsmen, spread extensively throughout the region and played a vital role in the rural and urban economy. There were different categories of artisan community in early South India like engravers, sculptors, carpenters, ironsmiths, painters, etc., who were mostly considered as a class of master craftsmen or skilled artisans. Through their skilled labour, compassion and association with art and craft activities, the artisans and craftsmen were able to exert great influence on the social and religious life of the people. The community had a vital role to play in the temple towns as these were nuclei of urban development in the medieval period of South India (Rajan 2003). During the Pallava Chola construction "boom" there emerged a distinct class of craftsmen that became known as "*sthapatis*"- architect/ designer. The term *sthapathi* is both a Sanskrit and local Tamil term given hereditary master craftsman who is an expert in either stone sculpting or bronze casting. In South India, the Vishwakarma community of artisans is also known as *kammalas* (Thomas E Levy et al. 2008).

Swamimalai (Tamil Nadu)

Swamimalai is a panchayat town near Kumbakonam in Thanjavur, district in the Indian state of Tamil Nadu. It lies on the bank of river Kaveri and is one of the six abodes of lord Muruga. Swamimalai bronze icons refer to bronze idols and statues manufactured in Swamimalai. It has been recognised as a geographical indication by the Government of India in 2008-09. During the reign of the Chola

empire, Raja Raja I commissioned a group of sculptors for the construction of the Peruvudayar Temple at Thanjavur. The sculptors helped sculpt statues for Airavatesvara Temple and later settled at Swamimalai. Woodcraft is a burgeoning revenue-generating industry in Swamimalai. The state whose skilful craftsmen once depended upon the patronage of the ancient monarchs to earn their livelihoods is now teeming with talented local villages and artisans whose expertise is manifested in the variety of indigenous artefacts created by them.

Making Process of South Indian bronze Casting: The craftsman from Swamimalai is still following the measurement of making bronze from ancient text *Manasara, Manasollasa* and *Sliparatna.* Brief information about casting technology may also be included in ritual manuals, called *agamas*, *tantras* and *samhita* of various religious schools, compiled in Tamil Nadu around the twelfth century. Finally, some information can be found in the Puranas, a large corpus of encyclopaedic texts extremely difficult to date, treating such diverse topics as the origin of the universe, legends about gods, iconography, and ritual (Joosje 2019) (see Fig. 1)

Fig. 1. Google image of Swamimalai

Technical Process of Casting Bronze Sculpture: The technique of casting by the *cire-perdue* process can be divided into four principal stages, they are: 1. model making, 2. mould making, 3. melting and casting and 4. chiselling and finishing.

Preparation of Wax: Wax must be prepared by mixing pure beeswax, resin from the dammar and ground oil, in a proper portion of 5:5:1. Resin must be ground into powder and heated till a thick liquid form. After this, it is added to the beeswax and stirred with a stick till it liquefies and is well mixed. After the wax melts, the liquid is filtered through a white cotton cloth into a tank containing cold water, thus allowing it to solidify. This is then used for making the wax model.

Preparation of the Wax Model: 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. Finally, the different finished parts of the image are joined 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 the case of large models, the pedestal must be made separately (see Fig. 2).

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 the case of small images, only three layers of clay are required but for large images, more layers are required. The clay which is sourced from the riverbed of the Kaveri is locally called v*andal mann*. During the application of clay, the wax model must be kept either on a piece of paper or on a white cloth. Soft clay: For preparation, four parts of well levitated which is used for making pottery and one part of ordinary clay are mixed. Preparation of very soft clay: Soft clay is mixed with cow dung until it becomes extremely soft (see Fig. 3).

De-waxing*:* After the mould is dry, it is placed over firewood and baked, till the wax melts completely and flows out. Once the wax is removed, the mould is removed from the fire and placed in a pit with the mouth facing upwards (see Fig. 4).

Casting: In South India, five metals were used to produce the idols which is called *panchaloha* (Kar 1952; Ruth 1962; Krishna 1976). These include a mixture of copper, silver, gold, brass, and tin. The rule used by the 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, coke or charcoal are used.

When the metal and mould temperatures are proper for casting, the mould is placed horizontally in a slightly slanting position over bricks. Stone should be avoided for this process. While pouring the metal liquid into the mould, cup-shaped bricks are held below to avoid mishaps. To avoid entry of impurities like charcoal floating on the surface of the molten metal, while pouring metal into the

mould, a piece of knitted jute cloth covers the mouth of the crucible. After completing the casting process, the mould is allowed to cool for a day (see Fig. 5).

Fig. 2. Preparation of the wax model

Fig. 3. Mould making

Fig. 4. De-waxing

Fig. 5. Casting

Final Working on Bronze Sculpture: The sculptor carefully removes burnt clay to extract the object. Iron rods and wires are removed, and the sculptor removes all unwanted runners in the bronze idol/object. 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 aspects (see Fig. 6).

Fig. 6. Final work on bronze sculpture

Udupi (Karnataka)

Udupi, a celebrated town of temples in Karnataka is renowned for its bronze and bell metal casting. The age-old process of the *cire-perdue* of the lost wax method is employed to create striking objects out of metal. Udupi is a rich source of tin and copper and thus a significant centre for artisans to produce varied utilitarian and religious objects rooted in regional identity. Karkala which is one of the oldest centres of Jainism is famous for its metalware icons. Ritual objects used in worship such as lamps, bells, pot/*kalasha*, *ginde* etc. besides the south Indian bronzes such as deities, are cast in the Chola and Hoysala style. Another example

of meticulous craftsmanship is the *bhoota* figures that can be found in metal masks and cast idols. These include the likes of *Mahisasura* or the bull demon and *bhoota* attendant figures. Being of Shaivite origin, the sun and moon are a part of the craft's iconographical vocabulary. Similar to the embellishment carried out on the *yakshagna* mask, beaded rope work and gold tassels are common details. Tools such as a blower, box moulds, clay crucible, emery paper, tongs, chisels, furnace, buffing machine etc. are used for crafting purposes (see Fig. 7).

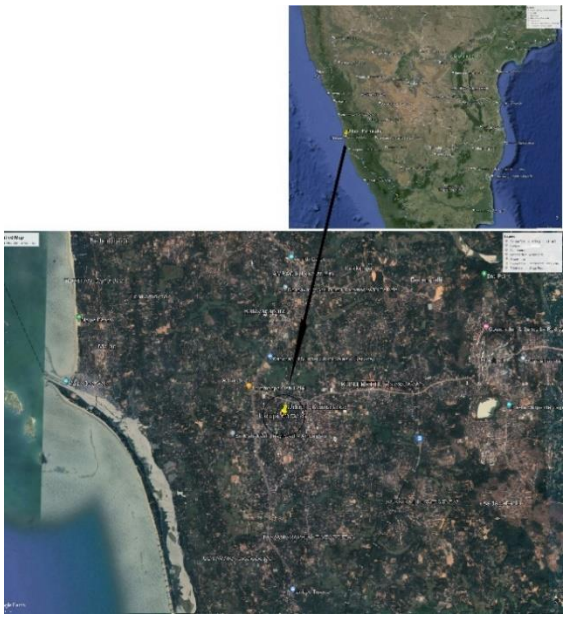

Fig. 7. Google image of Udupi

Making Process*:* The idol is modelled from a molten wax mixture in the required size and proportions. *Kunguliam* (resin) and *mezhugu* (paraffin wax) are mixed with an addition of *kadalaiennai* (groundnut oil). The mixture is heated on a stove and allowed to cool to a consistency and temperature that is comfortable to handle and shape. Torso, hands, legs, and the seating pedestal are fashioned from wax individually and then put together by heating and fixing. A sculpture that is metal all through is termed a solid cast. Solid casting is practised for temple sculptures. A hollow cast is made with a clay-fibre core and a cladding of cast metal on top. Decorative pieces, to reduce the consumption of metal and minimise weight are cast with a clay and jute fibre core. The idol is placed on a bed of sand atop a cloth face up. A layer of *vandal mann* (fine-grained clay) is applied to the wax idol. Care is taken to cover every nook and corner of the wax idol/model. *Vandal mann* is highly impressionable and captures the minutest of

details of the wax model. A mixture of *kali mann* (alluvial soil) and *manal* (river sand) mixed in 1:3 proportions are applied over this layer. The mud sheath on the face side is allowed to dry for about four days. The idol is turned, and channels called runners made of wax are affixed to the wax form. These channels act as outlets of wax and inlets for molten metal later. Two channels are placed side by side. This side of the idol is covered in *vandal mann, kali mann* and *manal* and allowed to dry for four days. A metal wire is wound around the mould to keep the casing intact. For multiple castings of the same form, plaster of Paris moulds is made instead of mud moulds. These can be used for casting about a hundred times before they wear out. The mould is placed with the channels facing downwards and heated. The wax melts and trickles down the channels. As the wax is removed, a negative space is created within the mould.

A rectangular pit with a metal grate and a side inlet for air is used as a furnace for heating metal. Two pots can be placed inside the pit. A small amount of damp mud keeps in place two bricks placed in the pit. The bricks are dusted with sand to prevent the pots from sticking when placed atop. On top of this makeshift stand, pots are placed. Metals are weighed and added to the pot, copper (85%), and zinc (10%). Coal is shovelled all around the pots and a few dried dung cakes are lit. An electrical air blower strokes the fire. The pots are covered with stone domes and the metal pieces are allowed to melt. Metal is constantly added in small quantities till the required weight is obtained (see Fig. 8).

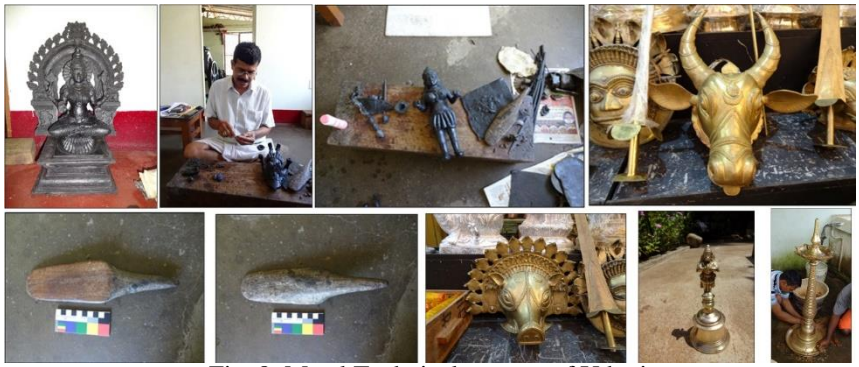

Fig. 8. Metal Technical process of Udupi

Current Wisdom of Iron Technology in Karnataka and Tamil Nadu

The beginning of the Iron Age in India was at first dated to the 5th century BCE, ascribing the diffusion of this metal to the contact with the Greek-Persian world (Wheeler 1959: 132). Subsequent excavations and research have enriched our knowledge of the Indian proto history, showing that ironworking precedes some centuries. However, an agreement on when and where iron technology was utilised for the first time is lacking. Bridget and Raymond Allchin (1982: 345-

46) divided the Iron Age into three stages: in the first stage (1300 - 1000 BCE), iron occurs in Rajasthan (Ahar and Noh) and Karnataka (Hallur); in the upper Ganges valley, it appears in a second stage (1000 - 800 BCE); and in the middle Ganges valley it appears only in a third one (800 - 500 BCE). Conversely, Roy (1983: 181) observed that iron objects were found during the same period in the Ganges valley, that is, before the introduction of the Northern Black Polished Ware (NBPW) and Painted Grey Ware (PGW). Chakrabarti (1977; 1992) indicated Madhya Pradesh (Nagda and Eran sites) as the earlier region where iron smelting occurred (1100 BCE).

Process of iron technology: In the subject of iron technology, there are two processes which are the primary process and the secondary process. In this research paper author will use technology analysis to understand the secondary process of iron technology in two different regions.

Primary process of iron technology (smelting process): Smelting is a process or a combination of processes to produce molten metal. The smelting of iron in the blast furnace is an example of reducing smelting in which coke serves both as fuel and as a source of reducing agent. In the presence of an excess of carbon monoxide, iron oxide can be completely reduced at about 900°C, but the melting point of the metal is 1535°C. *Secondary process* of iron technology (Iron smithing/ Forging process): Forging is defined as a metalworking process in which the useful shape of the workpiece is obtained in a solid state by compressive forces applied through the use of dies and tools. The forging process is accomplished by hammering or pressing the metal. It is one of the oldest known metalworking processes, with its origin about some thousands of years back. Traditionally, forging was performed by a smith using a hammer and anvil. Using a hammer and anvil is a crude form of forging. The smithy or forge has evolved over centuries to become a facility with engineered processes, production equipment, tooling, raw materials, and products to meet the demands of modern industry (Rathi et al. 2014).

Tingallur (Karnataka)

Tingallur: (Latitude: 13°04’14.09” N, Longitude: 77°34’08.46” E) Tingallur is a fully urban developed prime location in Bangalore, and it is 15 km away from the National Institute of Advanced Studies (NIAS) (see Fig. 9). The author has conducted a study on the ironworking of Tingallur, which is located in the Bangalore Urban location. The ironsmiths of Tingallur migrated from Andhra Pradesh, Tamil Nadu and Telangana States and belong to Viswakarama or *kamalar* community. *Kamalar* community from Tingallur are engaged in full-time ironworking for the whole year, and they do not participate in any other occupation such as agriculture. The *kamalar* from Tingallur has no knowledge

about the iron smelting process. They buy raw materials from the steel and iron market and make implements, or sometimes they collect old iron rods from the person who offers the job. Here author would like to give a detailed description of ironsmiths at Tingallur, specifically on the aspects of their settlement or workshop place, the structure of furnace, anvil, bellows/air blowers and the production of iron objects.

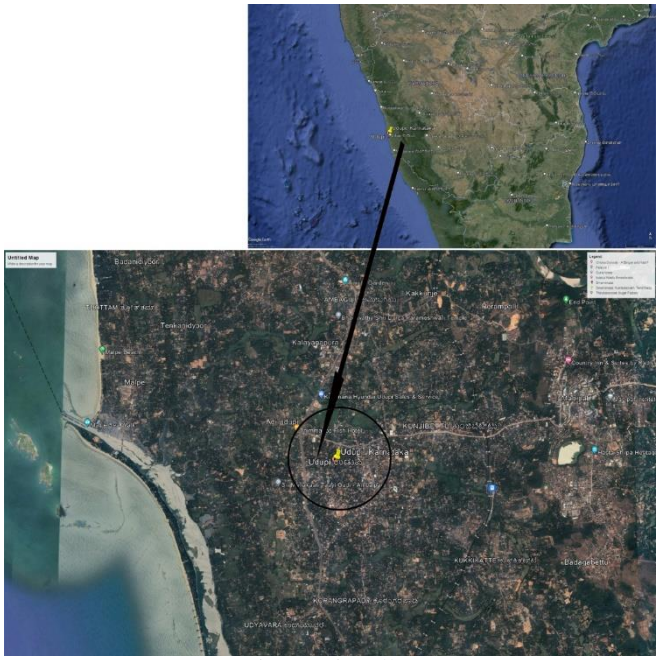

Fig. 9. Tingallur

Settlement of Tingallur Kamalar: The settlement of Tingallur *kamalar* is away from their workshop location due to lack of space and urban development. The working time of Tingallur *kamalar* starts from morning 9.30 am to evening 5 pm. The workshop area is well-planned, and the workshop place is well-plastered with red soil. The arrangement of the tools for the smith is proper and systematic.

Bellows: Tingallur *kamalar* uses a hand-turned air blower which is made up of steel and they have no information regarding the leather below.

Anvil and Workplace Platform: The anvil is mounted on a wooden stand, usually a tree stump but sometimes on a squared timber block. These were set into the ground and supported laterally with rocks or stakes to prevent the stump from moving. The ironworkers of South India use rectangular anvils with curved

corners. A working platform is placed to remove the rust from the heated iron object while working on the hot iron.

Furnace and Furnace Wall: The bowl furnace and circular furnace with a depth of 1 to 2 ft are used here. The bowl furnace is connected to the air blower, which supplies air to raise the required temperature. There is a furnace wall for which there are two reasons to build it. The first reason is to protect the person behind the furnace who is working on the air blower and the second reason is to avoid accidents. The furnace wall is built of brick, and red soil and brick count maybe 9 to 12. On top of the furnace wall, their *Kuladheivam* (family god) is fixed, which is made up of clay.

Technique and production: Forging or smithing is the technique used by Tingallur *kamalar*. Their pattern of work is like the Rajput Lohars. They make implements like knives, chisel, ploughshare and axes. Sometimes they also do welding work and repair work (Udayakumar 2021) (see Fig. 10).

Fig. 10. Tingallur blacksmith workshop

ManaMadurai

Manamadurai: (9.7°N 78.48°E) small village in the Sivagangai district of Tamil Nadu is known for its Ironworking (see Fig. 10). The tradition has been passed down from generation to generation. This is the first research on ironworkers from Manamadurai, its hidden craft centre place in Tamil Nadu. Unfortunately, due to various reasons such (as migration of different works, scarcity of raw materials, new government policy and development of higher education among the young generation), the work of a blacksmith is going to sunset, through the systematic fieldwork by the author is only 3 person is working on making the

iron object for agriculture tools and rituals artefacts. The ironworkers from Manamadurai will only from morning 10 am to 2 pm every day and they get very little work making the iron objects. The ironworkers from Manamadurai do not know about making iron smelting, they have knowledge of iron smithing work. Ironworkers from Manamadurai are experts in the secondary process (smithing), the manufacture and repair of artefacts. Iron smiths had several different alloys available, including ferritic iron, (pure iron, relatively soft), phosphoric iron (harder but more brittle) and steels (varying carbon contents, enabling very hard edges to be produced). There were four main techniques used by the smith, cold working, hot working, welding, and heat treatments (see Figs. 11 &12).

Fig. 11. Manamadurai

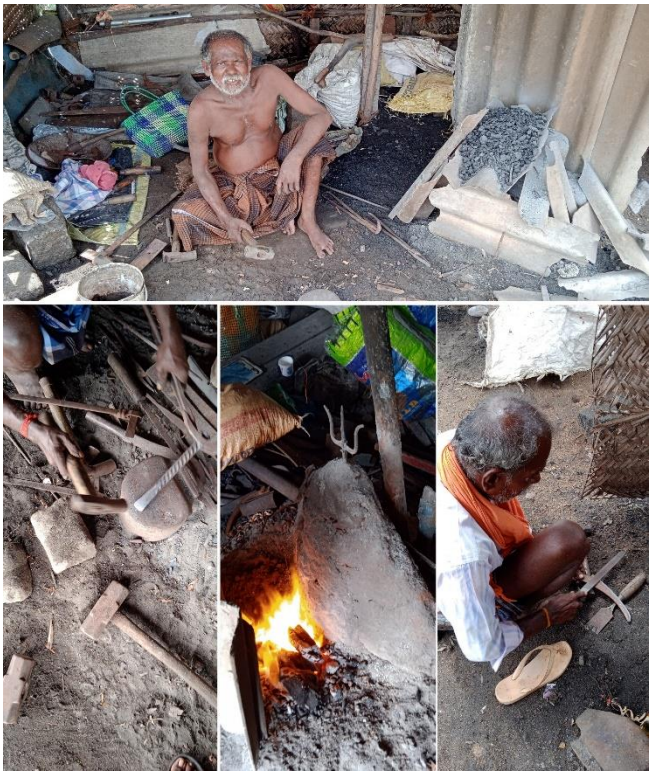

Fig. 12. Manamadurai ironworkers

Observations

Exploration of technology and technological process of ethnoarchaeological studies of metal production give the broad picture of economic status, agriculture production trade etc of the region of the study area. From as early as the start of the twentieth century, ethnographic accounts began to be used together with archaeological and analytical data to influence interpretations of archaeological remains (Thornton 2009). Somewhat unique to the archaeology and ethnoarchaeology of technology is the necessity to give due consideration to the technical, social, and cognitive symbolic elements of the process involved. The archaeometallurgist and ethnoarchaeologist often draws upon his or her personal experience of metallurgical techniques from that person's country or region of origin. His or her perspective will be broadened, however by interacting with a variety of modern practitioners and historical sources to understand alternative experiences and knowledge of techniques and technologies from across the globe (Louise 2014).

Finally, to get a better understanding of the current wisdom of the metal technological process is also needs more field work to trace the distribution of

metal workers in South India. With the systematic fieldwork of tracing the metal workers in South India. The author has traced almost 15 metal workers in South India, in this paper author has used only four major centres of metalwork in Tamil Nadu and Karnataka. This paper indicates there are many unique aspects of each region of metal workers. As researchers, we need to understand to do a comparative approach of technology of different regions. As a concern to the future of metal workers going into the sunset, due to various reasons such as more machinery equipment developed, metal workers not getting properly paid for their work, the young generation is not interested in participating in the metal work and many aspects of caste issues. On another hand we could see that classical crafts such as Chola bronze casting are developed numerously, developed as a centre of many regions and a lot of demand for Chola bronze casting. In the case of ironworkers, we could see very little opportunity even in the countryside or rural, so it is time to document the technical process of ironwork in any platform for future generations before the craft goes into the sunset.

Acknowledgement

Many thanks to NIAS Heritage team members and all artisans from South India. Thanks to TCS.

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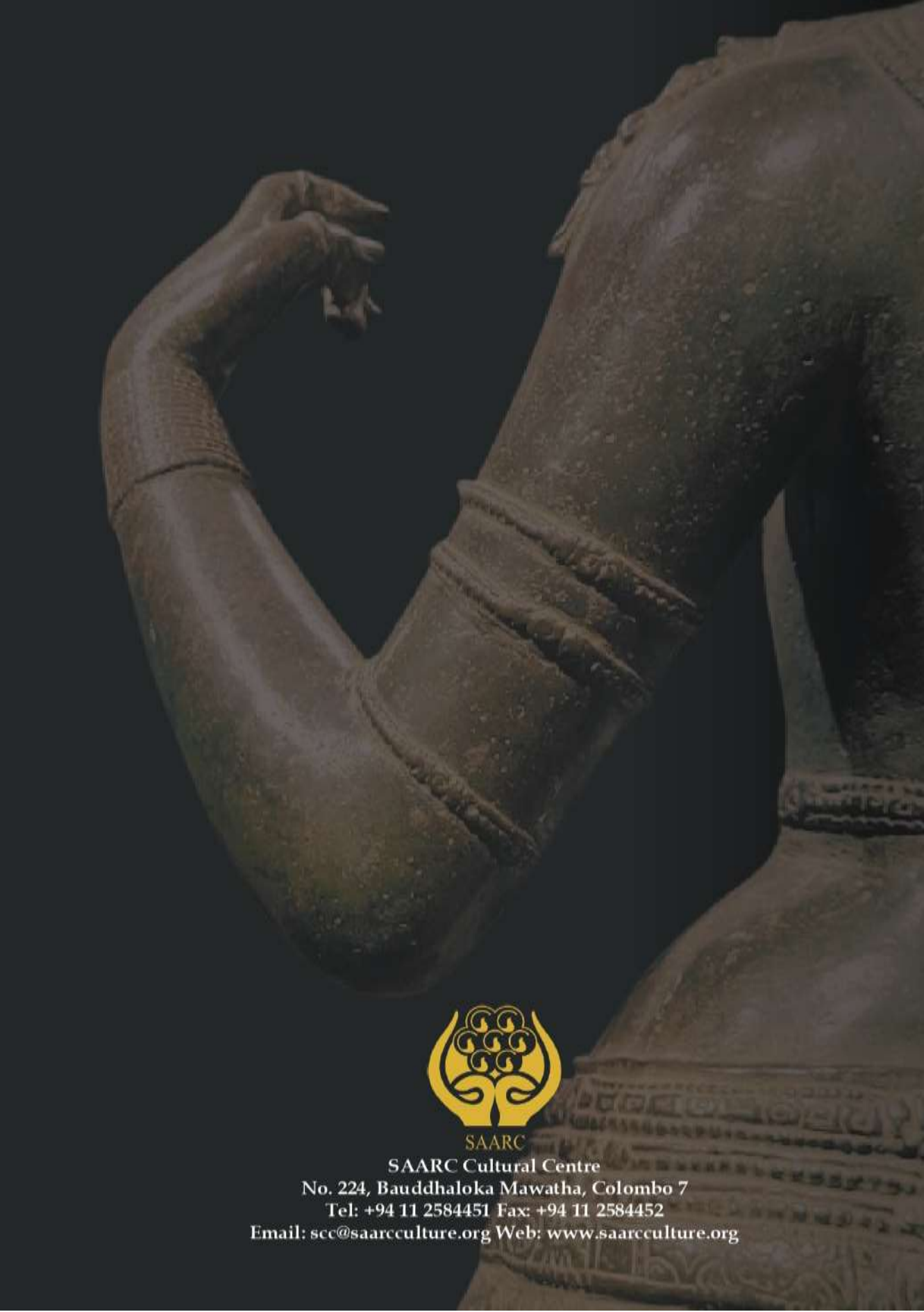

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