

METALLURGY AND TRADITIONAL METAL CRAFTS IN TAMIL NADU
(with special reference to Bronze)

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This paper studies metallurgy and traditional metal crafts in Tamil Nadu within the specific context of bronze and metal crafts, on the basis of archaeological reports, literary accounts, oral traditions and field interviews. The evidence of metals and metallurgical technology is to be found in megalithic sites in South India while sites like Arikkamēdu in Pondicherry have unearthed copper artifacts and are, by and large, pre-iron sites. Śānūr in Chingleput district has yielded major iron finds and Ādichachanallūr in Tirunelveli district is an important bronze site. The archaeological evidence from Tamil Nāḍu thus establishes the antiquity of metal crafts in Tamil Nāḍu.

Metal crafting has been the traditional occupation of the five artisanal castes collectively known as the Kammālar but referred to in early inscriptions as Rathakārar. They however prefer to describe themselves as Viśvakarmā Brāhmins and their origin myths are contained in the *Viśvakarma Purāṇam* composed sometime in the eighteenth or nineteenth century.

Literary references to the furnace and bellows of the smiths and even to the manufacture of steel (*ehgu*) are scattered throughout Śāṅgam literature, which is a corpus of anthologies dating between the third century B.C. and the third century A.D.

Metal crafting and casting techniques show a remarkable degree of continuity in Tamil Nāḍu. Kumbakōṇam and Kāñchipuram where metal crafts are living traditions, and go back to the eighth–ninth centuries as craft centres. The technique followed in metal crafts is known as *cire perdue* or the lost wax process. Solid casting has been preferred in these centres and it is only the pedestal (*pīṭham*), the halo (*tiruvāśal*) and the animal mount (*vāhana*) which are made through hollow casting. Icon casting in Tamil Nāḍu by the traditional Kammāla craftsmen was done strictly in accordance with the scriptural injunctions laid down in texts like *Sakalādhikāra*. However, since the turn of the century things have changed. The boom in tourism and the growing market for *Kiśch* has, on the one hand, led to prosperity for the more enterprising craftsmen but, on the other hand, it has corrupted the purity of traditional metal crafts in India.

The technology of metallurgy as well as metal craft centres in Tamil Nāḍu have shown a remarkable continuity over the past two thousand years. Kāñchipuram, Kumbakōṇam and Madurai have the unique distinction of more than a thousand years of unbroken craft history. The present paper on metal technology and metal crafts in Tamil Nāḍu is located within the specific context of bronze and bell metal crafts in the Tamil region. Besides the use of archaeological reports, literary accounts and oral traditions, this study is based on extensive field work and interviews with craft persons in these craft centres. Since the main thrust of this article is to examine bronze casting as an ancient craft which is even now a vibrant living tradition, participant observation

at these craft centres became a vital source of this study.

Metal crafts in South India was, is, and by the same logic, will continue to be in the hands of a professional caste called the Viśvakarmā, literally 'Makers of the universe'. These Viśvakarmā craftsmen are specifically known as the *Kammāḷa-Rathakārar* (meaning the Kammāḷa chariot makers) in the region of Tamil Nadu.

There is a fascinating myth regarding the origin of metallurgy in Tamil Nadu. The text *Viśvakarma Purāṇam* probably compiled around the late eighteenth-early nineteenth century, is a mythological account of the craft history of the Viśvakarmā comprising primarily the oral traditions of the community. This states that Brahmā, the creator of the universe according to Hindu mythology, and the divine architect Viśvakarmā, together created the universe. In their own special version of the Big Bang theory, the artisans claim that the five natural elements formed an enormous egg which burst forth like thunder and the universe came into being. Viśvakarmā, the divine architect of this universe, was born with five heads. Three of his faces were of three metals—gold, copper and iron from which emerged the goldsmith, the copper or bronze smith (brazier) and the blacksmith. The other two faces belonged to the mason or stone smith and to the carpenter. Viśvakarmā then made giant tongs out of the power emanating from Brahmā, the creator and Viṣṇu, the protector and joined the tongs with the nail symbolising the power of Rudra (Śiva, the third of the divine trinity in his role as destroyer). Thus was made the first tool of the smiths with the divine power of which the galaxies were fashioned. These elaborate origin, myths and geneologies also find an echo in early epigraphical records. Two important twelfth century inscriptions from Tiruvārūr (Thanjāvūr district) and uyyakonḍan Tirumalai (Tiruchchirapalli district) trace the social origins of the Kammāḷa-Rathakāra². Such systematic mythologies and geneologies unite the craft persons of South India all of whom are collectively said to belong to the Viśvakarmā community.

The first section of this paper will consist of a brief survey of the archaeological evidence pertaining to Tamil Nadu. The focus of this article is, however, the history of metallurgy in Tamil Nāḍu with special reference to bronze. The various sections of the article will demonstrate bronze casting by the Viśvakarmā smiths as a two thousand year old living tradition at Kumbakōṇam, Śvāmimalai and other metal craft centres of Tanjore district.

METAL CRAFTS IN TAMILNADU—ARCHAEOLOGICAL EVIDENCE

Metals like copper, bronze, and iron have been found at certain mégalithic sites in Tamilnadu. Copper has been found at Arikamēḍu in Pondicherry in the form of rattles, rings, bangles and rods, dating back to the first and second century A.D.³ T.V. Mahalingam, leading the archaeological excavations at the lower Cauvery valley mégalithic sites, has unearthed copper objects at Tirukkāmpuliyūr and Aḷagiri, both in Tiruchchirapalli district⁴. Manigrāmam near Pumpuhar (Kavēripūmpaṭṭinam) in Tanjavūr district as well as Kunnattūr and Kañchīpuram in Chingleput district have

been important megalithic sites with copper finds. Kunnattūr has produced copper artifacts like utensils, bowls, bells, rings and bangles. Another site in the same district at Sānūr has also yielded valuable iron objects such as spears, daggers, knives, hooks, bars, wedges, tanged arrow heads, sickles and horse bits⁵. Recent excavations made at Koḍumaṇal, a village on the banks of the Noyyal river in periyār district (near Coimbatore) in Tamil Nadu by the Tamil university, Tanjavūr, have yielded metal artifacts such as a copper tiger inlaid with precious stones, gold ornaments, iron spindles, iron weaponry and crucibles etc, all dating back to the second century B.C. The site also shows evidence of a furnace for smelting iron ore. Koḍumaṇal is close to the Chennimalai hills rich in magnetite ore.⁶ These copper objects are very similar to those found in Karnataka excavation sites like Brahmagiri, Piklihal and Māsiki⁷.

The megalithic cultures of South India were basically iron age cultures, although this association between lithic burial sites and iron technology is non-existent in the Iron Age cultures of Northern India which are chalcolithic. In South India iron is found at almost all the megalithic sites which have been excavated. The ancient Tamils seem to have smelted not only iron but also steel. The word in the Tamil language for steel 'ehgu' or 'ekku' is synonymous with 'spear' and 'sword' thus indicating that production of steel was very much a part of ancient Indian culture. The Sangam text *Puranānūru* refers to men carrying the flashing steel swords⁸ and the *Mullaippāṭṭu* refers to the 'yehgu' piercing the body⁹. India, unlike Europe, did not go through a separate bronze age culture and bronze is integrated into the iron age cultures. It is however significant in the context of metallurgy in Tamil Nadu that bronze is not found at the early megalithic sites like Tirukkāmpuliyūr, Alagarai, Kunnattūr or Arikamēḍu but is available in plenty in non-megalithic sites like Adichanallūr or kōrkai on the banks of the Tāmraparaṇī river in Tirunelvēli district. The site is roughly datable to the second-first century B.C. These have yielded the following bronze objects:¹⁰

Bowls of different shapes and sizes,

Round cylindrical jars with lids, highly ornamental,

Hollow plates and cups,

Pots with bell mouth,

Anklet with five bells,

Series of bangles and three bronze necklaces consisting of thin wire rings which are strung together,

(The site has also yielded some gold artifacts).

One remarkable find at the Ādichanallūr site has been a huge bronze vase stand decorated with four rams having long horns which radiate from the centre of the vase base. On the back of the animals are rods which bend inwards and upwards at an angle

towards a ring. On the ring is a hollow plate. This was most probably used as a stand for the large jars or bowls. The bronze jars and their lids are also decorated with figures of animals like antelopes, buffaloes with curved horns, dogs, cocks and tigers. A special feature of the Adichanallūr bronze is that it seems to have been very malleable since it had unusually high tin content of 23%. Two other major bronze sites in Tamil Nāḍu are the Nīlگیرis and Coimbatore. Breeks in his account of the Nīlگیری excavations has described bronze bowls and iron implements like razors and spear heads. Here again the bronze has been noticed to contain an even higher percentage of tin, that is 29.89% while the normal ratio of copper to tin in bronze is 10:1¹¹.

The metal crafts in 'Tamil Nāḍu show an amazing degree of continuity in terms of the nature of craft production and in the context of craft designs. Moreover the making of temple icons and metal craft products continues to be in the hands of the traditional metal-smiths, known as the Kammālar. In ancient inscriptions they are referred to as Kammāla-Rathakārar, literally 'makers of the chariots'. In modern times they prefer to use the nomenclature 'Viśvakarmā', thus claiming mythological descent from the divine architect and effectively repudiating the low-caste Śūdra status assigned to them.

In traditional town planning the temple was the heart of the town and craftsmen and other professionals lived in streets radiating outwards from the temple-town called *Tirumaḍaiviḷāgam*. Metal craftsmen continue to live in the *Kammala street* to this day.

The pursuance of traditional technology in metal crafts contributes to the excellence of the product since almost all the processes like cutting, chiselling and ornamentation are done by hand. At the same time the following of traditional techniques results in technological backwardness and the perennial impoverishment of craftsmen. Nowadays machine cutting has been introduced on a limited scale in the making of gold ornaments and silver or bell metal objects like lamps.

References to the use of furnaces and bellows made of goatskin in the melting of iron and the making of steel is referred to in Sangam literature. The *Perumpānāṭṭrupaḍai* describes the kollan/blacksmith blowing the bellows made of fine animal skin¹² and the Jain religious epic *Peruṅgaḍai* uses the burning of furnace as a poetic metaphor¹³. The raw iron mixed with sand is heated along with coal. The sand used in the smelting process was of a special variety. It is noteworthy that iron and bronze melting techniques in south India have shown a remarkable degree of continuity. Buchanan writing around 1800 describes iron and steel smelting at Chennimalai in Salem district in an identical manner and says that the special sand was obtained from Viracholapuram in Gangeyam district. The iron blocks were then sold in the form of either blocks or steel frames¹⁴. Epigraphical evidence from the Tamil country indicates that even in the early medieval period iron was sold in the form of blocks. The reference to a tax on iron blocks, apparently on its sale, is found in early Tamil inscriptions.

BRONZE CASTING

Bronze is essentially an alloy of copper and tin. However, according to Hindu tradition, the bronze alloy was supposed to be made up of five metals—copper, silver, gold, lead, and brass, brass itself being an alloy of copper and tin. The use of five metals (*Pañcaloha*) in the casting of sacred images, according to the Hindu *śilpa śāstra* (*Śilpa* means sculpture), rendered them more auspicious. Sometimes the icon could also be made of eight metals (*aṣṭaloha*). However, the presence of gold or silver in bronze icons are miniscule although the myth of their being present in these bronze images have led to theft and desecration of temple idols by marauders hoping to find traces of these precious metals.¹⁵

Much of the metal casting in Tamil Nāḍu is of the bell-metal which differs from bronze only to the extent that the ratio of tin to copper is much more. The usual proportion was 90% copper and 10% tin. Thus an input of more than 20% tin would make it bell-metal¹⁶. Actually analysis of the ancient south Indian bronzes have revealed the presence of other minerals like zinc, lead, arsenic and iron. Their presence has two kinds of implications. It indicates a level of technology in which the metal ores could not be completely purified allowing the impurities in the ores to remain. At the same time the presence of minerals like iron and arsenic hardened the bronze and rendered the casting process easier.

Bronze casting indicates the process by which molten metal is poured into a mould and then gradually solidified. When the molten metal has cooled, the mould is broken. The bronze object is then finished by chiselling, filing and polishing. A reference to the casting process appears as a metaphor in the poetry of Āṇḍāl, a mystic woman saint of the seventh century. In her composition called *Nāciyār Tirumozhi* she describes the downpour of rain in the metaphor of metal casting and likens Lord Kṛṣṇa to a skilled metal craftsman:

My beautiful love. It is as if
he has put clay around me and
poured wax into my heart.

(*Nāciyār Tirumozhi* : Xth decad¹⁷)

Similar metaphorical usages occur in the writings of the eighth century philosopher Śaṅkara. In his *Brahmasūtrabhāṣya* (I,2,12) he uses the phrase 'like images wrought of copper and other molten metal poured from a crucible into the mould.' The parable of molten copper assuming the shape of the mould is used by Śaṅkara as an illustration of the mind flowing into and taking the shape of objects comprehended by the senses.¹⁸

There are two main techniques involved in bronze casting—solid casting and hollow casting. The solid casting of bronze is defined as the *cire perdue* or "the lost

wax technique.” In the process the object is first made in wax and then a thick clay layer made of a special clay called *vaṇḍal* in Tamil is applied around it and allowed to dry. The mould is then heated and the molten metal poured into the hollow so that it fills every little crevice. The perfection of icon would depend on this. When the hot mould cools down it is broken open and the finishing touches to the bronze idol are made with chisel and mallet. If the image is of a deity, the sculptor adds an elaborate halo called *tiruvāsal*.

The hollow casting process is very rare in Tamil Nadu, but popular in northern and eastern India. In this a somewhat smaller version of the required object is made in clay. Wax is made into threads or tapes and wrapped round the core of clay. In this process the entire details of the object or icon is worked out to its finest details on the wax itself. A fine layer of clay which can make a clear impression of the wax model is built up. In the last stages of the heavy outer clay mould, a clay crucible is fixed. The mould would be provided with holes to facilitate the flow of the molten metal. The mould after drying is placed in the furnace heated to a relatively low temperature of about 300 degrees centigrade. In contrast to the precious metals, which melt at a very high degree, the metal needed for casting a combination of copper, brass, tin, and lead is heated to about 1500 centigrade. The molten metal is poured into the space left between the original clay model and the outer clay covering with its fine wax impressions. The mould would be buried in an upside down position, the funnel alone being visible above the ground. When the mould had cooled, the outer clay shell is broken and the hollow caste image is then polished and refined.

In South India, right from the earliest period of icon casting in bronze, which would be from the seventh century onwards, the period of the Pallava dynasty at Thonḍaimaṇḍalam (modern Madras—Chingleput especially Kāñchīpuram region) solid casting has been the practice. In both the Pallava and Chola inscriptions it is repeatedly stated that the image is ‘ghanam’, meaning solid. However the *tiruvāsal* or circular halo around the icon, *pītha* or pedestal and the *vāhana* animal mount used as the vehicle by the deity were done by the hollow casting technique.

The Chōla bronzes mark the golden age of bronze sculptures in South India and under the patronage of the Chōla queen Chēmbian Mādevi in the eleventh century, bronze crafting in Tamil Nāḍu reached its acme of perfection. Some of the most impressive bronze icons in the whole of India have been found at Tiruvālangāḍu, Gangaikonda Chōlapuram, Dhārāsūram and Kumbakōnam, all in Thanjāvūr district belonging to the tenth-eleventh centuries. Beautiful bronze images especially of Sōmaskanda and Naṭarāja have also been found at Kūram, Kañchīpuram and Mahābalipuram (Chingleput district) and at Chidambaram (South Arcot district). The creation of bronze sculptures under the Cholas is divided into three distinguishable periods—early Chola, mid-Chola and late-Chola. Some of the chief characteristics of Chōla icons were the rounded faces and tight modelling of the bodies. This fineness and refinement of features is however blunted in the bronze icons of the later-Chola period.

Pallava bronze sculpture had its own distinctive characteristics of ovoid faces, tall headgears, a tendency towards ornamentation as well as emphasis on looped waist girdles. One feature exclusive to Pallava sculpture was the *yajñōpavīta* (sacred thread) going over the arm. The Pallava images were also much smaller in size compared to the Chola bronzes. The *Naṭarāja* from *Kūram* which is the findspot of most *Paramēśvara Varman I*'s inscriptions, is also one of the earliest Pallava bronzes representing *Naṭarāja*. Some fine bronze specimens of the time of *Nandivarman Pallavamalla* (eighth century) are to be seen in the *Vaikunṭaperumāl* temple at *Kañchīpuram*.

The bronze *Sōmaskanda* from *Tiruvālangāḍu* (now in the Madras museum) represents the transitional phase from Pallava to *Chōla*. The bronze images of *Śiva* and *Pārvaṭī* are also interesting from the view point of craft technique. Since on the faces of the images, the pores caused by air bubbles in the process of metal casting are still visible. This indicates that the Pallava bronze casters fashioned the wax figure by etching into it the finer details which then got transferred to the metal replica. In contrast, from the later-medieval period onwards, the *stapati* or sculptor chiseled out the features from a crude metal image.

The bronzes of the *Vijayanagar* period although prolific, are somewhat mechanical and listless in contrast to the early bronzes. Some of the finer examples of bronze sculptures in this period are the portraits of *Krishnadēva Rāya* and his consorts at *Tirumalai* or the image of *Pārvaṭī* datable to the 16th-17th century which is at the *National Museum, Delhi*.

During the *Vijayanagar* and later the *Nāyaka* period, the bronzes became somewhat florid. Some of the distinctive stylistic features were the numerous threads of the *Yajñōpavīta* (sacred thread) appear more sinuous and ornamental. The elaborate shoulder tassels and circular decoration on the buttocks known as '*prṣṭha cakra*' also constitute special features of the *Vijayanagar* bronzes. In the case of *Viṣṇu*, the *Śrīvatsa* mark which is usually represented as a seated female figure in early chola images becomes stylized into a triangle in the *Vijayanagar* period¹⁹. Some of the best bronze specimens of the *Vijayanagar* and *Nāyaka* periods are thus stylistically in contra-distinction to the sculptures of the period of the *Pallavas* and early-*Chōlas*, although they do share some characteristics in common with the later-*Chōla* bronzes.

At present bronze casting is being done at *Madurai*, *Kāraikkūḍi*, *Kañchīpuram*, *Chidambaram* and *Kumbakōnam*. However the maximum bronze were in terms of lamps, bells and icons are still being produced at *Kumbakōnam*, *Svāmimalai* and *Nāchchiyār Kōyil*. Some of the bronze sculptors like *Dēvasēna Sthapathi* of *Svāmimalai*, *Gaṇapati Sthapathi* of *Kanchipuram* and *Ramaswami Sthapathi* of *Kumbakonam* have become celebrities in their own right. At *Nachchiyar koyil* as per the estimate made in 1992, there are two hundred workshops producing bronze lamps and the temple bells which emit the clear sweet tones that gives the South Indian bell metal its name. In fact the Tamil Nadu bronze is known by the name of bell metal because it has a much higher tin content than the normal bronze.

CRAFT-TOOLS

The traditional metal craftsmen at Kumbakonam—Shiv Shankaran, Ganesan and Arunajateswaran, all of them Sthapathis (sculptors) of *Dēvi Śīrpa Sālai*, and others at Svāmimalai, explained that the simplest of tools are still used in the process of bronze casting and icon making. The initial measurements are made with a thin coconut reed, but the level of accuracy that is achieved with this is remarkable. A small image of less than six feet is usually divided into five parts (*pañcavidhānam*), while the theoretical injunction for icon making is to divide the body into nine parts (*navadhānam*). As demonstrated to me by Shiva Shankara Sthapathi (20.10.1991), a traditional sculptor at Kumbakonam, a reed folded into half gives the measurement from forehead to waist and the second part from waist to feet. Detailed measurements for proportioning the image are taken first by having a measure for the face and then using that as a measuring stick for the other parts of the body. For example the length from neck to shoulder will be half the length of the face while the length of the arms will be double the face length and so on. Ganapati Sthapathi of Kanchipuram states that the *navadhānam* is, in fact, the *navarālam* or nine rhythms because the measurements determine the degree of grace and flow of life in the image.

The next step is the making of the wax model and this is made by a mixture of *unguliyam*, the aromatic milky substance of a herb plant with an equal proportion of beeswax. Spatulas made of sandalwood or any other fine wood are used for shaping the wax model. Even flat handled knives or thin sharp blades are used to scrap off unwanted wax. Steel scrapers of different sizes are very important tools in the shaping of the wax model as well as the bronze icons. Chisels and tongs are again very crucial to the craft of the metal smiths. It is interesting that these simple tools which may even appear crude, are ritually worshipped by the smiths of Tamil Nāḍu. They are regarded as symbols of the divine architect Viśvakarmā and the gift of the goddess Sarasvatī, the deity of learning and fine arts. Annually, in the month of September on the ninth day of the nine day festival called *navarātra*, the metal smiths worship their tools. The day is called Viśvakarmā day and on this day no craft work is undertaken. However, the excessive demand pressures of the commercial market resulting in dead lines for orders has led to the adoption of modern technological machinery at Svāmimalai. Dēvasena Sthapati and R. dhakrishna Sthapati at Svāmimalai told me (24.10.1991) that they used drillers, blowers and grinders. Lathes were only rarely used. This development is also to be found among the goldsmiths of Madurai who use machine cutting in the making of designs (Shanmuganathan, President of the goldsmiths association, Sōmasundaram and others at Madurai – 17.10.1991).

Brass, copper and tin scrap metals can be used for preparing the alloy. Arunajateśvara Sthapati at Kumbakonam informed me (23.10.1991) that they purchased brass in the open market at ₹ 100 per kilo. These days the government of India also provides brass and copper bars to the metal craftsmen on a 'quota' basis and the prices are almost the same as in the open market. The melted metals are purified by using a simple metal sieve. The bronze icon which is the final product, is polished with pure

lime juice which is cheap and locally available.

THE GRAMMAR OF METAL CRAFTS IN TAMIL NADU

The making of bronze icons for the purpose of temple rituals is a tradition that has its origins in the Chola period. Till the sixth-seventh centuries, the Buddhists and Jains had dominated religion and culture in South India. In terms of orthodox theory, both rejected idol worship and their concept of *śūnyatā* or 'emptiness' which underlay their philosophy of rejection, renunciation and asceticism were major deterrents to all fine arts and crafts. This was despite the fact that excavations at Nāgapattinam have unearthed some exquisite Buddhist bronzes and fine images of Jain Tirthankaras have also come to light. There was however no overt patronage of crafts, especially under Kalabra (Arabian kirg) rule. But with the overthrow of the heterodox faiths in the south, the period of the Pallava and Chōla kings ushered in the great temple building age and this was the golden age of South Indian bronzes. Since the installed deity in these temples was made of stone or granite, a smaller image was needed which could be taken out in ritual processions. This image called the *utsava mūrti* literally, 'festival idol' was made of bronze.

Not only the bronze icons but even the bronze (bell metal) bells, lamps and decorative plates and bowls, especially the bronze scrolls containing esoteric chants or prayers (*tagaḍu*) are closely associated with sacred rituals. Since these are linked to the deity and to temple rituals, their creation is also a sacred act for the craftsmen of Tamil Nāḍu. The techniques and textual injunctions for the metals craftsmen are embodied in ancient Sanskrit texts such as the *Sakalādhikāram* said to have been written by the mythological sage Agastya; *Mayanūl* (authorship unknown); *Vāstu Śāstram*, *Śilpa Śāstram* and the *Mānasāra*.²⁰ The authorship and chronology of all these texts are uncertain. The only exception is the *Mānasōllāsa* of the Chālukyan king Someśvara, written in the twelfth century which contains a detailed account of the technique to be followed in the circumscribed metal casting²¹.

What is very interesting in the case of the Tamil Nadu craftsmen is that their language Tamil is of Dravidian origin, while all these texts have been written in Sanskrit which is the language of the high tradition. Nevertheless I found the traditional craftsmen, especially those of the older generation, very conversant with these texts. In the case of these Tamil Nadu craftsmen, most of whom are illiterate, these *sastraic* or textual injunctions constitute a part of the oral tradition which gets passed from father to son. This includes the *dhyaṇa ślōkas* (meditation verse) which is in Sanskrit. It is the *dhyaṇa ślōka* describing the posture and attributes of the deity which provides the sculptor with the precise image of the icon. In a series of very complex calculations, the sculptor will multiply the required height of the image by the number 8 and then divide it by 12. The required height of the image is calculated by taking the length from the eyes to the waist of the main deity and then proportion the icon with this as the height. Alternately, the *nilabaḍi* or threshold of the sanctum sanctorum (*garbhagrha*) must be measured and the *utsava mūrti* should be exactly one-third of

its length. The craftsmen say that every bronze icon that is cast has a horoscope like any human being. They are born under particular constellations and have a definite life span. Sthapathi Shiv Shankaran in an interview made the remarkable statement that the sculptors of the old school could accurately calculate metal fatigue through traditional techniques and could state that the maximum life of a particular icon will be seventy or hundred years (28.10.1991 at Kumbakōnam). This statement of Shiva Shankara Sthapathi gets corroborated through the scientific analysis of metals. Bronze icons which involve a process of being coated by vandal mud or clay absorb into their system some of the corrosive elements present in the soil. These corrosive agents form a thin transparent layer over the bronze called edel patina which looks quite pleasing and gives it an enamel like appearance. The edel patina can be of a benevolent kind in which the bronze resists the evil effects of oxidation. But if the patina is malignant, and this malignancy can occur due to the excessive presence of copper salts such as chloride or sulphate, it can completely corrode the bronze image²². Although lacking in scientific knowledge of metallurgy, it is likely that the traditional metal craftsmen of Tamil Nāḍu like Shiv Shankaran are able to calculate the precise effects of this as a result of hereditary training.

Shiv Shankaran also stated that scripturally the auspicious time for casting an icon was determined by ascertaining the star of the buyer or of the patron (in the case of the temple being the consumer) and also the star of the place. For example, Kumbakonam, where Shiva Shankara Sthapathy lives and works has the special star 'tiruvōnam'. Secondly, the image should never be cast either on a Tuesday or a Sunday nor on the prathamā, the day following the full moon, nor on the amavasya, the day when it is totally dark, called the day of the new moon. The *śilpa śāstras* such as the *Sakalādhikāram* and the *Manasāra* also say that tithi (lunar day and time) aṁsam (auspicious signs), ādhayam (profit), virayam (loss) and yōni (direction) should also be taken into account before casting an idol. Since every image was unique and sacred, its installation was done by a special ceremony called 'nētra unmīlana' or 'jīvanōddhāra' literally, 'opening the eyes of the deity and thereby infusing it with life and divine grace.'

The metal craftsmen of Kumbakōnam and Svāmimalai tell me that today things have changed considerably. Traditional metal crafts is adjusting itself to changing consumer demands. A rough analysis of the general direction of trade in the metal craft industry of Tamil Nāḍu was possible on the basis of interviews with the Tanjore craftsmen and middlemen. Pumpuhar, the government owned cottage industries emporium makes bulk purchases from Svāmimalai and gets its supply of brass lamps from Nachchiyar koyil. The Sthapathis of Kumbakōnam like the proprietors of *Dēvi Śirpa Sālai* claimed that they had "excellent business", their main customers being foreign connoisseurs, Hindu temples in India and abroad and some commercial agencies. For example Arunajatesvaran told me that they were just working on a Trivikrama Viṣṇu commissioned by a private collector called Ernst W. Koelsperser from Munich. The five ft 400 kg. image would be paid a price of Rs. 15,000. Ganēshan another sculptor was preparing a Trimūrthy that is a composite image of the Hindu trinity

Brahmā, Viṣṇu and Śiva for the Thailand market. In the context of the internal market as well as the external market the thrust was towards giant images in bronze. Sculptor Ganesan was preparing a 10 foot Naṭarāja to be installed in a temple at Neyveli. Dēvasēna Stapathi had been commissioned to make a 20 foot Naṭarāja for the temple at Ganeshpuri ashram in Bombay by its American disciple David Crompton. (interviews at Kumbakonam and Svamimalai 23.10.1991 and 24.10.1991).

With the arrival of big money in metal crafts, traditional injunctions have necessarily to be ignored. Now-a-days as many of the Stapathis lament, idols are made, packaged and sent off to anonymous buyers, in a rush to meet the seasonal orders from abroad and from the Indian metropolitan cities. Thus the metal crafts of Tamil Nāḍu are flourishing today but by commercialising crafts. This is in total contravention of all that metal crafting and icon making has stood for in the culture and ethos of Tamil Nāḍu.

NOTES

- * This article besides using literary accounts and the oral traditions of craftsmen is also based on the extensive field work done in Tamil Nadu, especially Tanjavur and Tiruchchirapalli districts. The account of bronze casting and metal crafting in Svamimalai and Kumbakonam is the result of personal interviews with Arunajateswaran, Ganesan and Stapati Shiv Shankaran of Devi Sirpa Salai, Kumbakonam; Karunanidhi Stapati and Mohan Raj at Svamimalai and Ramaswami Stapati and Svaminata Pattar at Nachchiyar Koyil. To all of them I express my grateful thanks for all their help and cooperation.
1. *Viśvakarma Purāṇam*, Mackenzie Manuscripts, No. 72, Wilson collection, India Office Library, London.
 2. *South Indian Inscriptions* vol. XVII, No. 603, Tiruvarur, Nagapattinam taluq, Tanjavur district and *Annual Report of South Indian Epigraphy*, No. 479 of 1908 from Uyyakondan Tirumalai, Tiruchchirapalli taluq and district.
 3. Lal, B.B., *Ancient India*, No. 2, p. 104. Also see reference to Cosal, J.M.'s report on the Arikamedu excavations in Kuppuram, G, *Ancient Indian Mining, Metallurgy and Metal Industries*, two vols., Sundeeprakashan, New Delhi 1989, vol. I. pp. 94-95.
 4. Mahalingam, T.V., *Excavations in the Lower Kaveri Valley, Archaeological Survey of India*, Madras, 1975.
 5. Ghosh, A. *An Encyclopaedia of Indian Archaeology*, Munshiram Manoharlal, New Delhi, Two volumes, 1989, pp. 243-44; 392-93.
 6. I wish to express my gratitude to Prof. Y. Subbarayalu for drawing my attention towards these recent excavations which were undertaken between 1987 and 1989 by the Tanjavur Tamil university.
 7. Lal, B.B., 'Chemical Analysis of Copper and Bronze Objects from Brahmagiri', *Ancient India*, 1947-48. and Alchin R. and Alchin B., *The Birth of Indian Civilization*, Penguin, London, 1968.
 8. *Puram Nānūru*, ed. Svaminatha Iyer, U.V., Madras, 1956, Stanza: 25.
 9. *Mullaippattu*, stanza 48 cited in Velusami S., *Tamil Nagarigattil Irumbin Pangu* (in Tamil), ed. R. Nagasamy, published by Varalatu Peravai, Madras, 1979, p. 201.
 10. Rea, Alexander, *Catalogue of the Prehistoric Antiquities from Adichchanallur and Perumbalur*, Madras Government Museum, Madras, 1915; Paramasivan, S., "Adichchanallur Bronze" in *Proceedings of the Indian Science Congress* vol. XIII, 1933, No. 2, Sec. A cited in Kuppuram, *Op. cit.*, vol. I, p. 104.

11. Brecks, J.W., *An Account of the Primitive Tribes and Monuments of the Nilgiris*, London, 1837, especially Appendix C: 126-137.
12. *Perumpanatruppadi*, 199-200 and 206 in *Pattuppattu*, ed. Somasundaranar, P.V., Saiva Siddhanta Kazhagam, Tirunelveli, 1971.
13. *Peruṅṅadai* cited in Velusami S, *op. cit.*, p. 108.
14. Buchanan Hamilton, F., *A Journey from Madras Through the Countries of Mysore, Canara and Malabar*, Two vols., London, 1807. See vol. I, section on mining in the Salem district for an 18th-19th century account of the process.
15. Harinarayana, N., 'Bronze Casting' in *Decorative Arts of India*, ed. M.L. Nigam, Salar Jung Museum, Hyderabad, 1988.
16. Kuppuram, G., *op. cit.*, vol. I, pp. 98-99.
17. *Nāchchiyār Tirumōḷi* of Andal (seventh century), stanza X, in Hardy, Friedhelm, *Viraha Bhakri: The Early History of Krishna Devotion In South India*, Oxford University Press, Oxford, 1983, p. 423.
18. Sivaramamurthy, C., 'South Indian Bronzes' in *Marg*, vol. 33, pp. 56-72, 1979-80, p. 57.
19. *Ibid.* p. 58. See also Sivaramamurthy, C., *South Indian Bronzes*, Lalit Kala Academy, India, New Delhi, 1963, pp. 44-68.
20. *Mānasāra* ed. with critical notes by Prasanna Kumar Acharya, Munshiram Manoharlal, New Delhi, reprint, 1976 (original edition O.U.P., London, 1935; *Sakalādhikāra mss.*, Saraswati Mahal Library, Tanjavur; *Viśvakarma Vāstu Sāstra*, ed. K. Vasudeva Sastri, Saraswati Mahal Library, Tanjavur, 1990, A palm leaf manuscript of the *Mayanul* (in Tamil) is to be found in the India Office Library, London, (N.D.).
21. *Mānasollasa*, ed. Shrigondekar, Gaikwad Oriental Series, Baroda, 1939.
22. Kuppuram, G, *op. cit.*, vol. I, p. III.